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How Economic Growth Reduces Poverty

A General Equilibrium Analysis for Indonesia

George Fane and Peter Warr*

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Abstract

Do changes in poverty and inequality depend directly on the rate of economic growth, or does the source of the growth also matter? This paper uses a computable general equilibrium model of the Indonesian economy to explore this question by simulating increases in GDP arising from (i) technical progress in each of seven broad sectors, and (ii) the accumulation of each of six types of physical and human capital. The more a given amount of growth raises the returns to the factors that are more important sources of income for the poor than for the non-poor, the more it reduces poverty and inequality. Different sources of growth affect poverty and inequality differently because they affect factor returns differently, and because the poor and the non-poor own factors in different proportions.

Keywords: poverty, inequality, growth, Indonesia

JEL classification: D58, I32, O53

*Australian National University

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UNU World Institute for Development Economics Research (UNU/WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

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1. Introduction

Many studies have examined the relationship between the rate at which poverty declines over time and the rate of growth of real GDP. These studies indicate a strong statistical correlation between these two variables, but find that the quantitative relationship between them varies across countries and over time (e.g. World Bank 2000, Dollar and Kraay 2000). A frequent criticism of this type of study is that both the growth of real output and poverty reduction are endogenously determined within a general equilibrium framework and stable relationships between endogenous variables do not generally exist. This type of reasoning has spawned a large literature on the 'quality of growth', which investigates whether the impact that growth has on the poor depends on such factors as which sectors (such as agriculture, industry or services) expand (e.g. Ravallion and Datt 1996), as well as on the government's redistributive policies (e.g. Thomas 2000).

This paper investigates the determinants of poverty reduction in less-developed countries from a different perspective. It focuses on the variables that lie behind the poverty reduction / economic growth correlation by studying the way poverty reduction is linked to the exogenous factors driving the growth of GDP and its composition. The significance of this approach is that it does not assume that the effects these variables have on poverty operate solely through their effects on economic growth. Consider the reduced form equation for the percentage increase in GDP:

$$\Delta y = \Delta X \alpha, \tag{1}$$

where Δ denotes the difference operator, y is the logarithm of GDP, X is a vector of K exogenous variables and α is a vector of K reduced form coefficients. Similarly, the reduced form equation for the increase in some chosen index of poverty—for example, the headcount rate, p, relative to some given poverty line—can be written as:

$$\Delta p = \Delta X \beta, \tag{2}$$

where ΔX is defined above and β is again a vector of K coefficients. In this paper, the 'quality of GDP growth' derived from changes in exogenous variable i is defined to be the amount by which one unit of growth derived from exogenous variable i contributes to poverty reduction:

$$\phi_i = -\beta_i / \alpha_i . \tag{3}$$

If the K exogenous variables are numbered so that $\phi_1 \geq \phi_2 \geq \phi_3 \geq \ldots \geq \phi_K$, then variable 1 produces the highest quality growth, in the sense that a given increase in GDP due to an increase in variable 1 reduces poverty by more than the same increase in GDP due to an increase in any other exogenous variable, while variable K produces the lowest quality growth. If the only exogenous variable to change is variable i, the elasticity of poverty with respect to GDP is $-\phi_i . y/p$. Estimates of these elasticities are reported below for various exogenous sources of growth. With the signs changed, they are indicators of the 'quality' of growth derived from each source.

A stable relationship between increases in GDP and reductions in poverty will only exist under special and implausible assumptions—for example, that $\phi_i = \phi$ for all *i*, or that the exogenous variables always change by the same proportions. If these conditions do not hold, the relationship between poverty reduction and growth in any actual change will depend on the relative importance of 'high quality' and 'low quality' factors in generating the observed change in GDP.

If the poor and the rest of the population owned factors in the same proportions, then changes in factor returns would obviously have no effects on relative incomes and inequality. Whatever the source of growth, each person's income would rise or fall by the same proportion as each other person's, and all sources of growth would therefore have the same quality. In Indonesia, however, unskilled labour makes up a much larger share of the incomes of the poor than of the rest of the population, while skilled labour makes up a much smaller share of the incomes of the poor than of the rest of the population. Inequality is therefore reduced, and the quality of growth is relatively high, for types of growth that raise the returns to unskilled labour (and other factors that account for a relatively large share of the incomes of the poor), or that reduce the returns to skilled labour (and other factors that are a relatively small share of the incomes of the poor).

2. The WAYANG Model[1]

The simulation results reported in this paper are derived from the WAYANG model of the Indonesian economy (Warr *et al.* 1998, Wittwer 1999, Warr and Wittwer 2002). WAYANG shares many structural features with the ORANI general equilibrium model of the Australian economy (Dixon *et al.* 1982), although these features have been adapted to match the realities of the Indonesian economy. It assumes competitive profit maximisation by firms and competitive utility maximisation by consumers.

A major advantage of the WAYANG model for analysing poverty is that it contains ten broad household groups—seven rural and three urban—that are differentiated by socio-economic characteristics. The income of each of these household groups depends on its (exogenous) ownership of factors of production, the (endogenous) rates of return to these factors, and any net transfers from elsewhere in the system. Ownership of factors of production for each broad household group is derived from the official 1993 Social Accounting Matrix. Section 3 explains how the broad household groups distinguished by the basic model can be disaggregated to the level of individual households, so that estimates of poverty and inequality for Indonesia can be derived from estimates of the incomes and expenditures of the 10 broad groups, and the distribution of income within each broad group.

[1] Wittwer (1999) describes the technical features of the full model in detail.

2.1 Sectors and commodities

The model contains 65 producer goods and services produced by 65 corresponding sectors. There are 18 agricultural sectors, 5 resource sectors, 9 agricultural processing sectors, 18 manufacturing sectors and 15 service sectors. These sectors are classified as either ‘export-oriented’ or ‘import-competing’. The level of exports of an export-oriented sector are treated as being endogenous, while the exports of an import-competing sector are treated as being exogenous.[2] The criterion used to classify sectors is the ratio of imports to exports.

The 65 composite commodities can be sold to five different types of users: producers, investors, households, the government and the rest of the world. Composite commodities come from two sources, domestic production and imports. The proportions in which users purchase domestically produced and imported producer goods of each kind depend on their relative prices and on Armington elasticities of substitution.

2.2 Production

The model distinguishes four mobile factors: ‘skilled labour’, ‘unskilled labour’, ‘mobile agricultural capital’ and ‘mobile non-agricultural capital’. It is assumed that mobile agricultural capital is fully mobile across agricultural sectors, but cannot be used outside agriculture. Similarly, mobile non-agricultural capital cannot be used in agriculture, but is fully mobile across non-agricultural sectors.

The two types of labour are distinguished by the educational characteristics of the workforce: skilled labour is defined as those workers with lower secondary education, or more. Unskilled labour, which is defined residually, is assumed to be mobile across the entire economy. Since Indonesian labour force data indicate that very little educated labour is used in agriculture, it is assumed that no skilled labour is employed in agriculture, but that skilled labour is fully mobile across all non-agricultural sectors. These assumptions imply that unskilled wages must be equal in all sectors and that skilled wages must be equal in all non-agricultural sectors. In every sector, it is assumed that there are diminishing returns to scale to mobile factors alone. However, a sector-specific fixed factor is introduced in every sector to assure that there are constant returns to scale in production to all factors. The set of specific factors in the agricultural sectors is referred to as ‘land’, and the set of those in the non-agricultural sectors as ‘fixed capital’.

In each non-agricultural sector, skilled and unskilled labour enter a constant elasticity of substitution (CES) production function to produce ‘effective labour’. Effective labour, mobile non-agricultural capital and the sector specific fixed capital then enter the sector’s production function for domestic output. The structure of production is agricultural sectors is the exactly analogous, except that effective labour in agriculture is simply unskilled labour. Factor demand

[2] Given that the exported and domestically sold good are treated as being identical, this assumption is necessary to make it possible to separate the domestic price of the import competing good from the price of the exported good. Otherwise, the Armington structure described above would be redundant.

equations, derived from the CES production functions, relate the demand for each primary factor to sectoral outputs and the prices of each of the primary factors. The assumption of constant returns means that all factor demand functions are homogeneous of degree one in domestic output. In each sector, there is a zero profit condition, which equates the price of domestic output to the minimum unit cost of production. This condition can be thought of determining the prices of the fixed factors.

The demand for 'composite' intermediate inputs by each sector is determined by the Leontief assumption that they are required in fixed proportions to gross output. Composite intermediate inputs are produced under Armington assumptions from domestic and imported intermediate inputs.

2.3 Consumption and labour supply

Household consumption demands for each composite commodity are derived from the linear expenditure system (LES). The composite consumption commodities are produced under Armington assumptions from imported and domestic products. The household supplies of skilled and unskilled labour are assumed to be exogenous. The LES assumption that each individual household's spending on each good is a linear function of its income reconciles, on the one hand, the model's treatment of each of the ten broad household groups as if it were an individual whose income was equal to the total income of that group with, on the other hand, the assumption that each of the ten broad household groups actually comprises a large number of individual households. Without the LES assumption, the consumption of each household group would depend on the distribution of individual incomes within that household group, as well as on the average income for that household group.

2.4 Elasticity estimates

The elasticity estimates used in WAYANG for the consumer demand system and the factor demand system were taken from empirical estimates derived econometrically for a similar model of the Thai economy, known as PARA. These parameters were amended to match the differences between the data bases for WAYANG and PARA so as to ensure the homogeneity properties required by economic theory. All export demand elasticities were set equal to minus 20. In the basic runs of the model, the Armington elasticities of substitution between imports and domestically produced goods were set equal to 2 and the constant elasticities of substitution among the primary factors of production were all set equal to unity. Section 4 reports tests of the sensitivity of the simulation results to large changes in these assumptions.

2.5 Closure

The two main closure issues relate to: (i) balancing the government budget, and (ii) determining government spending, investment and the current account balance. This paper uses a 'long-run growth closure': the real value of the government budget balance, real government spending, real investment and the current account balance expressed in foreign currency are all made directly proportional to GDP. This treatment is more appropriate in the context of simulations that compare the distributional effects of various sources of long-run growth than the conventional 'welfare closure' in which the real values of these variables are assumed to remain constant. If government spending, investment and the current account balance were held constant, factor accumulation and technical progress would have to be used purely to generate additional consumption, and in some cases this would require large changes in factor and product prices.

The income tax rate is endogenously adjusted to balance the government's budget. Experiments which allowed the rate of value added tax to adjust endogenously indicated that the results are not sensitive to the choice between these alternative closures.[3]

3. Measuring and modeling poverty and inequality

This section explains the way changes in poverty and inequality, at the level of individual households, are estimated from changes in income and expenditure for broad household groups. The measures of Indonesian poverty and inequality used here are based on household expenditure because this is how the official Indonesian data on poverty are derived. However, since consumption is assumed to be directly proportional to after-tax income, the choice between income and expenditure based poverty measures is unimportant.

The Gini coefficient is used to measure inequality. Two familiar measures of poverty are reported: the 'headcount' rate, defined as the proportion of the population below the poverty line and the 'poverty gap', defined as the proportion of total national consumption that would just suffice (if provided by an external donor at unchanged prices and given other sources and uses of income) to raise the consumption of those below the poverty line to the poverty line.

It is assumed that, while households belonging to different groups may own factors in different proportions, those belonging to any one group all own the various factors of production in the same proportions:

$$F_k^{h,j} = \theta^{h,j}.F_k^h, \quad \textit{for all } h, j \textit{ and } k, \tag{4}$$

where $F_k^{h,j}$ is the amount of factor k owned by individual household j in household group h and F_k^h is the arithmetic mean over j of $F_k^{h,j}$ for all households in group h. Taking expectations in equation (4) shows that the arithmetic mean of $\theta^{h,j}$ over j for all households in group h is unity.

Let w_k be the price of factor k and assume that the total expenditure of each individual household in household group h is a fraction γ_h of pre-tax income:

[3] The reason is that large endogenous changes in tax rates are never needed, since the long-run growth closure constrains government expenditure to be exactly proportional to GDP and the main revenue items turn out to be nearly proportional to GDP at fixed tax rates.

$$E^{h,j} = \gamma_h . \sum_k w_k \theta^{h,j} F_k^h = \theta^{h,j} \gamma_h . \sum_k w_k F_k^h = \theta^{h,j} E^h . \quad (5)$$

The first equality in (5) is definitional. The second can be derived by taking expectations in the first and recalling that E^h is the arithmetic mean of $E^{h,j}$ over j and that the arithmetic mean of $\theta^{h,j}$ over j is unity.

For each broad household group h, $\theta^{h,j}$ is assumed to be log normally distributed over j with mean μ_h and standard deviation σ_h. Equation (5) shows that although factor prices affect the mean of the logarithm of household expenditures, they do not affect the standard deviation of the *logarithm* of individual household expenditures. It is therefore appropriate to assume that σ_h remains constant throughout all the simulations. From the assumption of log normality, it follows that:[4]

$$\mu_h = \log_e[AM_j(\theta^{h,j})] - 0.5\sigma_h^2 = -0.5\sigma_h^2 \quad (6)$$

where $AM_j(\theta^{h,j})$ is the arithmetic mean over j of $\theta^{h,j}$. Since this mean is unity, its logarithm is zero. The parameter σ_h was estimated separately for urban and rural households by searching for the values that replicate official national estimates of the headcount poverty rate and the Gini coefficient. Equation (6) makes it possible to derive μ_h from σ_h. Since the values of E^h before and after various shocks are given by the WAYANG model, equation (5) can be used to derive the distributions of individual household expenditures within each of the 10 broad groups. It is then straightforward to estimate how the shocks affect poverty and inequality at the national level.[5]

Table 1 summarises the basic data on household incomes, poverty incidence and inequality. The seven rural households account for 73 percent of the total population, but only 61 percent of total consumption expenditure. The four poorest household groups, measured in terms of average expenditure, are all rural. However, since it is assumed that factor ownership, and hence income, is log normally distributed within each household group, it follows that some members of each group are below the poverty line, and in fact poverty incidence is higher in the poorest urban household than in all but one of the rural households. Nevertheless, poverty is mainly a rural phenomenon: 77 percent of all poor households in Indonesia are rural.

Table 2 shows the proportions in which each household group derives income from the ownership of various factors as a proportion of its net income after all transfers and after payment of income tax. Unskilled labour is the single most important income source for the

[4] The first equality in (6) is an application of a well-known property of the lognormal distribution. See Aitchison and Brown (1957).

[5] A spreadsheet was used to approximate the lognormal distribution by dividing households in each broad group into over 200 subgroups defined in terms of narrow income bands. The proportion of all Indonesian households within each narrow income band was then estimated. Given these proportions, it was straightforward to derive the headcount poverty rate, the poverty gap and the Gini coefficient.

Table 1
Expenditure and poverty incidence by household group

Household group	% of total population in this group	Mean per capita expenditure (1993 Rp000/year)	% of this group in poverty	% of all poor people in this group
Rural 1	10.0	456	38.9	28.9
Rural 2	27.3	625	15.1	30.9
Rural 3	6.2	687	10.5	4.9
Rural 4	6.4	1011	1.5	0.7
Rural 5	8.8	610	16.5	10.9
Rural 6	1.5	1219	0.5	0.1
Rural 7	13.0	1268	0.3	0.3
Urban 1	12.4	789	21.3	19.7
Urban 2	2.6	916	15.4	2.9
Urban 3	11.8	2336	0.8	0.7
Indonesia	100.0	957	13.4	100.0
Memo items:				
Poverty line (1993 Rp000 per year)				369.5
Headcount poverty rate (%)				13.4
Poverty gap (%)				1.1
Gini coefficient (%)				39.6

Source: database of WAYANG model.

Table 2
Factor ownership of the broad household groups

Shares in household income (%):	Unskilled labour	Skilled labour	Mobile agric. capital	Mobile non-agric. capital	Fixed capital	Land
Rural 1	83.7	1.9	3.5	5.1	3.3	3.6
Rural 2	40.4	5.5	2.3	11.0	29.6	20.0
Rural 3	49.7	4.9	1.5	8.0	27.0	17.7
Rural 4	56.7	5.8	0.9	6.9	16.4	11.9
Rural 5	25.0	22.7	1.2	8.8	20.8	8.5
Rural 6	12.2	5.6	2.9	21.6	51.1	4.2
Rural 7	38.7	34.0	1.1	9.1	24.2	5.8
Urban 1	10.4	22.2	2.0	16.3	53.3	4.2
Urban 2	17.0	15.0	2.2	18.3	47.7	6.6
Urban 3	13.2	38.3	1.3	10.8	38.2	1.9
All poor households	45.0	10.2	2.4	10.0	26.1	10.2
All households	27.8	24.6	1.6	11.0	33.4	7.0
Ratio, poor households to all	1.62	0.41	1.50	0.92	0.78	1.45

Source: poverty sub-model estimates and database of WAYANG model.

Notes: For each household group, the shares do not add to 100 percent, because, in addition to the listed factors, households also pay out, or receive, net transfers from other households, the government and the rest of the world. The proportions for all poor households are obtained by weighting the proportions for each household group by the Table 1 estimates of the proportion of all poor people that are in that group.

four poorest rural household groups (that is rural 1, 2, 3 and 5), which together account for 76 of total poverty. Land is an important income source for rural household groups 2 and 3, which together account for over a third of all poverty. Capital that is mobile within the agricultural sector is a relatively minor source of income for all households, but its ownership is heavily concentrated in the poorest households. Unskilled labour, mobile agricultural capital and land are the factors with the greatest relative importance for the poor, while for the non-poor the corresponding factor is skilled labour. Fixed capital and mobile non-agricultural capital are slightly more important sources of income for the non-poor than for the poor.

4. The simulations

4.1 The shocks

Table 3 reports the effects of Hicks neutral productivity increases in various broad sectors. The results are reported as ‘elasticities’ of variables with respect to GDP. Since GDP is endogenous, these elasticities are the ratios of the percentage changes in the variables listed in each row to the percentage change in GDP in the simulation indicated in each column. Table 4 reports the effects of increases in the supplies of seven groups of factors. Since aggregate factor supplies are defined to be the sum across households of household factor endowments, these shocks are exogenous shocks to household factor endowments. The identity between the effects of shocks TFP1 and F1 provides a computational check on the model: the uniform increase in productivity in all sectors needed to raise GDP by 1 percent is equivalent to the uniform increase in all factor supplies needed to raise GDP by 1 percent.

Table 3
Elasticities with respect to GDP derived from Hicks neutral technical progress in broad economic sectors[a]

	TFP1	TFP2	TFP3	TFP4	TFP5	TFP6	TFP7	TFP8
Shock:	All sectors	Manufact.	Services	Nat. resources	Agric. processin	Agric.	Export agric.	Other agric.
Headcount poverty	–4.33	–3.51	–5.91	–3.31	–2.90	–1.46	–2.40	–1.10
Poverty gap	–6.40	–5.93	–8.16	–5.44	–4.85	–3.49	–4.49	–3.12
Gini coefficient	–0.03	0.41	–0.55	0.23	0.36	0.97	0.61	1.10
Skilled real wages	0.90	3.57	–1.64	1.80	3.99	4.96	3.66	5.43
Unskilled real wages	1.01	0.38	1.54	0.36	0.63	0.58	0.45	0.62
Real land rent, agric.	1.40	1.18	2.68	0.88	4.14	–4.14	–1.08	–5.28
Real rent, mobile capital agric.	1.31	1.07	2.60	0.86	3.36	–3.96	–1.01	–5.06
Real rent, fixed capital, non-agric.	0.83	0.17	0.59	0.80	0.73	2.59	1.57	2.96
Real rent, mobile capital, non-agric.	0.82	–0.57	1.27	–0.40	–0.21	2.57	1.57	2.94

Source: WAYANG model estimates.

Note: [a]The magnitude of each shock (e.g., Hicks neutral technical progress in manufacturing, with all other exogenous variables held constant) is endogenously determined to produce an increase in GDP of 1 percent. The elasticities reported in the table are the resulting percentage changes in the variables indicated.

Tables 3 and 4 confirm that balanced increases in supply (TFP1, F1) have very little effect on inequality, as measured by the Gini coefficient. What little effect there is comes from changes in the structure of demand as real incomes rise. However, when factor accumulation or technical change is not uniform, inequality sometimes rises and sometimes falls substantially, and there are correspondingly wide differences in the estimated qualities of growth resulting from different sources. Nevertheless—in conformity with the results found by Dollar and Kraay (2000) using actual data for developing countries—'growth is good for the poor' in all the simulations described here.

Table 4
Elasticities with respect to GDP derived from accumulation of factors of production[a]

Shock	F1 All factors	F2 Skilled Labour	F3 Unskilled labour	F4 Land	F5 Mobile capital, agric.	F6 Fixed capital, non-agric.	F7 Mobile capital, non-agric.
Headcount poverty	–4.33	–7.65	–2.51	–1.46	–1.61	–4.41	–3.63
Poverty gap	–6.40	–10.12	–4.56	–3.50	–3.67	–6.52	–5.90
Gini coefficient	–0.03	–1.11	0.63	0.97	0.92	–0.06	0.21
Skilled real wages	0.90	–4.46	4.00	4.94	4.85	0.89	2.48
Unskilled real wages	1.01	2.70	–0.34	0.59	0.69	1.05	0.52
Real land rents, agric.	1.40	3.11	0.26	–4.16	–3.70	2.11	1.94
Real rent, mobile capital, agriculture	1.31	3.00	0.24	–3.92	–5.56	1.96	1.80
Real rent, fixed capital, non-agriculture	0.83	0.45	1.12	2.60	2.48	0.60	0.45
Real rent, mobile capital, non-agriculture	0.82	1.47	0.62	2.57	2.49	0.46	–0.27

Source: WAYANG model estimates.

Note: [a] The magnitude of each shock (e.g., an increase in the supply of unskilled labour, with the population and all other exogenous variables held constant) is endogenously determined to produce an increase in GDP of 1 percent. The elasticities reported in the table are the percentage changes in the variables indicated.

Tables 3 and 4 are consistent with the proposition noted earlier: when growth is associated with a rise in the returns to factors owned intensively by poor, relative to the non-poor, it is associated with a fall in inequality. Agriculture is the exclusive user of two factors that are relatively important sources of income for the poor—land and mobile agricultural capital. Technical progress in agriculture releases these factors and drives down their prices. Agriculture is also a relatively intensive user of unskilled labour, but does not use skilled labour. Technical progress in agriculture therefore raises the wage of skilled labour relative to that of unskilled labour. For these reasons, technical progress in agriculture raises inequality and provides relatively small benefits to the poor. In the case of export-competing agriculture, these effects are muted by the opportunity to export additional output. However, the effects are particularly marked in the case of import-competing agriculture, which is dominated by rice growing. Since imports of rice in the base data are very small, most of any increase in output must be consumed domestically. Technical progress in rice growing therefore drives down the prices of rice and of the factors used intensively in producing it. A 1 percent increase in GDP due to technical progress in import-competing agriculture (TFP8) therefore raises the Gini coefficient by more, and reduces poverty by less, than the same amount of growth produced by technical progress in any other broad sector.

Services are at the opposite extreme to import-competing agriculture: a 1 percent increase in GDP due to technical progress in services (TFP2) reduces the Gini coefficient and both poverty measures by more than the same amount of growth induced by technical progress in any other broad sector. Because the service sector is a relatively intensive user of skilled labour, technical progress in services releases skilled labour and drives down its price. Because skilled labour is a relatively unimportant source of income for the poor, a 1 percent rise in GDP that involves a substantial fall in the wages of skilled labour tends to reduce inequality.

In the case of the factor accumulation simulations, the most extreme divergence is between a 1 percent rise in GDP due to the accumulation of skilled labour (F2)—which reduces the Gini coefficient, the headcount poverty rate and the poverty gap by 1.1 percent, 7.7 percent and 10.1 percent, respectively—and the same growth due to the accumulation of land (F4)—which raises the Gini coefficient by 1.0 percent, reduces the headcount rate by 1.5 percent, and the poverty gap by 3.5 percent. The explanation for these results is that the accumulation of skilled labour raises the wages of unskilled labour and reduces the wages of skilled labour itself, while the accumulation of land has a relatively large positive effect on skilled wages and relatively little effect on unskilled wages.

Factor accumulation depresses the real return to the factor being accumulated and raises the returns to other factors. Table 4 shows that, with one exception, these price effects outweigh the quantity effects: the accumulation of any one factor generally reduces the real returns to that factor. The one exception to this generalisation is fixed capital outside the agricultural sector. As a result, the accumulation of factors that are relatively more important income sources for the poor than the non-poor—such as unskilled labour, mobile agricultural capital and land—raises inequality and provides relatively small benefits to the poor, while the accumulation of skilled labour, which is the relatively least important source of income for the poor, reduces inequality and produces high quality growth.

4.2 Sensitivity analysis

A sensitivity analysis was conducted by raising the elasticity of substitution among the primary factors from one to two and the Armington elasticities of substitution between domestic and imported commodities from two to ten. In Table 5, the top rows for each variable reproduce the results in Table 3, while the bottom rows for each show the new results implied by the higher elasticities.

Under the elasticity assumptions on which Table 3 is based, both the headcount and poverty gap measures, 1 percent GDP growth is more effective in reducing poverty if it is due to technical progress in services than if it is due to technical progress in any other sector. In second place is technical progress in manufacturing, followed by natural resources, agricultural processing, export-competing agriculture and, in last place, import-competing agriculture. The same ordering of sectors also applies to reductions in inequality. Table 5 shows that all these results are robust with respect to the large increases in elasticities of substitution among factors and commodities that are analysed here.

Table 5
Sensitivity analysis: elasticities with respect to GDP derived from Hicks neutral technical progress in broad economic sectors under alternative parameter assumptions[a]

Shock:	Elasticities		TFP1	TFP2	TFP3	TFP4	TFP5	TFP6	TFP7	TFP8
	σ	*Arm*	All sectors	Manufact.	Serv.	Nat. res.	Agric. proc.	Agric.	Export agric.	Import agric.
Headcount poverty	1	2	–4.33	–3.51	–5.91	–3.31	–2.90	–1.46	–2.40	–1.10
	2	10	–4.29	–3.70	–5.42	–3.44	–3.19	–2.55	–3.14	–2.33
Poverty gap	1	2	–6.40	–5.93	–8.16	–5.44	–4.85	–3.49	–4.49	–3.12
	2	10	–6.37	–6.24	–7.67	–5.52	–5.20	–4.70	–5.29	–4.48
Gini coefficient	1	2	–0.03	0.41	–0.55	0.23	0.36	0.97	0.61	1.10
	2	10	–0.01	0.41	–0.35	0.10	0.21	0.57	0.30	0.67
Skilled real wages	1	2	0.90	3.57	–1.64	1.80	3.99	4.96	3.66	5.43
	2	10	0.93	3.10	–0.71	1.04	2.76	3.68	2.58	4.09
Unskilled real wages	1	2	1.01	0.38	1.54	0.36	0.63	0.58	0.45	0.62
	2	10	1.03	0.25	1.37	0.70	0.96	0.98	0.91	1.00
Real land rent, agric.	1	2	1.40	1.18	2.68	0.88	4.14	–4.14	–1.09	–5.28
	2	10	1.23	0.53	1.84	0.58	2.96	–0.59	1.09	–1.22
Real rent, mobile cap., agric.	1	2	1.31	1.07	2.60	0.86	3.36	–3.96	–1.01	–5.06
	2	10	1.18	0.44	1.77	0.56	2.48	–0.29	1.37	–0.92
Real rent, fixed cap., non-agric.	1	2	0.83	0.17	0.59	0.80	0.73	2.59	1.57	2.96
	2	10	0.92	0.68	0.65	1.01	1.05	2.05	1.32	2.32
Real rent, mobile cap., non-agric.	1	2	0.82	–0.57	1.27	–0.40	–0.21	2.57	1.57	2.94
	2	10	0.92	0.52	1.05	0.09	0.59	1.99	1.32	2.24

Source: WAYANG model estimates.

Note: [a]For each variable, the elasticity estimates in the first row for each variable are those given in Table 3 and are derived on the assumption that σ = 1 and *Arm* = 2, where σ is the elasticity of substitution among primary and intermediate inputs and *Arm* is the Armington elasticity of substitution between domestic and imported goods. The estimates in the second row for each variable are derived on the alternative assumption that σ = 2 and *Arm* = 10.

Although assuming higher elasticities of substitution does not alter the *ordering* of sectors by quality of growth, it does substantially reduce the *disparities* among sectors. For sectors in which technical progress sufficient to raise GDP by 1 percent reduces poverty (on either measure) by *more* than the uniform economy-wide technical progress that produces the same total growth, the reduction in poverty is *less* under the high elasticity assumptions than under the low elasticity assumptions. Similarly, for sectors in which technical progress sufficient to raise GDP by 1 percent reduces poverty by *less* than the uniform economy-wide technical progress that produces the same total growth, the reduction in poverty is *more* under the high elasticity assumptions than under the low elasticity assumptions. Table 5 also shows that an exactly analogous result holds for the relative effects of sectoral technical progress on inequality.

The explanation for all the results summarised in the preceding paragraph is that the higher the elasticities of substitution among goods and factors, the smaller (in absolute terms) are the changes in relative factor prices needed to restore equilibrium in response to technical progress in any one sector. The smaller the changes in relative factor prices, the more equally (in proportionate terms) is an any given increase in GDP shared among all households.

5. Conclusion

The results and methodology reported here suggest that large oversimplifications are involved in relating poverty reduction directly to GDP growth, without distinguishing among different possible sources of growth. Contrary to the implicit assumptions of many commentators, the poor do much better if a given amount of GDP growth is produced by technical progress in services, or manufacturing, than if it is due to technical progress in agriculture. Although more work needs to be done to improve on the parameter values assumed in this study, these qualitative results are robust with respect to wide variations in assumptions about elasticities of substitution among goods and factors.

The results also imply that growth in broad sectors—agriculture, manufacturing, services, etc.—will be associated with very different effects on poverty and inequality depending on whether the exogenous shocks affect demand or supply. For example, an increase in the supply of factors used intensively in agriculture depresses the real returns to these factors while raising agricultural output; whereas an increase in demand for agricultural products, perhaps due to policy changes, would raise both agricultural output and the real returns to the factors used intensively in agriculture.

Another important implication of the results found here is that education—modelled as the conversion of unskilled labour into skilled labour—is a *doubly* effective way of reducing poverty: besides its obvious direct effects on the incomes of those receiving education, the increase in the supply of skilled labour and the reduction in the supply of unskilled labour both help to reduce poverty by raising the wage bill of the remaining unskilled workers.

References

Aitchison, J. and J.A.C. Brown (1957) *The Lognormal Distribution, with Special Reference to its Uses in Economics,* Cambridge University Press: Cambridge.

Dixon, P.B., B.R. Parmenter, J. Sutton and D.P. Vincent (1982) *ORANI: A Multisectoral Model of The Australian Economy*, North-Holland: Amsterdam.

Dollar, D. and A. Kraay (2000) ‘Growth *Is* Good for the Poor’, mimeo, available online at: www.worldbank.org/poverty, World Bank: Washington DC.

Ravallion, M. and G. Datt (1996) ‘How Important to India’s Poor Is the Sectoral Composition of Economic Growth?’, *World Bank Economic Review* 10:1–25.

Thomas, V. (2000) *The Quality of Growth*, World Bank: Washington DC.

Warr, P.G., M. Aziz, H. da Costa and P. J. Thapa (1998) ‘WAYANG: An Empirically-Based Applied General Equilibrium Model of the Indonesian Economy’, mimeo, Australian National University: Canberra.

Warr, P.G. and G. Wittwer (2002) *Policy, Inequality and Poverty in Indonesia: A General Equilibrium Analysis*, forthcoming, Edward Elgar: Cheltenham and Northampton.

Wittwer, G. (1999) ‘WAYANG: A General Equilibrium Model Adapted for the Indonesian Economy’, Centre for International Economic Studies, University of Adelaide, prepared for ACIAR project number 9449, available online at: www.adelaide.edu.au/cies/indlist.htm.

World Bank (2000) *World Development Report, 2000/2001*, Oxford University Press: New York.