Multiply and be Fruitful

By: Ray Percival

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3000 AD Green Party wins power. Photo showing the complete success of their policies.

How could anyone doubt that the world has an overpopulation problem? Every school-child knows that in the face of a recklessly expanding population food is becoming scarcer and scarcer. Here is the ghost of Robert Malthus (the early 19th century population theorist) speaking through a book for children:

"When man first began to farm, there were fewer than five million people on earth, and it took more than a million years for the population to reach that figure. But populations increase geometrically - that is, they double (2,4,8,16,32,etc). Food supplies, in contrast, increase only arithmetically, a much slower process (2, 4, 6, 8, 10, 12, etc) ...

"If the population continues to explode, many people will starve. About half of the world's population is underfed now, with many approaching starvation."

(Fichter, *The Golden Stamp Book of Earth and Ecology*, Racine, Wis. Western Pub. 1972, pp 24-25)

Yes, as obvious and inescapable as 2+2=4. Right? Wrong. Recent trends in demographic theory are very critical of such models of population growth. Optimism is in the air.

But still the citadel of orthodoxy stands. One of its principal architects was Paul Ehrlich. Ehrlich had a taste for the dramatic. To this he added a flair for picking figures out of thin air and - abracadabra: "... a minimum of ten million people, most of them children, will starve to death during each year of the 1970s." (*The Population Bomb*, Ballantine Books 1968, p3). The prestigious Club of Rome is almost equally to blame. They shared Ehrlich's taste for tragedy but did not fancy themselves as magicians. Instead, they wheeled in an impressive computer and *voila*:

"If the present growth trends in world population, industrialisation, pollution, food production, and resource depiction continue unchanged, The Limits to Growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrolled decline in both population and industrial capacity.'

(D.L. Meadows, *The Limits to Growth*, 1972, p23).

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 1 of 12

Malthus and his Ghost

This is the Malthusian ghost. But it is not Malthus. The 'Neomalthusians' are wrong to invoke Malthus' name to give authority to their case. This is just verbal necromancy. It has obscured the original problem and how it has changed.

The 'Neomalthusians' see no current constraints on growth but only ultimate limits. The exact reverse of Malthus! Further- more, for the Neomalthusians, it is axiomatic that the human population grows geometric- ally. This, they insist, is the living nightmare. But for Malthus this was a utopian dream. The central problem that Malthus set himself was precisely that the human population does not grow geometrically, despite the strong sexual instinct that impells man to this theoretical maximum. Even the outstanding economist, Milton Friedman, has mistaken the ghost for the man (Price Theory, p210). T.W. Hutcheson (On Revolutions and Progress in Economic Knowledge, C.U.P. 1978, p71) rightly pointed to the difficulty of pinning down 'the' Mathusian position. But that population does not grow geometrically was something that Malthus himself never contradicted.

Malthus' argument was not based on the premise of an ultimate limit to the Earth's resources: "No limits whatever are placed to the productions of the Earth; they may increase forever and be greater than any assignable quantity." (T.R.Malthus, An Essay on the Principle of Population, Penguin 1979, p76) Rather he was concerned with a disparity in the maximum rates of population growth and food production. Compare the arithmetical and geometrical series in the quotation from the childrens book: 2,4,6,8, 10, 12; 2,4,8,16,32. They begin to diverge at the third term, before which population grows unconstrained. In the quotation this point is placed in the future. But Malthus placed it in the past, long before any recorded history. Beyond this point population growth had to conform to the ceiling set by the growth of food. Hence population grows at most arithmetically.

The quotation contradicts Malthus in two other important respects. First, from his point of view, if half of mankind had been underfed for a significant time, far from exploding, the population would not grow at all (Ibid. p77). The misery of inadequate food was one of the factors that prevented the population exceeding the food supply. Second, the human population does not 'explode', because man's sex drive is restrained by reason. Although Malthus thought that sex within marriage is unrestrained, he pointed to a number of methods used outside marriage by which the number of live births are deliberately controlled. These include celibacy, delayed marriage, contraception and abortion. Among the reasons for restraint were (a) care for the welfare of the potential offspring, (b) fear of being reduced in rank, (c) thought of the extra work and trouble to support the off-spring. Himes has recently shown that all societies practice some form of contraception. The popular idea that most babies in less developed countries must be unwanted because their parents do not connect birth with sex or because they cannot control their primitive urges is nonsense.

Other checks on population were such things as war, pestilence, and famine. Thus to Malthus, the curate of Albury, a geometrically expanding population could only have existed in Eden, where these checks of misery and vice were nowhere to be seen.

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 2 of 12

Conquest of Poverty

We can commend Malthus for his sober methodological individualism. He was right to give human choice and foresight a central place in demographic theory. He would have been right also to regard the unexpectedly rapid expansion of the population since his day as the victory of man over necessity. He did think that poverty was a necessity, however, and in this he could not have been more wrong.

Except perhaps for the labour theory of value, Malthus' theory has the unique distinction of being not only the most influential but also the most thoroughly refuted theory in the history of social sciences. The central implications of the theory are:

(1) The theoretical maximum growth rate of population is greater than the theoretical maximum growth rate of food.

(2) The long-term growth rate of food and population must be equal.

As Thomas Sowell points out (Classical Economics Reconsidered, P.U.P. 1974, p 87), since nearly all animals and plants reproduce in much shorter periods of time and with more numerous offspring than man, the theoretical maximum growth rate of food is of a higher geometric order than that of the human population. The second proposition cannot be rescued because it is dead and buried under an avalanche of historical data. Thanks to the emergence in England and Holland of a more efficient system of property rights, in which Crown and guild restrictions were reduced and intellectual property restored, real per capita income in these countries generally increased from about two hundred years before Malthus wrote, right up to the present day (D.C.North and R.P.Thomas, The Rise of the Western World, C.U.P. 1973, pp 1 16-7).

Between the end of the 17th century and the outbreak of the First World War, per capita income in England increased 6 fold (the absolute increase in production was 30 to 50 fold, far outstripping the rate of growth in population). (Long Debate on Poverty, IEA 1972, p16) Recent world trends reinforce the refutation. Data published by the US Department of Agriculture and, ironically, by the United Nations (correctly described by the Economist in 1952 as "... a permanent institution devoted to proving that there is not enough food to go around") show that in the four decades since WWII, world per capita food production has increased. Even more damaging is the fact that the birthrate and the food supply may move in opposite directions in the long term. Malthus insisted that the birthrate invariably increases when the food supply allows. True, as income increases from a low level, the birthrate increases. But there comes a point at which a further increase in income leads to a decline in the birthrate. The lowest birthrates are in the more developed countries, where food is most abundant.

Famine through a Crystal Ball

Hands up those who in the 1970s watched each year on television a minimum of 10 million people starve to death. Ehrlich's prophecy had two important similarities to the mumblings of a clairvoyant: (1) It was completely obscure how the predicted mini- mum figure of 10 million deaths per year was derived from theory and data - in his more technical book (Population, Resources and Environment, W.H. Freeman & Co. 1972, p51) - predictions are couched in terms of mere feelings. We can only surmise that the figure was discerned in a cloudy crystal ball that is Ehrlich's head. (2) It was a good gamble. If one prophesises a disaster and it occurs one is made famous by a public always fascinated by such coincidences (despite

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 3 of 12

the fact that, given the number of guesses, they are almost bound to occur). Yet if the disaster does not occur, one is likely to be saved from infamy as the one among thousands of flopped prophecies falls into that oblivion of unremarkable failures. Scientists will now naturally take Ehrlich less seriously, and this is the price he must pay. It will be some time, however, before he falls from grace with the public at large. As the publication of his and Carl Sagan's book (Nuclear Winter, Sidgwick & Jackson 1985) shows, where there's a prophet there's a profit.

What data there is on the incidence of famine over time, is an occasion for rejoicing, not for an orgy of gloom. Gale D. Johnson (World Food Problems and Prospects, 1974), argues that during the last quarter of the 19th century perhaps 20-25 million people died from famine. Adjusting for population increase, Johnson says, the figure for the third quarter of this century should have been at least 50 million, and for the quarter century we are now entering, at least 75 million. But, Johnson points out, for the entire 20th century to the present, there have been probably between only 12 and 15 million famine deaths. Many, if not the majority, were due to deliberate government policy, official mismanagement, or war - not to serious crop failure.

Although the immediate cause of the Ethiopian famine is drought, the disaster would not have occurred if it had not been for a long history of the factors that Johnson mentions. On the other hand, there is very little chance that the Ethiopian famine, tragic though it is, will result in anything more than a small percentage of the death toll predicted by Ehrlich, and no chance that it will reverse the trend. Even if this were not true, Ehrlich's recommendations are baseless. Food consumption in the world has been making tremendous strides despite the catastrophic bumbling and brutality of states, the very agencies to which Ehrlich wants to give more power.

Mathematical Fantasies and the Nature of Growth

Ehrlich has made much of the time it takes a population to double in size. He computed this from the Rate of Natural Increase (RNI: the percentage by which a population increases each year). He chose doubling time in his The Population Bomb (op.cit.) because it is *"... the best way to impress you (the reader) with numbers."* It also makes it easier for Ehrlich to indulge the tall stories of the British physicist, J.H. Fremlin. The magic formula for these stories is to pick a doubling time and - as if people bred like flies - simply project it and conclude that within a startlingly short time the Earth would be completely carpeted by a 2,000 storey building packed with people. But as any demographer worth his salt will tell you, using RNI as a basis for doubling time will exaggerate the prospects for population growth if the birthrate has fallen in the recent past; simply because people tend to have children when they are young and die when they are old. If people were recently having smaller families than their parents had, then by the time they are in their old age there will be a higher proportion of old people in the population. There will then be both a lower birth rate and a higher death rate, that is a lower RNI.

In the revised printing of his book (Feb.1971) Ehrlich, referring to America, made a perfunctory reference to the "... low birth- rates of the late 1960s, which are being replaced by higher rates as more post WWII 'baby boom' children move into reproductive years." (Ibid. p11) What he did not mention, but was clearly relevant to his appraisal and must have been known to him, was that the birthrate had been failing since 1955. By

1975 the total number of births was no higher than in 1909.

The failing birthrate was a part of the demographic transition, a process occurring throughout the more developed world when Ehrlich wrote his book. Notwithstanding the brief mention it gets in Ehrlich's book, it is the central event in the recent history of the human population. In the demographic transition both the birthrate and the death- rate fell from a high to a low level.

Ehrlich was aware of the demographic transition and even gave a rudimentary explanation of its second stage, the falling birthrate:

"As industrialisation progressed, children became less important to parents as extra hands to work on the farm and as support in old age. At the same time they became a financial drag - expensive to raise and educate ... people just wanted to have fewer children." (Ibid. p8).

Ehrlich was oblivious to the fact that this meant that population growth was neither explosive nor reckless - ideas that were essential to his campaign to make population growth seem frightening and thus pave the way for the state (which of course is never reckless) to step in and suppress the recklessness. Unrestrained by this lapse into methodological individualism, Ehrlich soon stumbled into some gross errors:

"It is important to emphasize, however, that the demographic transition does not result in zero population growth, but in a growth rate which in many of the most important overdeveloped countries results in populations doubling every seventy years or so. This means, for instance, that even if most under-developed countries were to undergo a demographic transition (of which there is no sign) the world would still be faced by
catastrophic population growth. No growth rate can be sustained in the long run." (Ibid. p8).

Ehrlich's fears were based on three principal errors:

(1) That the demographic transition was complete in the more developed countries, and that there was no sign of it in less developed countries.

(2) That population growth is inherently exponential.

(3) That after the demographic transition the only limits to population growth are external.

Actually, fertility had already begun to fall in less developed countries in the middle 1960s, before Ehrlich's book came to press. The demographic transition in more developed countries is even now incomplete. In the 1980s the growth rate of the world population has sunk from 2% to 1.7%. Although fertility is dropping and in some more developed countries has gone below the replacement rate, the population will continue to grow. But the UN now expect that it will stabilise at about 10 billion near the end of the 21st century, and this given only the behaviour of the population and not external constraints. Ehrlich could not have envisaged any such possibility. He took it for granted that the human population naturally grows according to an exponential curve (he likened it to compound interest). The mathematics of the process were somehow going to force us into catastrophe. As we have seen, however, the current growth rate is a poor guide to future growth. Herman Kahn (in World Economic Development, Croom Helm Ltd 1970, p70) points out that it is extremely misleading to think of growth as exponential. Growth generally follows a logistic curve. More important, growth slows down for reasons internal to that

which is growing, not as a result of external pressures or constraints. Far from giving any argument that the growth of the human population is different to the growth of anything else, Ehrlich himself pointed to the financial burden of children - nothing less than the most important internal reason for the slowing down of population growth. In his obsession with doubling times, which for him have a life of their own divorced from human foresight and choice, Ehrlich was blind to this implication.

Triumph over Death

When the human population is seen as a sort of mathematical monster, developments that would strike the non-mathematical as magnificent improvements in man's lot are instead seen as food for the beast. Ehrlich pointed in horror to the dramatic reduction in mortality in less developed countries. But exorcised of the reified mathematics of population growth, the dramatic reduction of the death rate in less developed countries can be seen for what it really is: the triumph of medicine. It, in turn, was made possible only by the economic development of more developed countries, a process that Ehrlich rejected as 'unfair exploitation' of less developed countries (LDCS) and as leading to increased death rates through pollution.

It took the 70 years between 1830 and 1900 for average life expectancy in Europe to increase from 40 years to 50 years. Due largely to the development of insecticides and drugs in more developed countries (MDCS) during the 1940s, the same increase in LDCs took only 15 years between 1950 and 1965. Furthermore, increases in life expectancy in LDCs began first in those which had had the most contact and commerce with MDCs such as India and Latin America (G.Watkin and Brandel, "Life Expectancy and Population Growth in the Third World', Scientific American, May 1982). LDCs took advantage of the benefits of the economic development of MDCs without having to wait until they had undergone the same amount of economic development themselves. The increase in the average life expectancy in the world right up to the present has contradicted Ehrlich's prophecy of an increase in the deathrate, and has also indicated that pollution has not increased. Confronted by this statistic a sophisticated disciple of Ehrlich's might try to salvage the prophecy by pointing to the birth control schemes launched, partly as a result of Ehrlich's propaganda, in China, India and elsewhere. These, he might say, saved the world from the increased deathrates that Ehrlich predicted would occur only in the absence of adequate birth control. Such a plausible defence, however, would be balanced precariously on Ehrlich's equivocation: Ehrlich vacillated between a categorical assertion of coming doom and a prediction of doom contingent on certain conditions. Thus, in Population, Resources and Environment, (op.cit. p5) Ehrlich made the predicted increase in the deathrate contingent on the growth of the world population being such that its size would not exceed 5,449,000,000 by the year 2000. However, the latest estimate from the UN is that by the year 2000 the world population will be 6.1 billion, and there is still no sign of the increasing deathrates that Ehrlich expected in the 1970s.

The Club of Rome Creates a Frankenstein's Monster

Surely we cannot but trust that bastion of frank discussion of the problems facing mankind, the Club of Rome? The whole import of their book, The Limits to Growth, (op.cit.) was an urgent call for a halt to economic growth: "We are by no means the first people to propose some sort of non- growing state for human society." But they added their voice to

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 6 of 12

the chorus because, as the Executive Committee of the Club of Rome said:

'We are further convinced that demographic pressure in the world has already attained such a high level, and is moreover so unequally distributed, that this alone must compel mankind to seek a state of equilibrium on our planet.' (p191).

Global equilibrium entails that:

(1) The birth rate equal the deathrate and the capital investment rate equals the depreciation rate.

(2) All input and output rates - births, deaths, investment and depreciation - are kept to a minimum. (p173)

In Chapter V the Club concluded that if stabilising policies with the above as necessary ingredients are not implemented before the year 2000, there will he a catastrophic collapse of food production, industry, and population sometime in the next century.

They went to great lengths to make the message palatable, being almost apologetic for suggesting such a course of action, and even chose the rather exciting term 'Global Equilibrium' to replace the grey and boring term 'no growth'.

Four years later, after their book had sold 4 million copies, we find that at a meeting in Philadelphia: *"Aurelio Peccie, founder of the Club of Rome and former manager of Olivetti, denied the club was a group of advocates of zero growth."*

and: *"Professor Ervin Laszlo, fellow of the United Nations Institute for Training and Research, who is directing a study for the Club of Rome emphasized that... 'The real issue is not whether to grow or not to grow. Rather it is how to grow:*

with what technologies and in what sectors of the economy." (New York Times, April 14, 1976, pp82-83)

To us simple folk the distinction between 'non-growing' and 'zero growth' is clearly the preserve of the erudite. Perhaps they changed their minds? Do they now reject that we are 'compelled' to adopt a 'stabilizing policy' before the year 2000 if we are to avoid catastrophe? Aurelio Peccie explained that it was not a matter of asserting what they believed was the truth but of following a strategy to change people's attitudes.

"Aurelio Peccie says that Limits was intended to jolt people from the comfortable idea that present growth trends could continue indefinitely. That done, he says, the Club could then seek ways to close the widening gap between rich and poor nations - inequities that, if they continue, could all too easily lead to famine, pollution and war. The Club's startling shift, Peccie says, is thus not so much a turnabout as part of an evolving strategy." (Time Magazine, April 26 1976, p43)

If the reversal of the Club's public position on growth was part of their original plan, then it was intended at the time that Limits was written that its conclusion would later be denied. We cannot be sure which position was the lie but one of them must have been.

Since its revelation several years ago, far from 'startling' anyone, the Club's pro-growth position has remained almost completely unknown. The old message lives on unabated. It is presumed to be the definitive pronouncement of the Club of Rome in journalistic work right through to supposedly well researched works such as Global 2000 (1980) (which is especially puzzling because the director of the study, Gerald Barney, is a colleague of Peccie's). It would seem that even such marketing geniuses as the

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 7 of 12

Club of Rome, funded by the Volkswagen and Xerox corporations, with press conferences organised by George Kettle Associates, can underestimate the market for gloom. The development of an ideology cannot be planned. Ideas have a life of their own. With their computer the Club of Rome helped to create an ideology of no growth. They might now feel that their creation is a Frankenstein's monster, an abomination out of their control. And they would be right.

The New Liar's Paradox

That a prediction is propounded as a lie does not make it false. The world is not always as it seems, even to a liar. Julian Simon, whose arguments on population are otherwise impeccable and whose position is upheld here, made the mistake of confusing lies with untruths in his criticism of *The Limits of Growth* (The Ultimate Resource, P.U.P. 1981, pp 286-288). He saw their mendacity as the 'most compelling criticism' of their book. But a theorist's bias or mendacity should never be decisive in rejecting his theory. It is on the impersonal qualities of truth and coherence that a theory ought to succeed or founder. The significance of the Club of Rome's mendacity is that it has impeded the search for the truth, caused unnecessary worry and despair, and must lead us to conclude that any further empirical reports from them should be given less weight in the controversy (not-withstanding that any purely logical points or criticisms that they might offer are unaffected). There is a proviso, however: Wilfred Beckerman was correct when he said (In Defence of Economic Growth, Jonathan Cape Ltd 1974, p 115) that doomsayers are eventually taken less seriously as their exaggerated predictions are repeatedly refuted. But this is not the whole truth; the fate of the dishonest may be worse. Their empirical data should and will be given more weight if it undermines the increasing scarcity hypothesis, just as one might give more weight to a reading on an instrument that was biased against giving this reading. To the extent that organisations such as the Club of Rome and the United Nations have resorted to deception and exaggeration they have increased their reliability as instruments for the refutation of their own case.

Such 'evolving strategies' are not uncommon in organisations devoted to the rescue of mankind. Paradoxically, the more concerned these self-appointed saviours are with the rescue, the more cynical and even misanthropic they become. This is the unacceptable face of philanthropy. It is corrupted by the theory that ideology is the plaything of expensive advertising campaigns, plus an obsessive desire to tinker with large systems. The Club of Rome believed that with the aid of modern media they could change public opinion how and when they wanted. But if the media were that powerful Britain would never have had a Labour government (since most papers are pro-Conservative), nor would religion still exist in Russia (where all media are controlled by an anti-religious elite). It is strange how those who pretend to an enlightened view of the world that scorns the immediate while embracing the long term prophecy, are the most short-sighted when it comes to propaganda. But in propaganda patience and honesty are the best policy.

The most telling criticism of The Limits to Growth is that the model on which it is based can produce rosy forecasts with slight, but realistic changes in the assumptions. The Science Policy Research Institute at Sussex University concluded: 'The model appears to be very sensitive to input parameters which have a wide margin of error and in fact it would appear that according to World 3 (one set of assumptions), a high rate of growth is just as likely as a catastrophic collapse.' (H.S.D. Cole, ed., Models of

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 8 of 12

Doom, 1973, p130) One is reminded of the computer programmer's acronym, GIGO - garbage in, garbage out. Herman Kahn (The Next 200 Years, William Morrow & Co, New York 1976, p 90-91) actually discovered significant misreporting of data on minerals in work by the Club of Rome. The Sussex group pointed out that prediction over such lengthy spans of time is extremely hazardous. A long-term prediction like the Club of Rome's but made in 1872 would have completely omitted two of this century's new and important sources of energy: oil and nuclear power.

One of the crucial assumptions of their model of the world, a long term increase in the scarcity of minerals, has no historical backing. As Julian Simon points out, if mineral resources had indeed become more scarce their prices would have increased. On the contrary, their prices on average have been sinking since as long ago as we can ascertain, indicating that they are now less scarce than they were. There is no reason why minerals will not get cheaper and cheaper. Furthermore, any shortages will be anticipated by a rise in the price of the mineral, inducing suppliers to find new sources of, and substitutes, for the mineral, and inducing customers to economize on its Use.

Ehrlich and the Club of Rome have somewhat eccentric views, at least among demographers. So perhaps knocking them down is not much of a victory. But even the more orthodox and sober view suffers from flaws that are no less damaging. These flaws also highlight the weaknesses in Malthus' theory, from which the orthodox model was largely derived.

Take the now standard model, that of Coale and Hoover. This model of population has been very influential, and so it is worth special note. Through Philander Claxton (at one time the highest ranking US State Department official involved with population matters) the Coale and Hoover model made birth control an important part of US foreign aid policy. There were two main elements to their theory:

(1) An increase in the number of consumers.

(2) A decrease in saving due to population growth.

Their conclusion was that in India income per consumer over 1956-86 could have been expected to rise from an index of 100 to 138 with continued high fertility; whereas it could have been expected to rise from 100 to 195 with declining fertility - some 2.5 times as fast. Julian Simon (op.cit. p277) points out that the result is obtained by (a) ignoring that in the long run a faster growing population produces a larger labour supply which implies a larger output, and (b) assuming that capital - land, machines, etc. - does not increase in proportion with the labour force, so that there are diminishing returns to labour. Subsequent models have given more weight to the effect of an increased labour force, but they still hold on to the 'capital dilution' assumption.

Even these refined models, Simon points out, are contradicted by both historical and cross sectional studies. There is no straight- forward correlation between population growth rate and per capita income. Strangely, in the light of our preconceptions, Simon and Gobin found that there is a positive correlation between population density and per capita income. (Simon & de Vanzo, eds, Research in Population Economics, Vol 2, Greenwich, Conn. JAI Pr.) Clearly a more complex model was needed.

Man - the Ultimate Resource

Julian Simon had the answer. Previous models of population had seen man mainly as a consumer. Simon saw that man was "the Ultimate Resource": he produces more than he consumes. Simon introduced a number of by now well documented factors.

There is a positive effect of an increased demand from a larger population upon business and agricultural investment. Larger demand makes possible larger, and therefore more efficient, manufacturing plants, and also longer production runs with consequently lower set up costs per unit output. A much larger scope for division of labour is also made possible by a larger demand, increasing output still further. Many services, because they are demanded by such a small proportion of the population, could not be supported by a smaller population (how many novelists or osteopaths could be supported by a village?). An extremely important economy of scale derives from 'learning by doing'. The more TV sets are produced by workers, the more efficiently they can make them.

With a larger population there are more minds to contribute to advances in knowledge and its application to production. Scientific output is proportional to population size, in countries at the same level of income. The US is much larger than Sweden, and it produces much more scientific knowledge. So why aren't India and China the most advanced countries in the world? The reason is that since they are poor they cannot afford to educate as many people. Contrary to popular wisdom, Simon and A.M.Pilarski found that the greater proportion of children in the population of less developed countries only slightly reduces the amount of education their children get (Review of Economics and Statistics, 61, 1979, pp572-84). Despite its poverty, India does have one of the largest scientific communities in the world, and mainly because of its large population.

As Simon has shown, man himself is the Ultimate Resource. Not just his muscle power; his brain power too. Ideas about how to produce things are wonderful tools: they never wear out. In fact the more they are used the more useful they become, as they are adapted to circumstances and become consolidated in people's memories. Scientific theories are more wonderful still. This is something that Simon has not brought out fully. While a type of machine may become uneconomic, a scientific theory can go on helping production forever (though as the very general ideas of the lever and the wheel show, a technological idea can carry on contributing to production for an indefinitely long period after the inventor has died; a clear example of someone producing more than they consume). It is not just that the theory, say, of atomic fission, can carry on helping the construction of the same type of fission reactor.

As Karl Popper has pointed out, any theory has an infinite number of implications. We can infer from this that the number of different technological applications of a scientific theory is in principle infinite. Similarly, abstract ideas like the wheel and the lever - because of their abstractness - can be realized in a literal infinity of machines.

A growing population brings with it more Edisons and Einsteins, who create more and more of these splendid tools of the mind. They pile up to form a mountain of wealth that is available for the use of future generations, whose problems are thus made more amenable to solution. No baby Edison ever deprives a future person of an ounce of

This article is written by Ray Percival
For further details please visit www.libertarian-alliance.org.uk
LA-13.pdf Page 10 of 12

bread, but makes him richer and more secure instead.

A popular nightmare is of more and more farmers scratching a living out of an ever dwindling supply of land. But in an economic sense, land is not a fixed resource. Increases in demand spur people to increase the stock of usable land and to work more intensively that which they already have. New crops and new methods of cultivation raise output even more, so that output per person is greater than if there had been no increase in demand. With humans, scarcity is the mother of abundance. When people want more usable land they just go out and create it. Take India: from 1951 to 1971 cultivated land was increased by about 20 percent. More impressively, the amount of irrigated land was increased by 25 percent between 1949-50 and 1960-61, and then by another 27 percent between 1961-65 and 1975. Even now India is not densely populated. Measured by the number of persons per hectare of arable land, Japan and Taiwan - hardly examples of starving populations - are about five times as densely populated. With muscle and imagination man brings usable land into existence on demand, and neither the sea nor the desert can stop him: everyone has beard of Holland's reclamation of land from the sea; Israel furnishes an instructive example for those who face the barren desert. The Israels are reclaiming the Negev desert for farming and for about 1 million people to live in. The once relatively dry Negev desert is being brought back to life by making the most of little water. Rainwater is recycled, thousands of acres of plastic are used to slow evaporation, and water in precise amounts is delivered to the roots of each plant by a system of plastic tubes with holes in -'trickle irrigation'. Further expansion will necessitate the use of underground water, which is salty - very uncongenial to ordinary crops, but not to the salt-tolerant ones that the Israelis are

creating. A desert-tolerant but tasty kind of cattle is also on the menu. One step in this direction is the 'goabex', a cross between a goat and a camel.

The Food and Agriculture Organisation estimated that there are in the world 3.19 thousand million hectares of arable land lying idle. Four times that now being harvested. Brazil alone, with about 3 million square miles of unused largely fertile land, could feed three times the current population of the earth. Tropical lands allow multiple cropping. If this is taken into account, that fourfold potential increase in arable land becomes a tenfold increase. But as Holland and Israel show even these untapped potentials do not set an upper limit to the amount of food that could be produced. Food, that is what we are interested in, not soil or the total quantity of land. To produce it, all that is required is some space and some imagination. Through- out the 1950s, America, the UK, Austria, and the Netherlands saw their agricultural output rise while the absolute amount of their land under cultivation fell. Some methods of producing food need very little land and no soil at all. Single cell protein - a foodstuff with all eight essential amino acids that is made from the cellulose in rubbish, paper, wood or agricultural waste - is produced in factories each with a capacity of 100,000 tons per year. SCP has a high protein content - up to 5 1%, compared with 42% for soybean, and can be produced at half the cost of soybean. (New Scientist, 28 November 1974, p 639)

Simon pointed out that the number of people working in agriculture has declined dramatically. But it would not be surprising if in future less and less of the Earth's surface was devoted to an ever growing level of food production. The popular nightmare of a growing population wresting less and less food out of an ever shrinking quantity of land is just that - a bad dream.

When population density rises it becomes profitable to build more roads and systems of communication, which in turn boost economic development. This idea was behind Australia's policy of encouraging immigration. We have heard how much of the horror of the famine in Africa is due to poor transportation. When people are so thinly spread over the land, as in Africa, there is little incentive to build roads. Most villages in India cannot be reached by motor transport. In advanced agricultural countries there are from 3-4 miles of farm-to-market road per hectare of arable land. This puts India's paltry figure of 0.7 miles well into the shade. The same sparseness of roads also affects Malaya (0.8 miles), and the Philippines (about one mile).

No "fine tuning" Thanks

There is no magic population growth rate. Whether a low, moderate, or high birth rate will maximise future income depends on the economic conditions of the country and the age structure of its population. But contrary to popular wisdom there are realistic circumstances under which even an extremely high birth rate would raise future income the most (though there are conditions under which a very high birth rate does worst economically).

Two conclusions, however, are unconditional: a declining population always does badly economically in the long-run; whereas all birth rates above the replacement level raise future income. As for the typical less developed country, Simon found that in the long-run (75- 100 years) a moderate birthrate does better than either a low or high birthrate.

These findings must be seen in the proper perspective lest the model on which they are based is taken as a breakthrough for those who delight in

"fine-tuning" the most personal aspects of our lives. In the short run a child is, of course, a financial burden, but clearly most people think the happiness that a child brings them is worth the cost. People are prepared to sacrifice a higher monetary income to have a child. The amount they are prepared to sacrifice depends on their values and the non-monetary costs and incentives that they face, factors of individual circumstance, which are not only unpredictable by any bureaucrat but also can never be fully specified even by the individuals concerned. Simon's findings in any case concern only the averages of individual income and family size. And clearly the same average of births and income can be realised by many different permutations of individual family circumstances. The pretensions of the would-be manipulator of birthrates founder on the rock of individual differences. If there is any "fine tuning" to be done, each family itself will manage splendidly, thank you. If we are faced with a declining birthrate need the state intrude and attempt to boost it by, say, imposing a 5% increase in income tax on persons who are not married before they are 25 years old (as is done in Rumania)? No. A declining birthrate means that people (on average) prefer fewer children and more of the goods - pecuniary and non-pecuniary - that they would have had to sacrifice if they had not had fewer children. Furthermore, if a declining birthrate does reduce income this will be self-correcting, as people will start to have more children at a lower income.

It is now time to lay to rest both Malthus and his troubled ghost, in the knowledge that population growth does not impede but actually contributes to Man's rise from poverty and hardship.

The more people there are, free to exploit their own and the earth's resources, the easier it is to feed them.