

Why Does Agricultural Growth Dominate Poverty Reduction in Low- and Middle-income Countries?

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“Alternative models have to compete on the basis of their ability to give a satisfying account of some facts. Facts ask for explanations, and explanations ask for new facts”.

Robert M. Solow, *Daedalus* (Fall 2005)

This paper provides an explanation of the relation between agricultural growth and poverty reduction for open economies with full employment. The analysis also shows that the poverty-reducing impact of agricultural growth in an open economy is far greater if there is unemployed labour or if the supply of labour is highly elastic—conditions often thought to prevail even in open economies. The model draws attention to the critical role of the rural non-tradable sector in poverty reduction. While ample data are available to show that sector to have a large share of employment, even relative to agriculture itself, data for other variables for the sector such as the share of GDP, labour intensity, price, and income elasticities of demand are not available. Thus, an important contribution of the paper is to establish the need for such data if the processes of poverty reduction are to be understood.

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INTRODUCTION

As early as the 1970s, analysis of the Indian National Sample Survey data showed change in agricultural productivity as the primary cause of change in the proportion of the population falling under the defined poverty line [Ahluwalia (1978), Narain as reported in Mellor and Desai (1985)]. That relation is counter intuitive since peasants in low-income countries are generally not among the absolute poor, and, in technology driven, rapid agricultural growth employment directly in agriculture is inelastic with respect to output [Rao (1975)].¹

However, two processes by which increased income of farmers are transmitted to the poor were offered. They both applied to a closed economy in which food prices

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¹The view of peasants falling under the absolute poverty line comes from including as peasants all persons with farmland, irrespective of how they earn their living. For example in the smallholder dominated Altiplano of Guatemala it requires 1 hectare of land to provide minimum food intake for a family and 1 ¼ hectare to meet the \$1 per day poverty line. Forty four percent of landholders have less than 0.5 hectare, controlling less than 10 percent of the land [Instituto Nacional de Estadística (2004)]. Survival requires the bulk of income to come from off the farm; they are peasants in neither employment nor income source.

respond primarily to domestic agricultural production. First, a decline in food prices causes an immediate increase in the real income of the poor, who are net purchasers of food and typically spend on the order of 80 percent of their income on food. That relationship was explored conceptually and empirically in Mellor (1976, 1978). Second, as the real wage adjusts to lower food prices, employment increases. Lele and Mellor (1981) provided a two-sector model that summarises those relationships.

Subsequently the view of the world and through the World Bank/IMF/Washington Consensus the reality as well, has become more neoclassical. Food prices in low and middle-income countries are now seen as less responsive to domestic production than previously.² World prices tend to prevail. Similarly, labour markets are now seen as more perfect than in earlier views. Labour is fully employed, even though often at wages insufficient to exceed the poverty line. Poverty is not reduced by increased employment; rather it is increased real wage rates that reduce poverty.³ Thus, in open economies old explanations for the link between domestic agricultural productivity and poverty reduction do not hold. Despite more nearly neoclassical conditions than in the past, recent data continue to show a strong link between agricultural productivity growth and poverty reduction. Important examples are Fan, Chan-Kang and Mukherjee (2002, 2005) for China and India, Ravallion and Datt (2002) for India, and Timmer (1997) and Thirtle (2001) for cross section data for a large number of countries and over time.

Ravallion and Datt as well as Timmer document several year lags in the full effect, consistent with the process working through indirect effects of farm income expenditure and their multipliers. Timmer notes that when asset ownership is highly skewed, as in concentrated land ownership patterns, the effect of agricultural growth on poverty reduction is largely lost, consistent with consumption expenditure by small farmers driving the system—an effect absent when ownership is dominated by large, especially absentee, owners with import and capital intensive expenditure patterns. Price effects of agricultural production increase would not lag the production increase and would not be reduced by the size distribution of ownership.

This article presents a three-sector model that fits the stylised facts, particularly the lags in agriculture's impact on poverty and the lack of impact from large farms. The model shows how in an open, neoclassical economy the poverty-reducing effect of agricultural growth works through the rising real wage rate as agriculture increases the demand for the labour intensive, non-tradable, rural non-farm sector. It is the agricultural income and its multipliers that drive the bulk of the growth of non-tradables. The model also shows that agriculture and industry grow through different processes, subject to different policy regimes, primarily because of land's role in agricultural production. The model leads to robust policy recommendations for raising real wage rates and reducing poverty. Simply opening to trade is not a sufficient condition for rapid poverty reduction because it ignores these sectoral distinctions and their policy implications.

It is notable from the past empirical work that consumption expenditure from farm income is far more important than production related expenditures, helping to explain the large impact of growth in agricultural incomes. Mellor and Lele (1973) noted that

²Of course, global increases in food production affect global prices and hence transfer income from farmers to consumers. The concern here is not with global events but with national policies of low- and middle-income countries, which differ greatly from country to country.

³Ravallion and Datt (2002) document the close relation between real wage rates and poverty.

consumption expenditure, including livestock and horticulture expenditure, represents on the order of 80 percent of the expenditure effect, with only 20 percent represented by production linkages. Johnston and Kilby (1975) documented in detail the backward and forward production linkages with agricultural growth. A relatively recent study by Hazell and Ramaswamy (1991) with a semi input-output model for South India notes that consumption accounts for 84 percent of the agricultural expenditure impact on the income multiplier. Delgado, Hopkins and Kelly (1998) show consumption expenditure as 90 percent of the total for Sierra Leone.

Early work by Mellor and Lele (1973) and Mellor (1976, 1992) suggested that the income multipliers from increased farm income are large. Haggblade, Hazell and Dorosh (forthcoming) cite 49 analyses of the income multiplier from increased agricultural incomes to the non-farm sectors. The simple average of these very different studies provides a multiplier of two. Many of the studies divide the multiplier between rural and urban, however much of the urban is comprised of market towns, which also produce largely non-tradables for the local market. Probably the most careful of these studies for our purpose are the early work by Bell, Hazell and Slade (1982) on Malaysia; by Hazell and Roell (1983) for Malaysia and Nigeria; and the review by Delgado, Hopkins and Kelly (1998) for Africa. The Bell-Hazell-Slade work provides a multiplier of about two which is specific to the rural non-farm sector. The Delgado-Hopkins-Kelly work provides much higher multipliers because they count much of agricultural production as non-tradable due to quality and transaction costs. Rangarajan (1982) took an entirely different approach to the issue of agricultural multipliers, through a time series analysis of the national income data for India, and reached similar conclusions. The next step from income multipliers in understanding poverty would be employment multipliers, which currently available data do not provide. However, if the employment intensity is higher in the rural non-farm sector than other sectors then an employment multiplier would be higher than the income multiplier.

Much of the early development literature described a large underemployed labour force [Lewis (1954), and Johnston and Mellor (1961)]. In such a situation increased demand for labour causes increased employment not a rise in the real wage [Lele and Mellor (1981)]. A neoclassical world is one of full employment, albeit at a wage rate even below subsistence and increased demand for labour should increase wages and thus poverty reduction occurs through the wage effect and not just employment effect. The empirical issue then is does rising agricultural income drive a rise in the real wage rate or in employment and by how much. Fan, Chan-Kang and Mukherjee (2005) report a roughly even split in poverty reduction between increase in employment and in the wage rate.

The issue, then, is the relative importance of agricultural and urban industrial sectors in generating demand for the employment-intensive non-tradable sector. The sectors will differ in their impact on the non-tradable sector if there are both different proportions of the factors of production in their production systems and if the expenditure of factor income on non-tradables differs one from another.

Two consequences follow from these differences in sources of growth. First, changing either the rate of technological change or the rate of capital stock growth can change the relative growth rates in the two sectors. Second, the policies required

for rapid growth differ between the two sectors. While urban industrial growth is largely affected by changing macro policy towards trade and investment openness, agricultural growth requires public investment, such as those for technological change. The model picks up a thread from the early paper by Johnston and Mellor (1961) that states increased demand for the non-agricultural sector as one of the several effects of agricultural growth. That effect was developed more fully by Mellor and Lele (1973) and by Mellor (1976, 1992) in terms of income multipliers, but not employment multipliers.

Four simplifying assumptions are important to the model.

First, we assume an open economy, in which decline in food prices cannot be the mechanism by which the benefits of increased agricultural production are transferred to the poor. Of course, few economies are completely closed or open and so actual transmission may be in part from the old mechanisms via prices and in part what we describe with our model.

Second, we assume full employment. That is a very stringent condition as our model shows and potentially greatly weakens the transmission of the benefits of increased agricultural productivity to the poor. We show that in an open economy, the presence of underemployed labour or a highly elastic supply of labour greatly increases the impact of increased agricultural productivity on the poor.

Third, we assume that poverty is largely determined by the wage rate and per the preceding point by employment. We could have limited our analysis to the effect of increased agricultural productivity on the wage rate, but preferred to connect with the strong base of empirical data on poverty reduction rather than the weak data base for real wage rates. Of course, poverty is multifaceted and some poverty is attributable to non-employability of some members of the labour force, but as discussed in later sections of the paper the connection between employment, wage rate, and poverty is strong.

THE MODEL

(a) Three Sectors

The economy comprises three sectors namely: agriculture, industry (both of which are tradable), and non-tradable. It is a small economy, which takes international prices of tradable goods as given and does not influence them. Production in the tradable agricultural sector is a Cobb-Douglas production function with three inputs as follows:

$$A = t_a L_a^\alpha K_a^\beta Z^\gamma \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

Where A is the agricultural output; Z , K_a and L_a are, respectively, land, capital and labour inputs; and α , β and γ are parameters. The exogenously given variable, t_a , measures technological change in the agricultural sector. Production in the industrial sector is a Cobb-Douglas production function with two inputs as follows:

$$Q = t_q K_q^\theta L_q^{1-\theta} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (2)$$

Where Q is the industrial output; K_q and L_q are respectively, capital and labour inputs; θ is a parameter; and the exogenously given variable, t_q , measures the technological change in the industrial sector. Production (NT) in the non-tradable sector is assumed to be proportional to the labour input (L_{nt}) as follows.⁴

$$NT = \lambda L_{nt} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (3)$$

where λ is a parameter. To simplify, the small amount of fixed capital used in the production of non-tradables is taken as a direct embodiment of labour and therefore subsumed under labour and the working capital of non-tradables. Similarly, tradables in retail stores is assumed as part of expenditure on tradables. K and L are respectively the total capital and the total labour exogenously given as follows:

$$L = L_a + L_q + L_{nt} \quad \text{and} \quad K = K_a + K_q \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (4)$$

(b) Market Equilibrium Conditions

The price of agricultural (P_a) and industrial sector output (P_q) is determined in the international market. We assume that the four domestic markets in the economy are competitive with equilibrium determined as follows: The labour market equilibrium is determined by differentiating Equations (1), (2) and (3) by L_a , L_q and L_{nt} , and equating the marginal products of labour, respectively, as follows:

$$t_a P_a K_a^\alpha r_a^{\beta-1} Z^\gamma L^{\beta-1} = P_{nt} = W \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (5)$$

and

$$t_a \beta P_a K_a^\alpha r_a^{\beta-1} Z^\gamma L^{\beta-1} = t_q (1-\theta) P_q K_q^\theta r_q^{-\theta} L^{-\theta} \quad \dots \quad \dots \quad \dots \quad \dots \quad (6)$$

Where $r_a = \frac{L_a}{L}$, $r_q = \frac{L_q}{L}$, and P_{nt} = price of non-tradables. Equation (5) shows that the nominal wage rate (W) is directly proportional to the price of non-tradables. The capital market equilibrium is determined by differentiating Equations (1) and (2), and equating the marginal products of capital as follows:

$$t_a \alpha P_a K_a^{\alpha-1} r_a^\beta Z^\gamma L^\beta = t_q \theta P_q K_q^{\theta-1} r_q^{1-\theta} L^{1-\theta} = R \quad \dots \quad \dots \quad \dots \quad \dots \quad (7)$$

where R is the rate of return on capital.

Only labourers and peasants consume non-tradables. The income of peasants is the sum of return from labour and land. The per capita consumption of labourers is assumed to be as follows:

$$C_{nt} = W^n P_{nt}^\epsilon \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (8)$$

⁴This is a simplifying assumption. Ideally the non-tradable production function should be considered as a function of local material and labour with diminishing returns to labour. It can be shown that even with such modified function the implication of the model and the comparative statics does not change in terms of real wages. In fact the effect on wage in this case is higher than that calculated in the paper.

Where η and ε are, respectively, the income and the price elasticity of the demand for non-tradables. We simplify that the labourers and the peasants are on the same demand function and therefore the per capita demand for non-tradables by peasants (C_{nt}^P) is given by

$$C_{nt}^P = \left(\frac{\gamma + \beta}{\beta}\right)^\eta W^\eta P_{nt}^\varepsilon \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (9)$$

The equilibrium in the non-tradable market is given, as follows, by equating the supply of non-tradables and the demand for them by peasants and labourers:

$$\lambda L_{nt} = C_{nt}(L_a + L_q + L_{nt}) + \left(\frac{\gamma + \beta}{\beta}\right)^\eta C_{nt} L_a - L_a$$

Or

$$\lambda r_{nt} = C_{nt} \left\{ 1 + \left[\left(\frac{\gamma + \beta}{\beta}\right)^\eta - 1 \right] r_a \right\} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (10)$$

where $r_{nt} = \frac{L_{nt}}{L}$

The real wage rate, ω , is equal to the nominal wages divided by, P , the weighted sum of the price of agriculture, industry and non-tradables, where the weights (α_a , α_q and α_{nt}) are the budget share of agriculture, industry and non-tradables in the consumption basket of labourers.

$$\omega = \frac{W}{P} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (11)$$

where $P = \alpha_a P_a + \alpha_q P_q + \alpha_{nt} P_{nt}$

(c) Comparative Statics

The derivations of the comparative statics for the model are given in Appendix A. The key equations related to the rate of change in the real wage rate are as follows:

$$\frac{d\omega}{\omega} = \frac{dW}{W} - \frac{dP}{P} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (12)$$

where,

$$\begin{aligned} \frac{dW}{W} = \frac{1}{\Delta} \left\{ -\theta \left(\frac{R}{r_{nt}} - \frac{r_q}{r_{nt}} \frac{K_a}{K_q} \right) \frac{dt_a}{t_a} - \theta \gamma \frac{r_q}{r_{nt}} \frac{K}{K_q} \frac{dK}{K} \right. \\ \left. + \left[\alpha \frac{R}{r_{nt}} - \gamma \frac{r_q}{r_{nt}} + (\beta - 1) \frac{K_a}{K_q} \frac{r_q}{r_{nt}} \right] \frac{dt_q}{t_q} + \left(\frac{R}{r_{nt}} + \frac{r_q}{r_{nt}} \right) \gamma \theta \frac{dL}{L} \right\} \end{aligned} \quad \dots \quad \dots \quad \dots \quad (13)$$

Where Δ written in the denominator of the right hand side of Equation (13) is as follows,

$$\Delta = (\eta + \varepsilon) \gamma \theta + \frac{R}{r_{nt}} (\alpha - \theta) - \frac{r_q}{r_{nt}} \left[\gamma + (1 - \theta - \beta) \frac{K_a}{K_q} \right] \quad \dots \quad \dots \quad \dots \quad (14)$$

$$R = r_a + r_{nt} \frac{I r_a}{1 + I r_a} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (15)$$

where,

$$I = \left(\frac{\gamma + \beta}{\beta}\right)^n - 1 \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (16)$$

Note $I > 0$.

The following assumptions determine the sign of the right hand side of the Equation (13).⁵ First, the share of capital is higher in industry than agriculture ($\theta > \alpha$) and the share of labour is higher in agriculture than industry ($\beta > 1 - \theta$).⁶ Second, the marginal propensity to consume non-tradables $(\eta + \varepsilon)b_{nt}$ is less than the sum of the share of the labour force in agriculture and industry.⁷ Third, the sum of the income and price elasticities of demand from peasants and labourers for non-tradables is less than one $\eta + \varepsilon < 1$.

The change in the weighted average of prices is given by the following equation:

$$\frac{dP}{P} = \frac{dW}{W} \left\{ \frac{P_a \alpha_a}{P} (\eta_a + \varepsilon_{a,nt} - 1) + \frac{P_q \alpha_q}{P} (\eta_q + \varepsilon_{q,nt} - 1) + \frac{P_{nt} \alpha_{nt}}{P} (\eta + \varepsilon - 1) - \alpha_{nt} \right\} \quad (17)$$

Inserting this Equation in (12) we get

$$\frac{d\omega}{\omega} = \frac{dW}{W} \left\{ 1 - \frac{P_a \alpha_a}{P} (\eta_a + \varepsilon_{a,nt} - 1) - \frac{P_q \alpha_q}{P} (\eta_q + \varepsilon_{q,nt} - 1) - \frac{P_{nt} \alpha_{nt}}{P} (\eta + \varepsilon - 1) - \alpha_{nt} \right\}$$

where η_a and η_q are, respectively, the income elasticities of demand for agriculture and industry. $\varepsilon_{a,nt}$ and $\varepsilon_{q,nt}$ are, respectively, the cross price elasticities of demand for agriculture and industry with respect to non-tradables.

Substituting $1 - \alpha_{nt} = \alpha_a + \alpha_q$ in the above equation and rearranging the terms we get,

$$\frac{d\omega}{\omega} = \frac{dW}{W} \left\{ \frac{P_a \alpha_a}{P} (\eta_a + \varepsilon_{a,nt} - 2) - \frac{P_q \alpha_q}{P} (\eta_q + \varepsilon_{q,nt} - 2) - \frac{P_{nt} \alpha_{nt}}{P} (\eta + \varepsilon - 1) \right\} \quad (18)$$

With the assumption that the income elasticity of demand by labourers and peasants for non-tradables is greater than that of the industrial goods, that is, $\eta > \eta_q$, along with the earlier assumptions, it can be shown that the sum of the terms in the curly parentheses is positive, and also since $\frac{dW}{W} > 0$, we conclude that the real wage rises. The data supporting these assumptions are discussed in the next sections.

⁵See Appendix B for the determination of the sign of Δ .

⁶This implies that the capital-labour ratio is higher in the industrial sector than that in the agricultural sector.

⁷This assumption is consistent with the empirical evidence in the developing countries. Poor households usually spend 60 to 80 percent of income on food and hence the budget share of non-tradables is less than 0.4. With at least 30 percent of employment coming from the rural sector ($r_a > 30$) we find that $r_a + r_q >$ the marginal propensity to consume non-tradable.

The income distribution implications can be drawn by examining the effects on the wage rental ratio, $\frac{W}{R}$. Note that,

$$\frac{W}{R} = \frac{K_a}{L_a} = \frac{K_a}{r_a} L \dots \dots \dots \dots \dots \dots \dots \dots (19)$$

DISCUSSION

What is critical for policy analysis is to know the relative effect of agricultural growth and industrial growth on the real wage rate. That can be derived from Equation (12), as follows:

Impact of agriculture on real wage rate when the rate of change in each of t_a , t_q and K is equal to 1
 = (rate of change in the real wage rate/rate of change in agricultural output)
 – (rate of change in the real wage rate/rate of change in industrial output)

$$= \frac{d\omega}{\omega} \left(\frac{dQ}{Q} - \frac{dA}{A} \right) \dots \dots \dots \dots \dots \dots \dots \dots (20)$$

Substituting $W = \frac{A}{L_a} = \frac{AL}{r_a}$ and $W = \frac{Q}{L_q} = \frac{QL}{r_q}$ in Equation (20), we get

Impact of agriculture on real wage rate when the rate of change in each of t_a , t_q and K is equal to 1

$$= \frac{d\omega}{\omega} \left(\frac{dr_q}{r_q} - \frac{dr_a}{r_a} \right)$$

$$= -\frac{1}{\Delta} \frac{d\omega}{\omega} \left[\left(\frac{R}{r_m} + \frac{r_q}{r_m} \right) \gamma + (\eta + \varepsilon)(1 - \beta - \phi) + (\eta + \varepsilon)\gamma\phi \right] \frac{K}{K_q} \dots \dots (21)$$

$$> 0$$

Based on the assumptions and previous discussion it can be seen that the right hand side of Equation (21) is positive. Thus we see that agricultural growth has a larger impact on increasing wage rate than industrial growth.

The Sensitivity Matrix in Table 1 shows that an increase in K and t_q increases industrial output (Q), decreases agricultural output (A) and can also decrease the non-tradable (NT) output. An increase in t_a increases agricultural (A) and non-tradable (NT) output and decreases industrial output (Q). Those relations are important to the impact on the real wage rate. Increase in both K and t_a increase the real wage rate. But, since agriculture and the non-tradable sectors are the major employers of labour, r_a and r_m are larger than r_q , the impact of increase in K on the real wage rate would be much less than the impact of t_a . Equation (12), discussed above, shows that to be the case. Technological change in agriculture raises wages more than returns to capital and thus shifts income distribution towards labourers and hence the poor. All other changes give indeterminate results. Note that in Taiwan, with strong technological change in agriculture income distribution became more equal with growth [Lee (1982)]. It can be

Table 1
Sensitivity Matrix*

Endogenous Variable	Exogenous Variable				
	P_a	K	t_a	t_q	L
K_a	+	-	+	-	+
K_q	-	+	-	+	-
r_a	+ / -	-	+ / -	-	+
r_q	-	+	-	+	-
r_{nt}	+	+ / -	+	+ / -	+
W	+	+	+	+ / -	-
W/R	+	+		+	-
A	+	-	+	-	+
Q	-	+	-	+	-
NT	+	+ / -	+	+ / -	+

*Positive sign (+) means that as the exogenous variable increases the endogenous variable also increases, holding the remaining exogenous variables constant. The negative sign (-) means the opposite. And, positive/negative (+/-) means that the effect is indeterminate.

seen from Equations (12), (14) and (21) that four variables are important determinants of the impact of agricultural growth on the real wage, as follows:

First, the larger the factor shares of capital in the industrial sector (φ) compared to that in the agricultural sector (α), the larger is the impact on the real wage rate (poverty reduction) of agricultural growth compared to industrial growth. Corollaries are: the higher the factor share of labour in the agricultural sector (β) the higher is the relative impact of agricultural growth on the real wage rate; the higher the capital-labour ratio in the industrial sector (K_q/L_q) compared to the agricultural sector (K_a/L_a) the higher is the relative impact of agricultural growth on the increase in the real wage rate; the higher the share of land in agriculture (γ) the higher is the relative impact of agricultural growth on the real wage rate. The last two corollaries are derived in the same manner as the second determinant (below). The next section corroborates these relationships.

Second, the higher is the income elasticity of demand of peasants for non-tradables (η), the higher is the impact of agricultural growth on the real wage rate. This is derived noting that Equation (21) depends on the magnitude of $d\omega/\omega$, and using Equation (15). Furthermore, as the marginal propensity to consume non-tradables, $(\eta+\varepsilon)b_{nt}$, increases the positive impact of technological change in agriculture on the real wage rate increases. Note that the key variable is the difference between the income and price elasticities, $(\eta+\varepsilon)$, so that the more inelastic the price elasticity of demand for non-tradables the greater the impact of agricultural growth on the real wage rate. That is, farmers are highly responsive to increased income in spending on non-tradables, but they are not so responsive to change in the price of non-tradables. Such behaviour is consistent with the observed large impact of agricultural growth on poverty reduction. The next section presents data supporting large budget shares and high-income elasticities of demand by peasants for non-tradables and discusses the lack of data on price elasticities.

Third, the larger employment is in the agricultural sector (r_a), the larger is the impact of agricultural growth on real wages. As shown in the next section, in agrarian low- and middle-income economies the share of agricultural employment is high.

Fourth, the higher is employment in the non-tradable sector (r_{nt}) the greater the impact of agricultural growth on wages. If, as will be shown to be the case in the next section, the demand for non-tradables is elastic, then the non-tradables sector will grow relative to the agricultural sector. Thus, in a low income country the agricultural sector will be large, but the non-tradable sector quite small. Agricultural growth will directly dominate poverty reduction. With growth, the relative size of the agricultural sector declines, reducing the impact of agricultural growth on poverty reduction, but the non-tradable sector will have grown, increasing the effect of agricultural growth on the real wage and hence poverty reduction. That is why agricultural growth is important to the real wage rate and to poverty reduction even in middle-income countries, in which the relative size of agriculture has declined markedly. Similarly, with growth, the importance of agriculture to employment, the real wage rate, and poverty reduction increases greatly relative to its impact on output. The large size of the non-tradable sector and its high proportion in rural areas is shown in the next section.

NEW FACTS ASKED FOR BY THE MODEL

The above discussion shows that various types of data are called for by our model. Some of the data are available while some are new facts called for as we discuss below.

(a) GDP, Employment, and Factor Shares by Sector

Bhalla (2004), in a substantial review of the vast Indian data sets, comments specifically on the importance of and the paucity of data for the rural non-farm, non-tradable sector. Nevertheless, reasonable approximations for the share of employment and GDP by sector, including the non-tradable sector, can be constructed (albeit labouriously) from national income statistics, supplemented by survey data. From those data factor shares can be derived.

Table 2 provides illustrative data for a low-income country (Rwanda) and a middle-income country (Egypt) for those variables.⁸ The employment data for Egypt are from the 1998 Labour Force Survey by the Central Agency for Public Mobilisation and Statistics, CAPMAS, [Egypt, Government of (2001 and 2002)]. They come close to providing what is needed. Greater extrapolation is required for the GDP data and for Rwanda. Excellent rural household survey data allow a rough division of the rural labour force between farm and non-farm and are consistent with the CAPMAS data [see Bouis (1999) and Haddad and Ahmed (1999)]. Thus, the rural division of employment is accurate. The numerous assumptions are stated in detail in Mellor and Gavian (1999) and Mellor (2002). The total non-tradable sector is the sum of the rural and urban non-tradable sectors and comprises 62 percent of employment in Egypt and 51 percent in Rwanda. Rural non-tradable comprises 70 percent of the non-tradable sector in Egypt. Agriculture's share of employment is of course much lower in middle-income Egypt than

⁸The paper focuses on Egypt and Rwanda because the authors did extensive empirical work on these countries.

Table 2

Employment, GDP, and Factor Shares, by Agriculture (Tradable), Industry (Tradable), and Non-tradable Sectors, Contemporary Egypt and Rwanda (all figures as %)

Sectors	Employment	GDP	Labour Share	Capital Share	Land Share
Egypt					
Agriculture	23	17	57	10	33
Industry	15	57	11	89	0
Non-tradable	62	26	100	0	0
Total	100	100			
Rwanda					
Agriculture	44	40	58	10	32
Industry	5	33	8	92	0
Non-tradable	51	27	100	0	0
Total	100	100			

Source: Calculated by the authors from Government of Egypt (2000 and 2001), Government of Rwanda (2002), Bouis (1999), Haddad and Ahmed (1999) and Morsy (2002).

in low income Rwanda at 23 and 44 percent respectively. The non-tradable sector is relatively larger in Egypt than Rwanda, consistent with income elastic demand for the sector and either underemployed rural labour or price inelastic demand. Note also that for Rwanda the labour share is much lower in the urban tradable sector than for Egypt, consistent with similar production technology but much lower wage rates in Rwanda.

The factor shares are derived using the neoclassical market equilibrium condition as follows: The GDP share in the non-tradable sector divided by the employment share provides the wage rate. The agricultural employment proportion times the wage rate divided by the agricultural share of GDP gives the factor share to labour in agriculture. For agriculture, after calculating the factor share of labour, the GDP shares must be divided between land and capital. Survey data by Morsy (2002) allows the division of the non-labour factor share into capital and land. It is notable that the land share is large in agriculture, and consistent with farmers who own their farms and work on them having much higher incomes than persons in the non-tradable sector who rely almost entirely on labour for income. It is important to the results whether land share is spent more like factor shares to labour or more like capital share. In the case of Egypt and Rwanda, the bulk of land income comes to peasants who spend that income like labour income [Bouis (1999); Mypisi (2000) and Loveridge (1992)]. The same procedure is followed for the industrial sector, without the necessity of dividing into capital and land.

The most important contribution of the preceding data is demonstration of the immense size of the non-tradables sector in employment. The employment data cited are the product of careful collection and are recent. The original sources also document the dominance of the rural non-tradable sector relative to the urban non-tradable sector.

(b) Marginal Propensity to Consume and Demand Elasticities

Ample data show for peasant farmers a high marginal propensity to consume non-tradables and that propensity remains high at least into middle-income status. Again, the most careful and relevant data set for this purpose is Bell, Hazell, and Slade (1982). They estimated 40 percent of incremental income of farmers was spent on rural non-farm goods and services. This is not far from the estimate in the seminal paper by Mellor and Lele (1973) that estimated from the Indian expenditure surveys that half of the farmers' incremental income was spent on rural non-farm goods and services, and an additional 30 percent on high value agricultural commodities, which had non-tradable characteristics. In various surveys Liedholm and Meade (1987) noted that the demand for the rural non-farm small enterprises comes from farmers. Gavian, El-Meehy, Bulbakl and Gender (2002) for Egypt also note that in rural areas and small towns the demand comes from farmers and the multipliers from farmer expenditure.

Household survey data provide expenditures from farm income for Egypt [Bouis (1999) and Rwanda Loveridge (1992)]. Farm income includes the return to farm family labour and to own land. For Egypt, 43 percent of farm income expenditure is for non-food goods and services, and the expenditure elasticity is 1.8. These data are consistent with Bell, Hazell and Slade's (1982) estimates of 40 percent of incremental income spent by farmers in Malaysia on locally produced non-farm goods and services, as well as Hazell and Roell (1983) for Malaysia and Nigeria, and Delgado, Hopkins and Kelly (1998) for several African countries.

It is notable that the survey data, despite in some cases poor definitions and in others for much earlier periods, are fully consistent with the large size of the rural non-farm sector shown in recent labour surveys cited.

(c) Income Elasticity of Demand for Non-tradables

Generally, sample surveys [e.g. Bouis (2002) for Egypt] show the income elasticity of demand by farmers for non-farm goods and services to be a highly elastic, of the magnitude of 1.5 or higher. Data specific to the rural non-farm sector for Malaysia [Bell, Hazell, and Slade (1982)] and for India [Hazell and Ramaswamy (1991)] provide the expenditure data consistent with that high elasticity. A survey for Egypt [Gavian, El-Meehy, Bulbakl, and Ender (2002)] shows that practically all demand in rural market towns comes from within the rural and market town area and that farmers make most of their expenditures in those areas. Apparently as farm incomes rise rural goods and service providers expand what they provide in keeping with changing tastes of farmers. Thus, the relative size of the non-tradable rural and market town economy expands with the high-income elasticities. Most likely the market towns expand relative to the purely rural areas.

The income elasticity of demand for agricultural commodities averages well below 1 as demonstrated by the declining budget share with rising income. Thus, the income elasticity of demand for the rural non-tradable sector is higher than for agriculture. Data are not available with sufficient precision to say that the income elasticity of demand for the rural non-farm sector is higher than for the industrial sector, but given that it is so high for rural non-tradables it is likely higher than for the industrial sector. Our model

focuses attention on the importance of more precise measurement of the demand characteristics of the non-tradable sector.

(d) Price Elasticity of Demand for Non-tradables

Our model is clear that increased demand by farmers for non-tradables raises the price of labour and hence the price of non-tradables. As a result the price elasticity of demand for non-tradables is a vital variable. Data do not exist for that variable. The model focuses attention on the importance of such data and therefore of finding means to estimate it. Rising price reduces the consumption of non-tradables and the impact of rising farm incomes on the real wage rate. However, if the supply of labour is highly elastic, either because of the nature of labour/leisure choices [Mellor (1963)] or because of underemployed labour then the effect is the same as perfectly inelastic demand for non-tradables in our model.

Our stand that the demand elasticity for non-tradables decreases as income increases is based on the following empirical result: First, the data sets we started with, those showing the relation between agricultural growth and poverty reduction are consistent with that stand. Second, data in Table 2 show that the non-tradable sector expands substantially in relative, and of course, in absolute size, with increased income. It is relatively much larger in middle income Egypt than low income Rwanda. In Rwanda, incomes are far lower than in Egypt, and so the average propensity to spend on the non-tradable sector is far lower (a higher proportion goes to food) and so the size of the non-tradable sector is lower than in Egypt.⁹ Note that the cost of output from the rural non-farm sector is entirely determined by the real wage rate, which with widespread poverty is low. That is the output from the sector is low-priced. The constraint to growth is effective demand. It is not surprising that increasing the real wage from very low levels would not drive demand towards goods with a much higher capital component. In tangible terms, farmers increase their housing expenditure as their incomes rise, and increased price of labour from very low levels does not turn them away from that expenditure.

CONCLUSIONS AND POLICY IMPLICATIONS

The poverty reduction oriented issue in both a closed and an open economy is how increased farm income gets transformed into income for the poor. In a closed economy, that happens through reduced price of food, the principle determinant of real income of the poor, and there are no lags in transmission of increased agricultural production to poverty reduction and no distinction in effect between peasant farmers and wealthy, absentee landowners. Price decline transfers income from non-poor farmers to poor labourers. With substantial unemployment of labour, under competitive conditions, the increase in real income of labour from lower food prices will translate into lower wages with respect to the output produced by labour and hence increased employment. The poor benefit from either lower prices or increased employment.

⁹Note, that these findings of a much larger rural non-tradable sector in Egypt than in Rwanda are inconsistent with Hymer and Resnick (1969) that postulated negative income elasticity of demand for the rural non-farm sector and hence the gradual demise of the rural non-farm sector. Their assumption, for which they did not present data, is inconsistent with the data presented here for the income elasticity of demand and size of the non-tradable sector, or with the data showing the rural non-tradable sector larger in middle-income countries than in low-income countries.

The traditional explanation of the relation between agricultural growth and poverty reduction still has relevance. Agricultural prices may respond to domestic supply increase because of a spread between export and import parity prices or remaining protection. Of course, technological change throughout the world's food sector will reduce world prices, thereby transferring income from farmers to poor labourers. Large countries such as China may measurably affect world prices. Similarly, labour market frictions may result in a highly elastic supply of labour to the rural non-farm sector. In that case, transmission of increased farm incomes to employment in the non-tradable sector will be highly efficient because the price of non-tradables will not rise in response to increased demand. Increased employment will reduce poverty rather than the increased real wage rate. Extrapolation of our model explains this situation as well.

However, our model is increasingly appropriate as economies continue to open, transaction costs are reduced, and markets work increasingly well. In an open economy, income from purely domestic increase in agricultural incomes is not transferred from farmers to labourers through lower prices. Rather farm incomes increase with increased production, driven by technological change. Farmers have a high marginal propensity to spend that income in the rural non-farm sector compared to the industrial goods, stimulating increased output, and demand for labour and hence increased wages. In the open economy, the poor receive increased wages (or, if there is underemployed labour, increased employment) and farmers do not experience lower incomes through lower prices. GDP grows both from the agricultural growth and from growth in non-tradables stimulated by increased farm incomes.

A large literature, built on the initial conceptualisation by Lewis (1954), explores the effect on growth of a large unemployed rural labour force. However, that literature saw the unemployed rural labour force as moving directly into urban industry, rather than first into the rural non-farm and market town sector. In an open economy the impact of agricultural growth on poverty reduction is similar whether there is unemployed rural labour or not. In both cases, the increased farm incomes are spent in the rural non-farm, non-tradable sector thereby increasing the demand for labour and the total wage bill. If there is unemployed labour the impact on the poor is through increased employment rather than increased wages and the impact will be larger because the price of the rural non-farm goods and services will not increase. If there is no unemployed labour the impact of increased demand for labour is reduced by the shift of demand induced by the increased relative price for the non-tradable sectors output.

Since the production functions for agriculture and industrial sectors are very different, the policies for achieving rapid growth differ between the two sectors. In the case of the industrial sector, growth is largely a function of the rate of growth of the capital stock. Emphasis on open trading regimes and free capital flows are critical to growth of that sector. Policy failures in this respect have a major impact on GDP growth, even in low-income countries, although the impact on real wage rate increase and poverty reduction is more modest.

In the case of agriculture, the limitation of the land area causes technological change to be critical to production growth. Because of the biological nature of agriculture, technology tends to be agro-climatic zone and hence country specific.

Policies are needed to bring about rapid technological innovation and application in agriculture. Because of the atomistic nature of peasant farming the public sector normally plays a major role in those processes. Policy failure in these areas may have only a modest impact on GDP growth but a devastating effect on growth of real wages (or employment) and hence on poverty reduction.

It follows that the standard recommendations for freeing goods and capital markets are important to growth of the industrial sector and of GDP but are not sufficient conditions for agriculture growth and hence for real wage rate increase and poverty reduction. Indeed, if macro policy concerns for balancing national budgets result in large reductions in public expenditure for technological change in agriculture, as has generally been the case in Africa, there will be a major negative impact on real wage rate growth and hence on poverty reduction.

Several additional policy implications follow. Agricultural growth is of course important to both GDP growth and poverty reduction in low-income countries. In middle-income countries the relative size of agriculture has declined sufficiently that agriculture growth has at best a modest effect on the growth rate of GDP. However, the proportion of the labour force in the rural non-tradable sector is still very large (see Table 2 for Egypt) and hence agricultural growth, generating demand for that sector, is still a dominant factor in poverty reduction.

Reducing poverty through agriculture growth requires focus on raising incomes of peasants. The literature shows clearly [Timmer (1997)] that growth on large-scale absentee landowner farms does not reduce poverty. Our model explains why, in terms of demand for goods and services from the rural non-tradable sector. The very smallest farms are not an appropriate focus because they represent such a small proportion of farm income and their incomes and their decision-making are much more influenced by the rural non-farm sector, which dominates their employment and income. This is contrary to much contemporary practice in anti-poverty programmes that focus on the lowest income farmers because they are the poorest. Similarly, focus on increasing production in poor resource areas with concentrated rural poverty will be ineffectual, since such areas tend to respond poorly to improved technology, with little increase in farm income and hence weak impact on the rural non-farm sector. That too is contrary to much of current fashion in rural development.

Similarly, the constraint to growth of the rural non-tradable sector is demand. Hence micro credit and other micro enterprise programmes will do little to reduce poverty in that sector without growth in farm incomes that will raise demand for the sector. That is contrary to much poverty oriented programming. The appropriate focus for poverty reduction is on the small commercial farmer and only then on maximising the effect of higher incomes to those farmers on growth in the rural non-farm, non-tradable sector.

APPENDIX A

Derivation of Comparative Statics

In order to study the effects of various exogenous variables like the total capital stock and labour force, technological changes in the agriculture, industry and non-tradables on the endogenous variables such as K_a , K_q , r_a , r_q , r_{nt} , P_{nt} , W and ω we logarithmically differentiate Equations (5), (6), (7) and (10) with respect to various exogenous variables. Differentiating these equations with respect to technological change in the agricultural sector t_a and rearranging the terms we get:

$$\alpha \frac{\delta K_a}{\delta t_a} \frac{t_a}{K_a} + (\beta - 1) \frac{\delta r_a}{\delta t_a} \frac{t_a}{r_a} - \frac{\delta P_{nt}}{\delta t_a} \frac{t_a}{P_{nt}} = -1 \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.1)$$

$$(\alpha + \varphi \frac{K_a}{K_q}) \frac{\delta K_a}{\delta t_a} \frac{t_a}{K_a} + (\beta - 1) \frac{\delta r_a}{\delta t_a} \frac{t_a}{r_a} + \varphi \frac{\delta r_q}{\delta t_a} \frac{t_a}{r_q} = -1 \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.2)$$

$$[-(1 - \alpha) - (1 - \varphi) \frac{K_a}{K_q}] \frac{\delta K_a}{\delta t_a} \frac{t_a}{K_a} + \beta \frac{\delta r_a}{\delta t_a} \frac{t_a}{r_a} - (1 - \varphi) \frac{\delta r_q}{\delta t_a} \frac{t_a}{r_q} = -1 \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.3)$$

$$\frac{R}{r_{nt}} \frac{\delta r_a}{\delta t_a} \frac{t_a}{r_a} + \frac{r_q}{r_{nt}} \frac{\delta r_q}{\delta t_a} \frac{t_a}{r_q} + (\eta + \varepsilon) \frac{\delta P_{nt}}{\delta t_a} \frac{t_a}{P_{nt}} = 0 \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.4)$$

The changes in K_q , ω and r_{nt} can be found by using the following equations:

$$\frac{\delta K_q}{\delta t_a} \frac{t_a}{K_q} = - \frac{\delta K_a}{\delta t_a} \frac{t_a}{K_a} \frac{K_a}{K_q} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.5)$$

$$\frac{\delta \omega}{\delta t_a} \frac{t_a}{\omega} = \frac{\delta W}{\delta t_a} \frac{t_a}{W} - \frac{\delta P_{nt}}{\delta t_a} \frac{t_a}{P_{nt}} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.6)$$

$$\frac{\delta r_{nt}}{\delta t_a} = - \frac{\delta r_a}{\delta t_a} - \frac{\delta r_q}{\delta t_a} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (A.7)$$

The above equations can be solved simultaneously for the changes in 7 endogenous variables, namely, K_a , K_q , r_a , r_q , r_{nt} , P_{nt} and W , and the values can be found in terms of the parameters and exogenous variables. The set of solutions are the percentage changes in the values of endogenous variables with respect to the percentage changes in K_a , r_a , r_q and W are as follows:

Endogenous Variables**Solutions****Capital Stock (K)**

$$K_a \quad \frac{r_q}{r_{nt}} \frac{K}{K_q} \frac{(1-\theta-\beta)}{\Delta}$$

$$r_a \quad \frac{r_q}{r_{nt}} \frac{K}{K_q} \frac{(\alpha-\theta)}{\Delta}$$

$$r_q \quad \frac{(\eta+\varepsilon)\gamma\theta + \frac{R}{r_{nt}}(\alpha-\theta)}{\Delta} \frac{K}{K_q}$$

$$W \quad \frac{(1-\alpha_{nt})\gamma\theta}{\Delta} \frac{r_q}{r_{nt}} \frac{K}{K_q}$$

Technological Change in Agriculture (t_a)

$$K_a \quad \frac{1}{\Delta} \left[(\eta+\varepsilon)\theta - \frac{R}{r_{nt}} - \frac{r_q}{r_{nt}} \right]$$

$$r_a \quad \frac{1}{\Delta} \left[(\eta+\varepsilon)\theta - \frac{r_q}{r_{nt}} - \frac{K}{K_q} \right]$$

$$r_q \quad \frac{1}{\Delta} \left[(\eta+\varepsilon)\theta \frac{K_a}{K_q} - \frac{R}{r_{nt}} \frac{K}{K_q} \right]$$

$$W \quad -\frac{\theta}{\Delta} \left(\frac{R}{r_{nt}} - \frac{r_q}{r_{nt}} \frac{K_a}{K_q} \right)$$

Technological Change in Industry (t_q)

$$K_a \quad \frac{1}{\Delta} \left[(\eta+\varepsilon)(\beta-1) + \frac{R}{r_{nt}} + \frac{r_q}{r_{nt}} \right]$$

$$r_a \quad \frac{1}{\Delta} \left[-(\eta+\varepsilon)\alpha + \frac{r_q}{r_{nt}} \frac{K}{K_q} \right]$$

$$r_q \quad \frac{1}{\Delta} \left\{ (\eta+\varepsilon) \left[\gamma + (1-\beta) \frac{K_a}{K_q} \right] - \frac{R}{r_{nt}} \frac{K}{K_q} \right\}$$

$$W \quad \frac{1}{\Delta} \left[\frac{R}{r_{nt}} \alpha - \frac{r_q}{r_{nt}} (1-\beta) \frac{K_a}{K_q} \frac{r_q}{r_{nt}} \right]$$

Labour Force Growth (L)

$$K_a \quad \frac{1}{\Delta} (1-\beta-\theta) \left(\frac{R}{r_{nt}} + \frac{r_q}{r_{nt}} \right)$$

$$r_a \quad \frac{1}{\Delta} \left[-(\eta+\varepsilon)\gamma\theta + (1-\beta-\theta) \frac{r_q}{r_{nt}} \frac{K}{K_q} \right]$$

$$r_q \quad \frac{1}{\Delta} \left[(\eta+\varepsilon)\gamma\theta - (1-\beta-\theta) \frac{R}{r_{nt}} \frac{K}{K_q} \right]$$

$$W \quad \frac{1}{\Delta} \left(\frac{R}{r_{nt}} + \frac{r_q}{r_{nt}} \theta \gamma \right)$$

APPENDIX B

Determination of the Sign of Delta

To Prove $\Delta < 0$

From Equation (14) we know the following

$$\Delta = (\eta + \varepsilon)\gamma\theta + \frac{R}{r_{nt}}(\alpha - \theta) - \frac{r_q}{r_{nt}}[(\gamma + (1 - \theta - \beta))\frac{K_a}{K_q}] \dots \dots \dots \text{(B.1)}$$

Rearranging the right hand side of the above equation, and substituting the following term for r_{nt} ,

$$r_{nt} = b_{nt}(1 + Ir_a) = \frac{C_{nt}}{W}(1 + Ir_a), \text{ Equation (B.1) can be written as,}$$

$$r_{nt}\Delta = (\eta + \varepsilon)\theta\gamma b_{nt} - (r_a + r_q)\gamma \dots \dots \dots \text{(B.2)}$$

$$+ b_{nt}Ir_a(\eta + \varepsilon - 1) + (1 - \beta - \theta)r_a[-\frac{K_a}{L_a}\frac{L_q}{K_q}]$$

Poor households usually spend 60 to 80 percent of income on food and hence the budget-share of non-tradables is less than 0.4. With at least 30 percent of total employment in the rural sector we find that the marginal propensity to consume non-tradables $b_{nt}(\eta + \varepsilon) < r_a + r_q$. In addition, we are assuming $\eta + \varepsilon < 1$ and therefore, it can be seen that the right hand side of the above equation is negative as long as $\theta > \alpha$, $1 - \beta > \theta$ and $r_a > r_q$.

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