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Distinguished Lecture

An Escape from the Malthus Rectangle? Poverty, and Conversion Efficiency*

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> The object of those who really wish to better the condition of the lower classes of society must be to raise the proportion between the price of labour and the price of provisions [Malthus (1803), cited in Himmelfarb (1969): 499].

I. THE CENTRAL CLAIM

Malthus (1798, 1803, 1824) wrote during the world's first period of sustained and widespread growth in real income per person: the "Northern" agro-industrial revolution of 1740–1970. When he wrote, it was widely believed that not only growth, but also poverty reduction, depended substantially on what he called "schemes of improvement". Malthus's **central claim** is that these could not reduce poverty in the *long* run, unless fertility declined.

This, he believed, was because any *short*-run success of "schemes of improvement" in reducing poverty would increase the rate of population growth among the poor. This would raise the supply of labour and the demand for food. Owing to diminishing marginal returns to extra hectares-plus-persons as new, inferior land was brought into cultivation, "the proportion between the price of labour and the price of provisions" would then fall, thus returning the poor to poverty. Unless fertility fell, the long-term well-being of the poor could not improve much. Being largely dependent on the real wage, it was boxed in by the **Malthus rectangle** (Figure 1) of population, labour supply, land, and food, and the interactions among them.

The strong [1798] version of Malthus's central claim is flawed. Above all, he does not set out values for biological and economic parameters–total fertility rates, relevant elasticities, etc.–to show that his strong central claim, that long-run poverty cannot be reduced *at all* by schemes of improvement, is justified. In other words, he does not establish that population growth (fertility *minus* mortality) is biologically able, and is economically willed, to increase so much–in response to the "incentive"

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of extra food availability–that the poor must sink back to the level of subsistence prior to the improvement.

Nevertheless, Malthus's arguments do powerfully support a weaker version of his central claim: that, other things being equal, poor people's initial gains from "schemes of improvement" set in train fertility (and mortality) responses that significantly restrain real earnings and therefore eliminate a large part of those initial gains (Section VI and Figure 1). This version of the central claim is deeply relevant to the success–or failure–of growth to reduce poverty during the world's second, much faster and more widespread, period of accelerated growth: in Asian and Latin America since 1950. Malthus is right that technical progress, even if endogenous to population growth, is irrelevant to his central claim. Malthus (1824) is also right that some of the usual accompaniments of growth (notably better health and education) may lead the poor to reduce fertility voluntarily, especially if accompanied by appropriate policies. However, this takes time, perhaps especially in Pakistan, where both the population record itself, and the health and education variables seen by Malthus and the moderns as harbingers of fertility reduction, are less favourable than in many other Asian countries (Table 1).

This paper suggests a third option for "schemes of improvement", apart from technical or political advance on the one hand, or fertility reduction on the other. This option in many cases appears to have a better chance, compared with the political and technical schemes rejected by Malthus, of swiftly reducing poverty. This is because the third option often does not tend to re-ignite population growth, even in the interim period before family size norms have been reduced. The third option is to increase the conversion efficiency along the income-consumption-food-energy-work-income chain, and related chains (Section VII and Figure 2).

II. MALTHUS'S ARGUMENT REVIEWED

In the absence of fertility decline, Malthus believed that *all* schemes of political and technical improvement–while often raising total and sometimes per-person national product, the welfare of the non-poor, and even in the short run the welfare of the poor–were powerless to reduce poverty incidence or severity durably. In the *political* sphere, that applied not only to the comprehensive assaults on privilege proposed by Godwin and Condorcet, with which Malthus had little sympathy [Malthus (1798)], but also to Arthur Young's suggested land reform (cottagers' rights), and even to the grand Smithian vision of policy reform to liberate production and exchange and thereby to induce specialisation, investment and technical progress. *Technical* "improvements", to which Malthus [(1798), 12; (1803), *passim*] often refers–such as Jenner's smallpox vaccine, or agricultural innovation along the lines of Tull and Coke–were equally powerless to reduce long-run poverty, unless

Table 1

Population Growth and Related Variables

	Population 1992	Rates of Population Growth (% per Year) 1965–90	1990–2015 (Projected)	% Increase 1990–2015 (Projected)	Child Mortality (1990)	Adult Female Literacy (1990)	Female ÷ Male Literacy (1992)	% of Married Women of Child-bearing Age Using Contraception (1989)	Primary Female Enrolment: % of Age-Group
Bangladesh	120	2.7	2.2	70.4	137	22	47	31	68
China	1187	1.9	0.9	26.4	35[a]	68[a]	74	83	>100
India	880	2.2	1.6	49.5	127	34	55	45	83
Indonesia	191	2.2	1.4	40.2	95[a]	77[a]	85	50	–
Pakistan	155	2.9	2.5	*86.1*	139	21	45	12	39
Sri Lanka	18	1.7	1.1	31.5	22[a]	83	90	62	>100

Sources: Jha *et al.* (1993): 4; UNDP (1994); Sathar and Reza [this conference: Tables 1, 8]; Mahmood and Tariq [this conference: Table 2]; UN (1992); World Bank (1994: 212).

Note: [a]1992.

the poor reduced their fertility.

Malthus believed this because he concluded, from the limited historical and biological evidence, that humans (like all other species) increased the population in proportion to the means to subsist. Therefore, unless poor people's supply curve of children (plotted against means of subsistence per person) shifts down–or their "supply curve" of deaths up[1] any technical or political improvement that raises poor people's access to food staples will cause their numbers to rise accordingly. In quantity space, this continues until *available* food per poor person has fallen back to "subsistence" level. In price space, the process immediately and progressively raises labour supply[2] and food demand, reducing the real wage-rate and hence the food which the poor are legally *entitled* to claim [on entitlements and availability see Sen (1981)]. Both processes bear especially harshly on the poor, because they spend a larger proportion of outlay on food staples than the non-poor, and derive a larger part of income from wage-labour. Malthus believed that "the passion between the sexes" was restrained only by the need for all family members to meet subsistence requirements, and that the evils of contraception (a form of "vice") outweighed any possible benefits. On these assumptions, his problem cannot be escaped.

J. S. Mill, convinced by Malthus's logic but not by his ethics, strongly advocated (at least in his early work [Hollander (1985) 968–70] active policy to spread modern contraception, as do neo-Malthusians today. Fertility does respond somewhat to the cheapness, acceptability and accessibility of the means of contraception [Easterlin and Crimmins (1985)]. The poor are harmed, indeed often killed, by the effects of high fertility, some of it unwanted. Thus the view that modern contraception should be encouraged, spread, and perhaps subsidised is persuasive. However, this alone may do only a little to solve Malthus's problem. *Each* working poor couple may well behave "rationally" by having many children; the Malthusian problem is that the effects, perhaps in quantity space on available food per person but certainly in price space on the real wage-rate, bring the well-being of *all* such couples back down [Sen (1967); Cassen (1978); Schultz (1981)]. Thus the spread of contraception is constrained mainly by demand.

Such extra demand for reduced fertility was once seen as a lagged effect of growth itself: the demographic transition. More coherently, fertility decline is now seen as a *frequent* result of events or incentives that *may* (usually do–but not, for instance, in Libya: [*ibid*] accompany growth. These include events such as reduced

[1]Malthus distinguished two forms of checks on population growth, positive and preventive. Positive checks are extra deaths, especially from famine, whether due to upward shifts in a given "supply curve" or to a reduction in the poor's means of subsistence along it. "Preventive checks" are fertility reductions, "prudential" if through later marriage or abstinence, otherwise "vicious".

[2]At once, as parents were pushed by need to supply more work [cp. Chayanov (1966)]; and later, as adolescents and adults joined the labour market.

child mortality, and growth-related incentives to substitute child quality for quantity, and to free women's time from motherhood to education and earning [Becker and Lewis (1973)]. Moreover, improved means of contraception, even if desired to reduce family size, normally spread slowly, being dependent on greater female equality as much as on knowledge and access.

In some ways, modern knowledge makes the problem look worse than when Malthus formulated it. First, evidence (and medical advances) since Malthus lead us to stress the effects of improved subsistence for the poor in enabling them to "buy into" better nutrition, sanitation and health care, thus reducing their mortality, rather than in raising their fertility.[3] Excellent as this is, it brings a bigger and swifter rise in both food demand and labour supply than would accrue if the population increase were due mainly to extra fertility; the effects have been sharpest among the poor.[4] Second, strengthening such effects, there has been a faster and larger *exogenous* improvement in health than Malthus envisaged. Third, there may be gradual, or even threshold, damage to soil, water or biodiversity from rapid growth of population, further diluting gains to the poor from "schemes of improvement".

Fourth, even fertility reduction–which Malthus recognised as the only logical escape–needs to be rather widespread, if it is to ensure that "schemes of improvement", if successful in reducing poverty in the short run, do so also in the long run. This follows at once from Malthus's model that (subject to biological constraints) couples that have *not* reduced their fertility will breed up to their means of subsistence. The same conclusion follows from the less contentious modern formulation, that the supply of children responds to their (food) costs while they are dependants and to their eventual (wage or remittance) returns afterwards. Suppose that fertility reduction is not widespread among poor couples: that, say, only one-third of them were to halve their *absolute* total fertility rate (TFR). This would lead to the expectation of more (cheaper) food and more (better-paid) work for the offspring of the other two-thirds, whose TFR would therefore rise[5]–possibly in absolute value,

[3]For the very poorest, fertility does initially rise somewhat as income and nutrition improve, but the fall in age-specific mortality is much greater.

[4]This is not only because they have the highest propensities to consume food staples, and to derive income from wage-labour. Also, because poor people's initial death-rates are highest, a reduction of the same proportion in annual death-rates among poor and non-poor–say from 200 to 100 per thousand poor aged 0–5, and from 50 to 25 for the non-poor–means a much bigger proportionate rise in demand for commodities (especially food staples), and ultimately in labour supply, among the poor. Also, for populations of similar size, the 200-to-100 reduction is usually easier and cheaper to obtain than the 50-to-25 reduction.

[5]We cannot be sure that it would rise enough to mop up the gains to the poor altogether, as in Malthus's model. If the natalist two-thirds already have a high TFR of seven or more, there is little biological scope for a substantial or rapid further rise. And, of course, if (say) three-quarters of the poor halve their TFR–absolutely, or as a function of the real wage–the remaining one-quarter could not "compensate" by any remotely plausible rise in *their* TFR.

certainly net of their (declining) death-rate. Matters are even worse if we suppose, more plausibly, that one-third of the poor were to halve their TFR as a *function of the real wage* (money wage deflated by price of main food staple), while that function remained unchanged for the other two-thirds. Since such functions are increasing, the rise in the real wage–as the "one-third" reduce their food demand and labour supply–would again increase the TFR of those who had initially reduced it, as well as among the obstinately natalist two-thirds!

Yet Malthus increasingly recognised that widespread declines in fertility, and hence in long-term poverty, were possible. Better child survival prospects, mass education, and rising standards *for* living–substitution of (educational) quality for quantity [Becker and Lewis (1973)] in children, embourgeoisement [Winch (1987)] in parents–were mechanisms that Malthus (1824) explicitly recognised as causes of fertility decline, both exogenously and as results of carefully selected schemes of improvement. But in Pakistan this decline is proving slow (Table 1).

III. TECHNICAL PROGRESS

It is often argued that technical progress can durably reduce poverty, even if the labouring population continues to grow (because its crude birth-rate exceeds its crude death-rate). Technical progress can be relevant only if it increases both the global supply of food staples, and the capacity of poor people to afford them at the local delivered price. Malthus often reviewed potentially relevant *exogenous* technical progress in food production. He dismissed it as (i) unable to keep up with geometric population growth, (ii) limited by diminishing returns, and above all (iii) tending, even if successful, to destroy its benefits for the poor by reigniting population growth. The first two arguments have been much challenged and, as presented, were sometimes wrong in detail; the existence of ultimate limits to food production is hardly in doubt, but those limits are much more distant that Malthus imagined. His third objection is fundamental. However, it is not proven that the fertility response to "schemes of improvement" will be as large and harmful as Malthus claims. As the poor gain in the short run from such schemes, their biological scope for increased TFR, absolutely or relatively to their death-rate–or the TFR's elasticity to the real wage-rate–could be quite low. If so, then the gains to poor people from an initial "scheme of improvement" may not lead them to raise the long-run supply of labour and demand for food enough to wipe out (rather than merely to reduce) those initial gains.

Moreover, Malthus did not directly consider modern arguments that population growth would induce just the sorts of *endogenous* technical progress that would feed and employ the poor. Three main types of endogenous technical progress are adduced by modern economics.

Boserup (1965) argues that an increased demand for food, as induced (for example) by population growth, increases the demand for forms of technical change that raise the supply of food. On her reading of agricultural history, necessity is the mother of invention (or rediscovery) of food-intensifying methods of production, such as shorter fallows. If so, one of Sen's (1981) two types of food problem–deficient availability–even if initially worsened by the Malthusian impact of rising food demand due to population growth, will endogenously remedy itself by inducing supply of food-intensifying technical change.

Hayami and Ruttan (1985) and Binswanger and Ruttan (1978) contend that an increased supply of labour, as induced (for example) by population growth, increases the effective demand for labour-using technical progress in agriculture. If so, Sen's other type of food problem–failure of exchange entitlements among the poor–even if initially worsened by the Malthusian impact of rising labour supply due to population growth, will endogenously remedy itself. As rising labour supply induces labour-intensifying technical change, the demand for labour (per hectare) is again pulled up, and with it real earnings.

Innovation, invention or discovery along the lines of both Boserup and Hayami-Ruttan are *necessary* to solve Malthus's problem [Lipton (1990)]. Even together, these supply responses need not be *sufficient*, or fast enough, to prevent the worst sorts of Malthusian "positive checks": communities in the aftermath of population acceleration have sometimes been destroyed by hunger. However, a third endogenisation of technical progress might save the day. Simon (1986) argues that population growth also increases the supply-elasticity of technical progress. More people mean more-than-proportionate increases in interactive learning, and hence technical progress, in (implicitly) endogenously growing economic systems.

Unfortunately, there are several objections to the belief that these three forms of endogenous technical progress, even jointly, take the sting out of Malthus's central claim. Three of the objections are not (I think) made by Malthus. First, technical progress (or something else) has to induce not only sufficient extra production of food staples globally, but also sufficient increased affordability of those staples for the poor; even if all inventions and innovations are induced, neither the basic science nor the high supply elasticities implicit in these joint requirements can be taken for granted. Second, technical progress is induced, if at all,[6] not only by demand for the end-product (e.g. food) and by the changing ratio of factor scarcities (as reflected, for example, in the wage-rental ratio), but also by changing world-views and peer-pressures among direct producers such as farmers, firms supplying

[6]Some is not. The "green revolution" is traceable ultimately to the sweet-pea breeding experiments of Mendel, an Austrian monk, in the late nineteenth century. Neither the basic science nor most of the subsequent research can have been "induced" by Asian food needs or labour availability, in the 1950s.

them with inputs, and scientists. Third, to the extent that the supply of inventions (as well as innovations) is induced by a demand that is derived–e.g. from the final demand for food, or from intermediate demand for different land/labour ratios in production–the inducing source of demand is global. The cost-cutting requirements of capital-intensive, organised, wealthy temperate-zone farmers–and the final demands of meat-eating, wealthy consumers–are liable to be the main "inducers" of technical progress. It may be rather lightly influenced by poor people in poor markets, let alone by the rate of change in the numbers of such people–whether they apply their exiguous market pressure for technical change as producers seeking land-intensification or as consumers seeking food-intensification.

Malthus himself makes three other objections, including the most fundamental one, to the view that technical progress (even if endogenous) solves his problem. First, investment–and, even more, technical progress–is induced, if at all, with a time-lag behind the sources of extra demand, such as population growth; but the impact of population growth on the real wage (via extra demand for food and extra supply of labour) is immediate. Second, technical progress may (though Malthus was wrong to suggest that it must) have increasing marginal cost per unit of extra product generated; a related point is that such technical progress must have limits, "when every acre of this Island is like a garden" [Malthus (1798): 12], although the biophysical limits to the conversion of sunlight, nutrients and water via biomass into food are much further off than Malthus envisaged. However, Malthus's fundamental objection was that technical progress–to the extent that it succeeded in improving food availability and entitlements for the poor–would induce them to renew the growth of their numbers. This indeed *slows* the reduction of poverty, but need not *prevent* it: it is wrong to assume that population increase will continue until subsistence-level incomes are again reached.

IV. A POSSIBLE INTERIM SOLUTION?

Technical progress may be swift or continuous enough to overcome the Malthus problem for long enough to permit changes in behaviour that induce fertility decline. However, labour-intensive innovation, which seems both likeliest and most desirable in labour-surplus countries, *increases* natalist incentives for poor households, which are most dependent on labour for incomes. Even with no change in the family size norms of the poor, technical progress might durably reduce poverty, if we reject Malthus's assumption that the poor produce offspring until their income-per-person declines to the old level of subsistence. Then, the effect of technical progress on the total labour supply, food demand and real wage, and hence on poverty, depends on a number of elasticities, and on the biological limit to increased fertility. Nevertheless, without a rise in acceptable minimum subsistence, or some other change that lowers family size, Malthus is right that technical progress alone

sets up demographic responses that reduce its initial poverty-reducing impact, perhaps substantially.

Reduced family size norms, as Malthus's writings increasingly stressed, are possible in the wake of social advance, especially higher standards for what comprises subsistence. "Civil and political liberty and education" would probably induce the poor to prefer small families at a "respectable, virtuous and happy" level of subsistence, to maximal family size at a barely survivable level of subsistence [Malthus (1824): 40]. However, continued high norms may well continue for many decades to be rational for the poor. It is they who must insure against the biggest risks of destitution in their old age, and of each child's prior death, unemployment, or failure to support them. Also, the poorest children normally impose the lowest costs (and shortest pre-employment periods) of child-rearing, and start soonest to return income to the household.

To overcome Malthus's claim, and to justify the renewed hope in his later work for progress against poverty, one needs to show that it is the poor whose command over food is durably improved by technical progress, or who reduce their family size norms. World history shows that this happens in the long run. Can improved conversion efficiency help to reduce the number of poor people who die before the long run arrives? Behavioural (including "policy") and biological adaptation [Payne and Lipton (1994)], by persons, households and larger groups, can improve conversion efficiency along the income-consumption-energy-work-income chain. Some of these possible improvements need not, even under Malthus's assumptions and even with no fall in family size norms, rekindle population growth.

V. POVERTY AND HOUSEHOLDS: SOME EVIDENCE

Let a household's YC be its income or consumption of all commodities (private, including self-consumed "subsistence"; common-property; or publicly-provided), per person or per adult equivalent.[7] A household is in *ultra-poverty* if and only if such YC is less than YC*, the ultra-poverty (or food poverty) line. YC* is the amount of YC that just permits all the household members' dietary requirements to be met–if the household is "typical" in the sense that it (i) divides YC among uses like the average household of its own YC, size and demographic composition, and (ii) allocates nutrients to household members in proportion to their requirements. If we consider only "energy" as a nutrient, this is the "food-energy method" to fix a line of (ultra-) poverty.

[7]This is intended to admit a range of positions in the arguments about income *vs* consumption, and above equivalence-scales, in devising indicators of economic welfare. See Lipton and Ravallion (1994).

Household surveys lead us to two sets of cross-section observations. The first set is consistent with Malthusian observations that the demographic behaviour of poor families impedes their struggle against poverty, though not with his earlier (1798) position that this impediment vitiated all "schemes of improvement". The second set of observations is relevant to the prospects for interim progress against poverty by improved conversion efficiency, even before family size norms fall substantially. In the following discussion, "poor" is used to mean ultra-poor: exposed to household YC below YC*, endangering the dietary energy adequacy of household members. Most of the following observations apply also to surveyed behaviour around higher levels of YC that reflect more generous definitions of poverty.[8]

The **first set of observations** centres around the fact that poverty incidence, intensity and severity tend to be greater in bigger families [Lipton (1983, 1988); Jha *et al.* (1993): 19]. Recent work [summarised in Lipton 1994] shows that this applies not only in Asia and Latin America, but also in many areas, such as West Africa, where it was once questioned. It applies in Pakistan, despite surprisingly high economies of scale in consumption with increasing household size [Lanjouw and Ravallion (1994)].[9] In the cross-section at least, this is a fertility effect: poor households are bigger than non-poor because likelier to overcompensate for higher infant and child mortality by adopting much higher total fertility rates, whether due to replacement effects, (over-)insurance due to greater absolute risk aversion, or other factors. Poorer households' greater dependence on labour income, and shorter periods of child-rearing with lower direct and opportunity-costs,[10] may well account for this. However, such sound economic motivation for pro-natalism among poor people–with little hope of rearing a few children to educated adulthood, rather than many children through unskilled working adolescence–does not alter the fact that high fertility, leading to a high dependency ratio, is (arithmetically speaking) a cause of much transient, and some permanent, *individual* poverty. This high fertility strengthens the Malthusian effect in *aggregate* food and labour markets.

So does the fact that larger and poorer families, partly because endowed with much fewer income-earning assets (especially land) or human capital per person, are much more likely to depend, for income, on unskilled wage-labour and especially on casual work [Lipton (1994)]. These large, poor, labour-dependent families are thus much more heavily reliant, for income, upon real wage rates and employment

[8]For example, a "moderate poverty" line YC' per adult equivalent such that–for the household allocating its YC typically of households of that size, demographic structure and YC level–positive savings (in the sense of net accumulation of *total* capital, physical, financial and human) occurs if and only if YC' > YC.

[9]At the poverty line a 13 percent fall in mean household size is associated with a rise in mean consumption per person (of private and locally public goods) of only 10 percent [*ibid.*].

[10]Because mothers' foregone income (e.g. wage-rate) is lower than for the well-off.

prospects, and for the poor *as a whole* these are depressed by the rational individual pro-natalism of *each* poor couple [Sen (1967); Cassen (1978)]. The surveys further confirm the vulnerability of the poor to increased population and hence reduced corn-wages (with rising food demand and labour supply) by showing that, as YC falls towards YC*, there are increases in both the proportion of income spent on food (Engel's Law) and age- and gender-specific workforce participation rates, casualisation, and time-rates of unemployment [Lipton (1994)].[11]

Malthus argues that poor people's high fertility, family size and dependency ratios–which although individually "rational" are clearly helping to keep the working poor as a group in poverty–were in part permitted by past "schemes of improvement". The above set of observations does not, of course, prove that claim. Indeed, it is possible that the better-off households, who show lower fertility in a cross-section study, had benefited from improvement, made income gains, and subsequently faced incentives or institutions that had induced them to reduce fertility and maintain those gains. Malthus (1824) explicitly recognises that possibility. He concludes, from then recent cross-sectional material (especially from Switzerland and Norway), that places with "extreme healthiness", especially if supported by mass education and a culture that induced the poor to raise their expectations, could entrench reduced fertility, and by implication could reduce poverty as well. The first set of observations confirms, not necessarily the central claim, but surely the primacy of the "Malthus rectangle" (Figure 1), i.e. the interaction between population and the real wage, in explaining poverty.

The **second set of observations** from cross-section studies [Behrman (1988); Behrman and Deolalikar (1988); Lipton (1988), Payne and Lipton (1994)] is relevant to the possibility that improved conversion efficiency (Figure 2) may be a way out of the Malthusian rectangle (or box), even before fertility falls. The observations suggest that, among households, variations in YC account for only a rather small proportion of variations in nutritional levels. Many households and groups with YC below YC* show few or no signs of nutritional damage. They show either conventionally "good" anthropometries, or "bad" ones but with no clear ill-effects (higher standardised mortality or morbidity, impaired mental or physical functioning). Conversely, some households above YC* do show signs of nutritional damage.

Outside parts of Pakistan, Bangladesh and Northern India, bad nutritional performance for a given YC–whether above or below YC*–is not due in significant part to what has been termed "family failure" [Kabeer and Humphrey (1991)] to distribute nutrients within the household in proportion to their needs [Harriss (1990); Svedberg (1990)]. Nor is above-average nutritional performance (at any

[11]There is some evidence [Lipton (1994)] that these trends cease to apply among households whose YC < YC*. For such households the proportion of income spent on food typically appears to stabilise at around 80 percent.

given level of YC) mainly traceable to "positive deviance" [Zeitlin *et al.* (1987)] in the management of young children. Are particular poor working households responding with special success to given demographic pressures–from their own size and dependency ratio, and (via real-wage prospects) from the changing sizes (and hence food demands and labour supplies) of such households as a whole due to greater conversion efficiencies along the chains shown in Figure 2, or perhaps due to better capacity to increase such efficiencies under stress?

VI. FOOD AND LABOUR PRICES: THE MALTHUS RECTANGLE

Malthus, especially in his early work, does sometimes reason as if the main basis for his central claim is about *quantities*–global food *availability* per person. This appears in his famous, and misleading, juxtaposition of geometric increase in populations with (allegedly) arithmetical increase in food supply; and in his occasional tendency to commit *petitio principii* by assuming that a given rise in population at once outpaces food supply [e.g. Malthus (1798): 53]. To pose the problem in quantity terms, as an issue of what is technically feasible, is empirically dubious; it would take at least 150 years of population growth at 3 percent per year to approach a human population level that threatened *sustainable* food production consistent with limits on the supply of edible global biomass (and one day we may farm the planets). To set any lower limits to *technical* feasibility of providing the necessary food *quantities* to prevent "positive checks" is to beg the question of supply responses–which Malthus, of course, elsewhere considers fully. Most seriously, the quantity-availability approach fails to address the question of who gets the food, and thus of whether it is the poor who suffer.[12]

However, Malthus's more considered expositions, especially in his later work, relate to the effects of population growth on wages and food prices. It is this exposition of the effects of population growth–whether or not induced by schemes of improvement–on poor people's food *entitlements* in *price* space that constitutes Malthus's contribution to the analysis of development now. The sequences are spelt out in the "Malthus rectangle" (Figure 1).

Malthus enquired what would happen if population growth among the poor were stimulated by the resource-enhancing changes that he saw in Western Europe. He analysed the manner in which such changes might fail to benefit the poor in the long run because of interactions around the "rectangle". Each of these European changes has recent parallels, relevant to the reinterpretation of the Malthus rectangle

[12]This is an ironic failure, given Malthus's critique of Smith's transition from the valid claim that his scheme of improvement, viz. sound economic policy, induced growth, to the less certain claim that it reduced poverty.

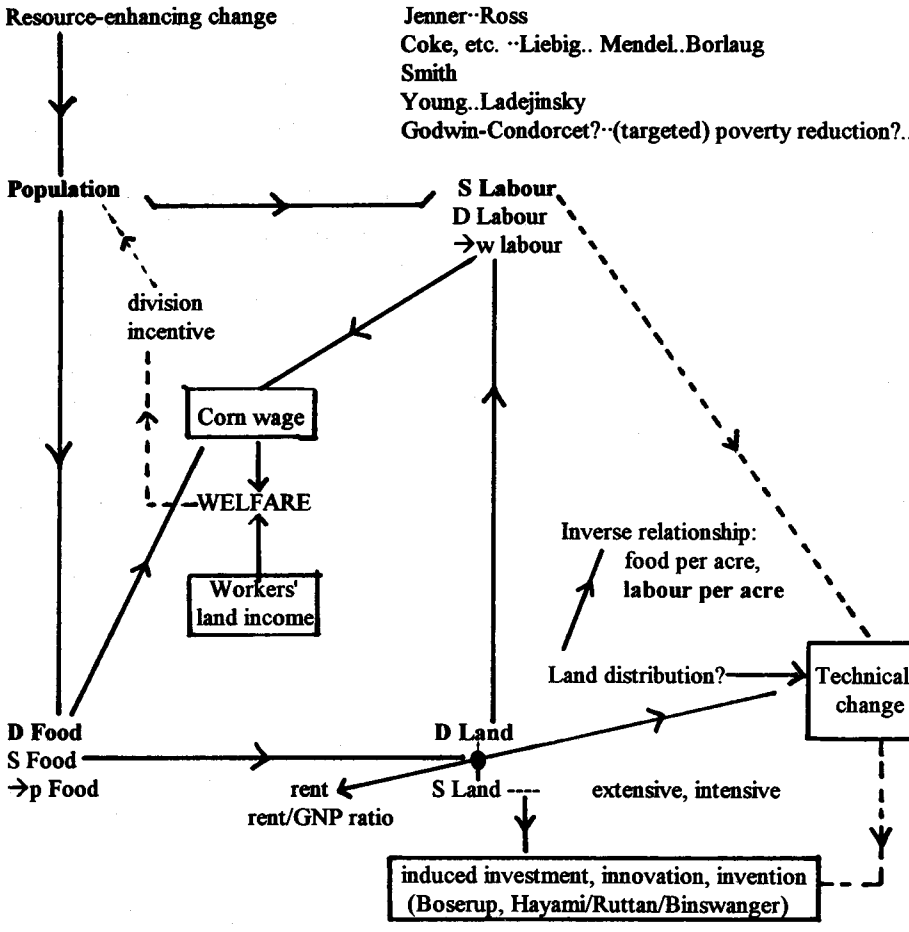


Fig. 1. The Malthus Rectangle.

in the context of Asian development prospects. In the **medical** sphere, Malthus reviews Jenner's discovery of cowpox vaccination against smallpox in 1796. Its demographic impact prefigured (faintly) that of Ross's discovery of the transmission mechanism of malaria in 1895–8, once insecticides made mass spraying feasible in the 1940s. In **agriculture**, the innovations of English experimental farmers –Townshend and Tull in the 1730s, and Coke in the 1780s–were well known to Malthus and surely were in his mind as he traced, around the rectangle, the scope of agrotechnical progress. Such advances prefigured, in the extra livelihoods they made possible, such diverse events as the development of rice mangrove swamp cultivation by the experimental farmers of Sierra Leone in 1880–1925 [Richards (1985)] and of bamboo tubewells by those of Bihar in the 1960s; the research of Liebig in

Prussia in 1840–60; and later the work of Borlaug and others in modern seed development. As for **land tenure**, Arthur Young's proposed reforms of cottager tenure were criticised by [Malthus (1824) 35, and 58, fn. 40] for "rectangular" reasons, viz. their long-run effect in re-igniting population growth among the beneficiaries and hence destroying their gains. Such proposals prefigured the Mill-inspired [Hollander (1985) Vol. 2, Ch. 11] nineteenth-century reforms of Irish land systems, and the wave of land reforms since 1945 in which Wolf Ladejinsky played a leading role.

The rectangle illustrates the forces by which population increase–whether due to better health, improved agriculture, land reform, or other things, and whether or not traceable to "schemes of improvement"–harms the poor through price changes. Population increase can do this in three ways. **First**, extra labour supply reduces the equilibrium wage-rate; even if population increase comprises only extra births, it raises the supply of labour not only later, when the extra children enter the labour force, but at once, as their parents increase their labour supply because the marginal utility of food to the household has risen relative to that of leisure [Chayanov (1966)]. **Second**, extra demand for food staples raises their price. **Third**, as land supply (extensive or intensive) responds, the share of differential Ricardian rent in GNP rises, as does the marginal cost of farm production. All three effects tend to reduce the corn-wage.

Malthus *implicitly* recognises that the first effect induces employers to move up the demand curve for labour, and that the second effect induces movements up the supply curve for food. These induced responses, he argues, will lead to "oscillations" in the real wage [see especially Malthus (1816)]. Marshallian supply and demand curves confirm Malthus's intuition that such movements along the curves cannot stop the corn-wage from being lower in the new equilibrium–with more labour supply and food demand–than in the old. This formal analysis, not available to Malthus, may help to explain why Marshall was a confirmed neo-Malthusian!

Modern evidence is relevant both to the rectangle as a whole and to several vertices and interactions within it. A large part of cross-section and time-series variability in the incidence of poverty in India is associated with the price of food staples: the Dharm Narain hypothesis [Mellor and Desai (1986)]. Across countries and over time in South and East Asia, higher poverty is strongly (but not perfectly) associated with rising labour-supply and resulting dampers on wage-rates (see evidence in Lipton and Ravallion (1994). Across nations, a 1 percent higher rate of population growth is associated with a 1.6 percent fall in the income share of the 40 percent of households with lowest total household income [Chenery and Syrquin, cited in Ahluwalia (1974)],[13] though of course these overlap very imperfectly with

[13]The elasticity of 1.6 applies when these two variables, and several other explanatory variables, take their mean values.

the poorest households in per-person terms.

Related evidence at several points of the "Malthus rectangle" has interesting implications for some of the key policy options, at least against rural poverty. For example, Malthus, as we saw, feared that even "letting land to labourers" [1816 Appendix, in James (1987) Vol. 2, p. 222]–while good for their output and income-per-person in the short term–might self-destruct via increased fertility later. So what about land reform as a re-igniter of fertility?

The evidence is as follows. Greater equality of **owned** holdings (and of assets overall [Repetto (1979)] is associated with lower total fertility rates, probably because higher income (due to more land ownership) brings new chances to substitute quality for quantity in children, and the prospect of mortgage (instead of reliance on remittances from one or other of numerous children) in emergency. However, greater equality of **operational** holdings, probably because it brings higher demand for labour per unit of land, is associated (at least in the short term) with higher total fertility rates [Schutjer and Stokes (1984); Lipton (1991))].

There is also evidence on the effects of technical progress. The "green revolution", across Indian Districts, appears to be linked to slower fertility decline in the short term, but faster decline in the long term [Vosti and Lipton (1991)]. Once again, the short-to-medium-run power of real-wage effects in the Malthus rectangle, and their impact on poverty, appear to be supported by recent evidence. But the very rapid economic growth of much of modern Asia–first alongside unprecedented population increase, and later with incentive changes that have greatly slowed that increase–confirms that Malthus's "quantity-space long-run" may well, as Malthus himself hoped and half expected, never happen.

It might be objected [Simon (1986)] that many societies have experienced fast population growth but faster economic growth, and thus cut poverty. There *is* a strong positive link between rapid economic growth and poverty reduction. Indeed, at first glance, the experience of both India and Pakistan since Independence appears to contradict Malthus's "principle of population" in every respect. Population has grown at an unprecedented rate, which is only now beginning to decline (Table 1). Yet the growth of real income per person, and even the reduction of poverty–though less than elsewhere, and than might have been the case under better policies–have also been unprecedented, and since the early 1970s accelerating.

Yet a "second glance" suggest that the development experience of Pakistan, at least, is rather close to Malthus's mature model. This model does not predict that real income per person cannot grow, but that poverty cannot in the long run decline unless the working poor reduce their family size norms. In fact, total fertility rates *have* declined between 1960 and 1992 in Pakistan–but only by 8 percent (to 6.3), compared with a decline of 33 percent to (to 4.0) in India, of 27 percent (to 4.3) in Bangladesh, and of 60 percent (to 2.3) in China [UNDP (1994) 174-5)]. It is safe to

assume that the decline, however, was more for the non-poor, and from an initially lower level. Conversely, the fall in the death rate–as indicated by falls in the infant mortality rate between 1960 and 1992, from 163 to 99 in Pakistan, as compared with falls from 165 to 89 in India, 156 to 109 in Bangladesh, and 150 to 27 in China [*ibid*: 176–7]–was probably more for the poor, since the best-off had lower death-rates to begin with. Hence it is poor, largely labourers, populations that especially in Pakistan, have experienced the most marked expansion in labour supply and food demand.

In South Asia as a whole, labour supplies (and numbers demanding food staples) have continued to grow at 2.2–2.5 percent per year; and the decline in poverty incidence, while quite clear, has been modest and regionally patchy. Real wage-rates of unskilled rural labourers have grown only very slowly [Lipton and Ravallion (1994)], much less than other components of real income per person. They have been restrained where extra population most increased the supply of labour and the demand for food; Evenson (1984) showed that faster growth in labour-per-hectare was associated, across Indian Districts, with relatively faster-falling wage/rental ratios. Hence the link between economic growth and poverty reduction is not uniform; its strength varies across space and time.

In part, this is due to the weak version of Malthus's central claim: past "schemes of improvement" have in many cases induced poor people to raise their supply of labour and demand for food, thus slowing down the reduction of poverty. Some of the regional variations are due to differences in policy, and hence in the structure of the State or the balance of pressures from "civil society". These variations also affect fertility responses. These appear to be much less pronatalist in villages where poor people feel they have more security, and better prospects of equal treatment under law, from the civil power [Cain (1982)].

All in all, the evidence does not suggest that technical or social progress provides an escape from the *direction* of the effects outlined in Malthus's rectangle, although the gradual retreat of poverty (and fertility) in Asia and Latin America suggests that the *scale* of those effects is less destructive than Malthus had feared. The evidence also suggests that fertility responses to growth, unless it is unusually equal and well-managed, may take a long time–as is the case in Pakistan. It is therefore important to ask what can be done meanwhile.

VII. IMPROVED CONVERSION EFFICIENCY?

Figure 2 shows the main paths through which people can convert assets into welfare. This section shows that (i) many of these paths can be operated at varying rates of conversion efficiency; (ii) these efficiencies interact; (iii) poor and near-poor people can often increase them–albeit seldom costlessly via biological or behaviour-

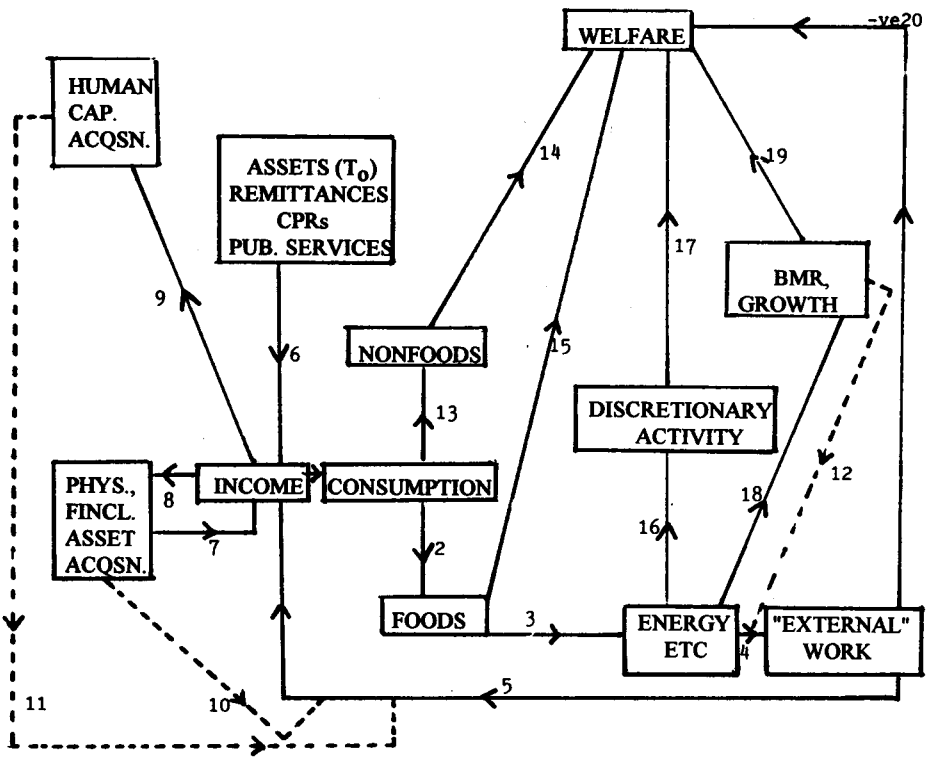
al responses to "schemes of improvement" or the population growth that such schemes induce; (iv) such responses are frequently not open to the objection that they rekindle population growth. The relevance to Malthus's central claim is twofold. First, a possible escape, from the danger that "schemes of improvement" fail to reduce long-term poverty as a result of induced population growth, is opened up. Escape is feasible, not only by technical progress (which is of uncertain effect: Section IV above) or fertility reduction (which is effective but can be slow), but also as *individuals* adapt so as to increase conversion efficiency. Second, if population growth–whether exogenous or induced by "improvement"–presses levels of living down towards subsistence, *policies* may exist to help the poor to raise conversion efficiency.

Especially for the poor, the conversion of resources into well-being usually involves a **central circuit** comprising the connections 1 to 5 in Figure 2: from income, via consumption, to food, energy, external work, and income. More income can be made available, both to obtain food for this circuit and to achieve welfare (including reduced poverty) by other means, along **income-related** paths, numbered 6–9 in Figure 2. The rate of conversion of external work into income along the central circuit can be improved by three **work-enhancing paths** involving physical or human assets (10–12 in Figure 2). Direct **welfare paths** also exist, necessarily so in the case of the path from energy to welfare via basal metabolic rate (BMR) and growth (18-19 in Figure 2), and optionally by the use of consumption for non-foods (13-14), for tastier or more varied food rather than for "mere" energy and other essential nutrients (15), or for discretionary leisure activities (16-17 and *minus* 20). However, these processes 10–20 divert resources–consumption, food or energy–away from the part of central circuit that turns food via energy into work (3-4 in Figure 2). Complicating the issue, up to a certain level the use of energy for growth to larger body size (and perhaps to fuel a higher BMR) may increase the capacity for some sorts of work (12).

We have mentioned the variable strength of relationships between population pressure and poverty–and between growth, increased population among the poor, and poverty reduction–across India's Districts. Some of these relationships are probably due to differences in conversion efficiencies. In Southern India, infant and child mortality and measured undernutrition are in general lower than in parts of Northern India with lower incidence and severity of poverty, in the sense of $YC<YC^*$ at average all-India energy requirements. This is partly due to social policy, especially in Kerala, but there seem to be adaptive features of Southern Indian populations–notably lower child height ceilings, leading to smaller risk of wasting. It is almost certain that groups historically long subject to dietary energy stress have selected genes not only for relatively low height but also for low BMR/kg, which commonly shows an interquartile range of 10 percent within communities and at

least as much variation among means for ethnic groups [Payne and Lipton (1994)].

Such biological-genetic adoptions take some time, often more than a generation. They can explain why groups exposed to persistent dietary stress, of particular sorts, show conversion efficiency improved along relevant paths and in relevant ways. However, this is a "way out" of Malthus's central problem only if the adaptations themselves inhibit fertility, or require reduced family size. That is true of some adaptive improvements in conversion efficiencies along paths in Figure 2, but not in general.



Paths: 1–5 Central Circuit.
6–9 Other Income Related Paths.
10–12 Work-enhancer Paths.
13–20 Welfare Paths.

Fig. 2. Conversion Efficiencies.

Shorter-term, individual biological adaptations to energy stress directly raise the possibility that a *given* population, by improving an appropriate conversion efficiency, might avoid Malthus's problem.[14] Circumstances may well force parents with expectation of prolonged energy stress to map their children onto somewhat slower bodily growth paths, amounting to anthropometric status often defined as mild or even lower-moderate undernutrition. This causes hunger and discomfort, may delay recovery from some illnesses, and is an evil, but there is no convincing evidence that it does significant or permanent harm–not enough, in any event, to outweigh the fact that it enables the growing adolescent and the adult, being smaller, to survive future periods of energy stress [*ibid.*]. If improved conversion efficiency of this sort induced parents to enhance fertility on Malthusian lines, their small children's anthropometric status *would* become dangerously inadequate. Especially if parents know that risk, the Malthusian response should not happen.

Furthermore, one important way to increase *household* conversion efficiency is to avoid "wasting" dietary energy, earned by work for income in the "central circuit" 1–5 (Figure 2), on pregnancies that lead to stillbirths or on the initial years of infants and small children doomed to sadly early death. The World Fertility Survey shows that elimination of fourth- and higher-order births, plus adoption of birth spacing of at least two years, would reduce mortality at ages 0–5 by about 25 percent [Trussell and Pebley (1984)].

In any case, a recent literature review Payne and Lipton (1994) confirms that **behavioural** adaptations by potentially poor people, tending to reduce their poverty risk, are more important (and often more immediate) responses to dietary energy stress than are biological adaptations. Also, behavioural adaptations are likelier to be amenable to incentives, learning, and associated policy measures, than are biological adaptations. Behavioural (and perhaps some biological) adaptations to potential poverty risk, via increasing conversion efficiency in the income-consumption-food-nutrients-work-income circuit, are largely ignored by economists.

Yet such adaptations are less likely to be associated with renewed incentives towards faster growth of population or labour supply–or with resource depletion –than is the case for the adaptations on which Malthus (and his critics) concentrated, viz. land expansion at the extensive or intensive margins and/or technical progress. Improved conversion efficiency may thus be an important weapon in preventing the price changes that lead to Malthusian impoverishment, while policy-makers wait for (and stimulate) incentive changes towards reduced fertility. Improved conversion

[14]Controversy arises over the extent to which, as Sukhatme and Margen (1982) claim, some or all individuals biologically "tune down" their intrapersonal BMR *per kg* somewhat in response to some sorts of energy stress–a *very* short-run response. This is known to happen in extreme situations of near-starvation. In less extreme cases, the scale, causes, and "costs" of such adaptation are little understood. Nor is the extent of such adaptation in some critical at-risk groups, such as infants.

efficiency may, indeed, itself create such incentives, which in the *very* long run are necessary to avoid a biomass/sunlight food shortage (quantity "crunch").

It is on the conversion efficiency of effort into income–in particular into food directly–that economists have mainly concentrated. We have already considered the scope and limits of technical progress. However, all the twenty linkages shown in Figure 2 seem open to variations in conversion efficiency. This paper can only begin to comment on the research agenda, and to relate it to Malthus's problem.

Each of the links is, as a rule, put under *stress* by population growth (among other things), but *adaptable*, either to stresses or to incentives, i.e. improvable, although normally at a cost. For instance, at link 1, income can be transformed more efficiently into consumption by using (at a cost) more time to shop, gather, or learn. At link 3, food can be converted into more energy-source by avoiding waste in cooking and on the plate, again at a cost. At link 4, there is an economics (as well as a biochemistry and an ergonomics or bioengineering) of improving the conversion of available food energy into energy usable by the body and thence into income-yielding work.

Some adaptive behaviour affects several links at once. For example, under dietary energy stress (e.g. in the time surrounding the birth of a new child, and the withdrawal of the mother from some or all of her outside earning activity), a male worker may choose to accept a more unfavourable link 20 in order to increase conversion efficiency at link 5. This could well involve working less comfortably but more productively.

Most of the discussion of adaptation and response to dietary energy stress deals with links in the central circuit. However, there are relevant conversion efficiencies affecting other, supporting paths as well. For example, the non-food links 13 and 14 are little studied, but these conversions are clearly variable (adaptable). Their efficiency–or lack of it–interacts with the food chains via income availability, as well as commodity substitution and/or complementarity. An example of extra *availability* is the fact that more income can be freed up for food consumption by the marginally undernourished–and therefore for conversion into work and higher income along the central circuit 1-2-3-4-5 (Figure 2)–if the household finds ways or motives to improve the efficiency with which it converts income into adequate fuel or shelter (path 13-14).[15] An example of *commodity substitution* is that better shelter, sanitation, or (in cold and hilly places) heating or transport can reduce food-energy requirements. An example of *complementarity* is that better sanitation, if it

[15]This assumes that the requirement of "adequate" fuel and shelter is more or less fixed in quantity and quality. If this is false to the extent that poor people's demand for these goods is more than unit-elastic to (income-uncompensated) price changes–not very likely if these people are hungry–then a rise in conversion efficiency of consumption expenditure into fuel or shelter, which has similar effects to a price fall, will actually increase outlay on these items and reduce food intake.

improves health, usually increases the conversion efficiency of food into energy.

In that context, the efficiency of conversion along links 13 and 14, in itself and as it affects the volume and efficiency of conversion in the central circuit, is itself affected by the range of feasible shelter. Similar effects could arise from the presence or absence of addiction. In this context, three things are noteworthy.

Firstly, the role of addiction and shelter illustrate how a concern for conversion efficiency, in other paths than the basic income-food-work-income circuit, draws instant attention to–and may be the most cost-effective way to improve–the availability and efficiency of resources in the basic circuit itself. That may be the "best" way to reduce poverty *and* the "damage/poverty ratio".

Secondly, should we interpret a given event as (i) changing the conversion efficiency of A into B, or as (ii) changing the requirements of A to handle C and thereby altering the A-resources available to be converted into B? Though the distinction may seem purely formal, it needs to be modelled. For example, if schistosomiasis (C) is eliminated in a person, this substantially raises the food-energy (A) available to that person for work (B), because food is better absorbed and retained [Stephenson (1986)]; this could be seen either as a rise in *conversion efficiency along* link 3, or (since it reduces energy requirements to cope with disease) as a rise in *input to* link 3.

Thirdly, the discussion so far in this section is at individual level. Clearly, the efficiency of some of these links at a more aggregate level can be affected by redistribution, e.g. of food energy within the household. Such redistribution might be between boys and girls; or between household members currently at higher risk of damage due to undernutrition, and members at lower risk; or between actual and potential workers; or between members of the workforce and dependants. It is not obvious that all Pareto-improving exchanges within the household are made; two infants might both gain if they exchanged, say, milk for a blanket; or two adults, if they traded times of work, or more leisure for more food.

There are three objections to efforts to raise some conversion efficiencies (or to reduce requirements), especially in the "central circuit". First, such efforts are sometimes seen as at best mere palliatives, at worst brainwashing the poor into dumb acquiescence in low standards that deny them full use of their capabilities [Sen (1981)]. Second, it is argued that such efforts involve "victim-blaming" and distract from the need for basic social change. A third objection is that analysis of conversion efficiencies, unless it is embodied in production functions or production possibility frontiers, belongs to natural science, not economics. Such objections have some force, but have been vastly exaggerated in scope and importance, especially in conditions of extreme need. Nevertheless, it must be emphasised that improved conversion efficiency is not an excuse to soft-pedal policies against poverty. On the contrary, it is a means to increase the impact of such policies upon poverty.

One important response to energy stress is to reduce pregnancies, especially at difficult seasons. This is, however, only an extreme case of a general proposition: that in many cases, and perhaps in general, improvement of conversion efficiencies along non-production (non-labour-demanding) paths–adaptations to reduce losses along links shown in Figure 2–directly reduce possible future population pressures on land, rather than re-igniting them as the Boserup, Hayami-Ruttan and other responses to Malthusian stresses may well do, at least in the short term. Often, it is obvious to a couple that extra children will destroy, or close access to, the benefits of improved conversion efficiency. Because this happens directly at household level, it is much more obvious than the effects through the food and labour markets when extra poor people reduce the gains, to the poor, from earlier advances in, say, land access or farm techniques.

More fundamentally, there is no "prisoner's dilemma" about the individual decision whether to have more children, if they will negate the effect of part gains in conversion efficiency. But an isolation paradox *does* cause problems about a decision, by an individual poor couple, to refrain from producing extra children (labour supply, but also wage source) if neighbouring couples may not do likewise [Sen (1967)].

However, a basic objection to the whole conversion-efficiency approach, in the spirit of Malthus's argument, would run as follows. Suppose that the members of a household are persuaded–perhaps by the consequences of past population rises in reducing its level of living–that it has now become advantageous to them to increase conversion efficiency at one or more links along the chain, and to incur the costs of doing so. Why should this net improvement (or recovery) in well-being not *either:*

(1) Fail in the short run, for example because sufficient couples make the improvement as to so affect labour and food markets that the improvement reverses itself in the short run via the "rectangle", so that the demand for food and/or the supply of labour is raised sufficiently to negate most of the gains to the poor even without population growth; or
(2) succeed, but therefore lead to increased fertility, again raising labour supply and food demand around the "rectangle", and eventually leading (perhaps) to a local quantity "crunch"–in either case again reducing household welfare in the medium to long run?

Why, in other words, in the absence of delayed marriage, or other reductions in family size norms, is the household any likelier permanently to restore its well-being via improved conversion efficiency than via increased labour supply or food demand–either because of short-run price movements, or because of long-run price

shift, perhaps with a quantity crunch as well?

A detailed answer would require specification and modelling of several possible adjustments in conversion efficiency. But there are *general* reasons to believe that conversion-efficiency adjustments are much less likely than are labour-supply or food-demand adjustments to self-destruct in either of the two above ways, even without any change in the what may be called "family size norms as a function of a household's minimum acceptable, or target, level of living or well-being".

In the case of the short-run effect (1) above, a labouring household does not in general generate pecuniary external diseconomies in food or labour markets–and thus harm its neighbours–by improving any of its twenty "conversion-efficiencies" in Figure 2, whether in response to increased household size or otherwise. Indeed, in many cases, such improvements will lead household members to *reduce* labour supply and/or food demand, tending to raise the real wage-rate. By contrast, to the extent that labouring households as a whole respond to their increased size by demanding more food (and/or supplying more labour), they lower the real wage-rate; each household, by responding in that way, therefore injures its fellow-labourers, unless food is in completely price-elastic supply (and/or labour in completely price-elastic demand).[16] Moreover, it is not practicable for farm labour households to discover in advance, or to detect afterwards, the responses of their fellow-households to increased size–in food or labour markets–let alone their fertility decisions; so no cartels are feasible. In the case of the long-run effect (2), if food supply and/or labour demand is sufficiently price-elastic, the response to extra household size (or to anything else) of "buy more food and/or sell more labour" will lead to a net rise in short-run household welfare–but, on Malthus's model, also to a further rise in household size in the longer term, cutting back the increase. But there is no such general effect, if it is through increased conversion-efficiency that the household responded. That is because the household, in adjusting conversion efficiency, does so in a context that implicitly selects a new equilibrium that includes its desired family size; indeed, to change the household's time-path for that size would as rule be to destroy the optimality of the newly-selected set of conversion efficiencies (net of the costs of attaining them).

Even without Malthus's assumption about breeding up to the level of acceptable subsistence–with its implication that only by raising couples' expectations, and hence reducing their family size norms, can poor people's living standards be durably improved–Malthus's long-run problem (2) can still arise via the isolation

[16]Indeed, the extent to which Malthus is right *instantaneously* about the self-elimination of benefit to all per households, from each household's increased labour supply or food demand, depends on quite precise (i.e. unitary) elasticity assumptions. In the long run, of course, his assumption of "breeding up to subsistence level" would, if correct, guarantee self-elimination of such benefits for the representative household.

paradox. Each couple is driven to seek a large number of offspring as "tickets" to the queue for jobs (and hence as prospects for its own support in old age), yet in so doing lengthens that queue. The conversion-efficiency solutions, to the extent that they are available and attractive to households, avoid this form of (2) as well.

VIII. CONCLUSION

This paper has argued that Malthus's analysis poses two problems, about human and food *quantities* and about labour and food *prices*. The quantity (rationing) problem must bite eventually; indeed, before global population doubles every 25 years for three centuries, i.e. rises 4096-fold, there has to be a food constraint, though not because food output necessarily rises only in arithmetic progression! The price problem is more immediate, but also more tractable. There are three possible treatments.

Technical progress in agriculture fails unless it *both* increases labour-based access to income among the local poor, *and* global supply of food staples for such income to buy. Such failure could arise because technical progress responds to the supply and demand mainly of rich farmers, consumers or nations. Anyway, technical progress ultimately cannot alone solve the quantity problem.

Reduced family-size norms, absolutely or as a function of total real family income, can solve the problem. But they are not automatic. They can be slow. In Pakistan, both rapid fertility decline and its preconditions may be considerably delayed.

This leaves a third "treatment": improved conversion efficiency. There may be scope here, because conversion efficiencies are neither clearly *endogenous* nor clearly *self-defeating*. Modern economics tends to endogenise all treatments (e.g. to claim that the food-producing, labour-using impacts of technical progress are themselves determined partly by population growth; or that family size norms are economically optimising for the couple, not as Malthus claimed maximal for evolutionary and/or sexual reasons). Malthus claimed that–except for "abstinence"–all treatments, whether endogenous or not, were self-defeating because they rekindled population growth. Whether or not this is true in general (and it has been little researched), neither Malthus nor modern research indicates how it might apply to improved conversion efficiencies. Apart from their possible intrinsic importance, the levels, variability, and policy-proneness of such conversion efficiencies therefore need more research than the present very low levels.

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Comments on "An Escape from the Malthus Rectangle? Poverty, and Conversion Efficiency"

Dr Lipton's paper raises a number of interesting issues with important policy implications. The focus on opportunities for reducing the human misery associated with poverty by means of improved conversion efficiency opens up new perspectives for sustainable improvements in the well-being of the poor. Dr Lipton focuses correctly on behavioural rather than biological adaptation. The potential of the latter in reducing energy and nutrient deficiencies, and increasing the energy expenditure efficiency has, in my opinion, been exaggerated.

I agree that improved conversion efficiency, as defined and applied by Dr Lipton, should be further explored from a policy perspective. But it should be viewed as a *complement* to other more powerful forces to reduce poverty and poverty-related misery, not as a substitute for these other factors. It is also noteworthy that, as Dr Lipton points out, the concept of conversion efficiency is broader than energy and nutrient utilisation. It includes conversion of income to food and possibilities for increasing conversion efficiency in that regard.

I have no doubt that total fertility rates will fall in response to factors associated with increasing incomes such as higher education and falling child mortality rates. However, the relationships are not simple as illustrated by the current high fertility rates in Pakistan. A number of cultural factors may be of importance, including the status, education, and decision-making power of women in low-income households. Current low literacy level of women in Pakistan is likely to be an important reason for the high fertility rates. It is not likely that labour-intensive economic growth will lead to higher fertility. Current high rates of population growth in Pakistan reflect mortality rates that fall faster than fertility rates. Enhanced household incentives to reduce fertility rates are likely to be of importance.

Returning to the question of conversion efficiency, we need to ask why we would expect unexploited opportunities for improving the well-being of the poor through behavioural changes. In other words, if poor households are rational, and I believe Dr Lipton agrees that they are, why would conversion efficiencies exist?

Let me suggest three reasons.

First, the existence of intrahousehold externalities. Those making decisions may not have to take the consequences, and power over household resource allocation may be unevenly distributed. Individual goals may not be shared by the decision-maker. For example, according to IFPRI research in Pakistan, women prefer

smaller household sizes than men. The question of relative power over decision-making related to fertility then becomes critical. The definition of well-being and household goals as interpreted and expressed by outsiders may not correspond to those of the decision-maker. For example, while outsiders may find high child mortality and malnutrition deplorable, the household decision-maker may be faced with the choice between that and failure of the income-earning unit to survive.

Second, constraints external to households may be a reason for the existence of conversion efficiencies. For example, poor sanitation, unclean water, and lack of primary health care may impose diarrhea and other diseases which reduce energy and nutrient absorption. This, in turn, would result in low conversion efficiency.

Third, the cost of time needed to improve conversion efficiency may be underestimated in Lipton's argument. While the paper recognises that time is not a free good, it is basically dismissed as an insignificant factor in explaining conversion inefficiencies.

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