Economists are not dismal, the world is not a Petri dish and other reasons for optimism

Article

Published Version

Food and Energy Security
Open Access
REVIEW

Economists are not dismal, the world is not a Petri dish and other reasons for optimism

Richard Tiffin

Food Economics and Marketing, University of Reading, Ag BuildingEarley Gate, Reading, RG6 6AR, UK

Keywords
Agriculture, food, food security

Correspondence
Richard Tiffin, Food Economics and Marketing, University of Reading, Ag BuildingEarley Gate, Reading RG6 6AR, UK. Tel: +44 118 378 8965; Fax: +44 118 975 6467; E-mail: j.r.tiffin@reading.ac.uk

Received: 30 May 2012; Revised: 19 June 2012; Accepted: 20 June 2012

Food and Energy Security **2012; 1(1): 3–8**

doi: 10.1002/fes3.7

Abstract

One of the recurrent themes in the debate around how to ensure global food security concerns the capacity of the planet to support its growing population. Neo-Malthusian thinking suggests that we are in a situation in which further expansion of the population cannot be supported and that the population checks, with their dismal consequences envisaged by Malthus, will lead to a new era of stagnant incomes and population. More sophisticated models of the link between population and income are less gloomy, however. They see population growth as an integral component of the economic growth which is necessary to ensure that the poorest achieve food security. An undue focus on the difficulties of meeting the demands of the increasing population risks damaging this growth. Instead, attention should be focused on ensuring that the conditions to ensure that economic growth accompanies population growth are in place.

Introduction

One of the themes in the current debate around food security is a renewed interest in the population theories of Thomas Malthus which highlight the issue of what size of population the planet can sustain. Interest stems from the unprecedented increases in population which are currently being experienced and concern that these may not be sustainable with a fixed endowment of natural resources. The Malthusian observation that unchecked population growth proceeds geometrically whilst food production can only increase (at best) arithmetically, brings to mind an analogy with a growing population of micro-organisms on a Petri dish which is eventually checked by the size of the dish and the availability of nutrients.

Malthus is widely blamed for giving Economics the reputation for being the dismal science. The reason for this is his theory of income and population determination which argued for the existence of a long-run equilibrium with a stationary population and static (low) levels of income. Unfortunately for Malthus, soon after he had presented his theory, both population and income in Western Europe began their rapid increases of the 19th century. The mechanisms by which Malthus' model achieves its equilibrium concern the bi-directional relationship between income and population. Increases in per capita income increase population through reduced mortality and increased birth rates. Increased population, however, lowers per capita incomes through a reduction in labor productivity. These relationships are commonly referred to as the positive and preventative checks, respectively. In the model, the reduction in productivity is the consequence of limited natural resources.

The purpose of this article is to outline the subsequent development of the Malthusian model to better reflect the reality of industrial and post-industrial economies, and to argue that focusing only on population growth in isolation from the role that it plays in growth, risks restraining economic development in those parts of the world where it is most needed. It will be argued that framing the challenge as being one of matching food supply to the demands of a growing population, without taking into account the ways in which the growing population can itself contribute to increased food supply, is in danger of being an over-simplification.

Empirical Evidence

The reasons for the increased concern over the capacity of the planet to support its population are well rehearsed. The world's population recently passed the 7 billion mark and is predicted to reach 9.3 billion in 2050. Lam (2011)

notes that the time taken for the world's population to double from 3 billion in 1960 to 6 billion was 39 years compared to 70 years for it to double from 1.5 billion to 3 billion and 150 for 0.75 to 1.5 billion. Figure 1 shows UN population estimates over the period 1950–2100. The prospective data for the period 2011–2100 are based on country-level predictions which assume two processes. The first is based on a double logistic function to capture the transition from a high fertility rate to the replacement level of 2.1 children per woman, and is applied to countries undergoing the demographic transition.[1] The second process is applied to countries which have completed the transition and is based on a time-series model which assumes that, in the long term, fertility will approach and fluctuate around the replacement level of 2.1. Figure 1 shows medium, high, and low variants. The difference between each of these variants concerns the assumptions that are made regarding the fertility rate of the population. The high variant assumes that fertility in the second phase is 0.5 children per woman above the medium variant whilst the low variant assumes it is 0.5 below. Thus, for a country which has reached the replacement level of 2.1 children per woman in the medium variant, fertility will be 1.6 and 2.6 children per woman in the low and high variants, respectively.

Figure 1 is used by Lam (2011) to emphasize that the growth rate for the world's population has peaked. Thus the reductions in doubling time that were seen up to 1999 will not continue. Figure 1 also shows the UN estimates of the population in sub-Saharan Africa where the population growth rate will continue to be high throughout the twenty-first century. For example, the annual growth rate for the global population is 1.1% in 2012 whilst for sub-Saharan Africa it is 2.4%. By 2050 the global growth rate is expected to have fallen to 0.4% per annum whilst that of sub-Saharan Africa will still be 1.6%. This means that, whilst in much of the world population will be relatively static between now and 2050, sub-Saharan Africa's will increase from 0.9 billion to almost 2 billion and as result it is widely argued that it will have to double its food production over this period.

The picture which emerges from these population statistics is therefore mixed. At a global level those who point at the apparently exponential rate of population growth, and following Malthusian logic predict disaster, seem to be unduly pessimistic. At a regional level, however, and in particular in sub-Saharan Africa there would appear to be more cause for concern. This assumes that

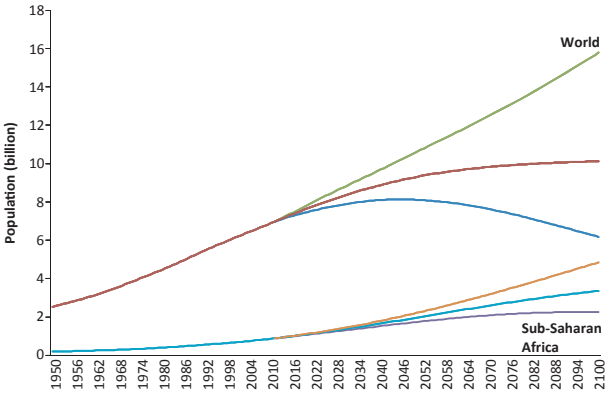

Figure 1. Global and sub-Saharan population 1950–2100 (Source: United Nations 2011).

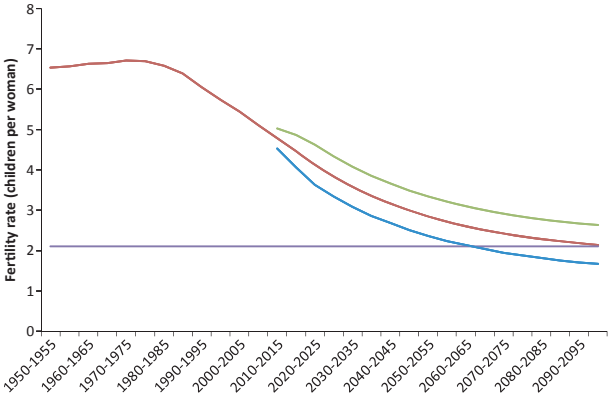

Figure 2. Sub-Saharan fertility rates 1950–2100 (Source: United Nations 2011).

the UN's medium variant forecast for population growth is accurate. If reality is such that we end up closer to the high variant more pessimism may be called for. Under this variant the population growth rate for sub-Saharan Africa is above 2% until 2050 and above 0.9% for the rest of the world until 2054. As a result global population would increase to 10.6 billion in 2050 and that of sub-Saharan Africa to 2.2 billion.

Figure 2 shows the fertility rate which is assumed for sub-Saharan Africa in producing the population projections in Figure 1. For the period from 2011, the three lines correspond to low, medium, and high variants as above. The figure emphasizes the further substantial decline in fertility rates that must occur if any of the population variants in Figure 1 are to be realized. More importantly the figure emphasizes the comparatively small differences in fertility that exist between variants. Compared with a reduction from the current 5.10 children per

[1]The demographic transition refers to the descriptive framework for patterns of population growth in which high mortality and fertility are gradually replaced by low mortality and fertility (Lee 2011).

woman to 3.00 in 2045–2050 which would lead to the medium variant, a reduction to 3.49 would result in the high variant. The sensitivity of the population estimates to this assumption therefore demands that consideration be given to the factors which drive the fertility rate. It is therefore worth seeking to understand some of the deeper mechanisms which underpin this key driver of population growth along with its counterpart, the mortality rate.[2]

Post-Malthusian Theory

Becker et al. (1990) note that mainstream, or neoclassical, models of economic growth such as those developed by Harrod and Solow respond to the failure of the Malthusian model by essentially ignoring any link between population and the economy. The Solow (1956) growth model explains how the level of investment adjusts to determine the equilibrium capital stock of a country which in turn determines the level of income. When the capital stock is low, depreciation, which is a fixed proportion of the capital stock, is less than investment, so the capital stock expands. When the capital stock is high, the reverse is true, and as a result of negative net investment, the capital stock contracts. With this equilibrium condition, changes in the relationship between the capital stock and income cause the economy to grow (or contract); thus, incomes rise if human capital improves, the labor force increases, or the savings rate goes up. Technological progress also causes the economy to grow and one failing of the neo-classical models is that they treat this as exogenous. A failing which is rectified in the so-called new or endogenous growth theories (see, for example, Romer 1990).

In terms of our discussion, the failure of the neo-classical models to adequately consider the relationship between population and income is more serious than their treatment of technological progress as exogenous. The sensitivity of the population growth rate to changes in the fertility rate has been highlighted above. Beginning with Malthus, the fertility rate is of central importance to models which seek to explain the relationship between population and income growth. Becker et al. (1960) argue that Malthus' theory is built on a "strongly economic framework" and proceed to provide a "generalization" of it. They argue that children provide utility, or in their terminology, psychic income to parents. As such, in an economic framework, children are classified as a consumption good. They also recognize that this may not sit easily with many, but emphasize that it is not meant to imply that the utility derived from children is morally comparable to that derived from more conventional consumption goods. The advantage of adopting this classification, it is argued, is that it makes it possible to relate the "demand" for children to a well-developed economic framework which is useful in analyzing patterns in fertility. Thus, fertility is determined by income, child costs, knowledge, uncertainty, and tastes. Becker et al. (1960) also draw an important distinction between the quantity and quality of children. The latter is the additional utility that parents draw from children that are the beneficiaries of better schooling and other activities which are costly to parents. They argue that children are "normal" goods in the language of economists, meaning that as incomes increase, the demand for children increases. They argue, however, that the demand for the *number* of children responds only weakly to income whilst the effect of income on the *quality* of children is stronger. A substitution effect is also present between the quality and quantity of children. Thus, as productivity increases, the price of consumption decreases relative to that of child rearing whilst the return on investment in the quality of children increases. As a result, fertility would be expected to decline and the quality of children to increase.

A number of economic influences are therefore argued to affect the fertility rate. First, there is the direct cost of raising children which is the result of the time that is spent in raising them. As labor productivity increases, in particular that of female labor, the opportunity cost of having children increases. Thus, labor productivity is negatively related to fertility and the impact of raising the productivity of female labor in particular will be apparent. Increased productivity also impacts on the child-rearing decision by easing the household budget constraint, which increases the resources available for children. This is termed the income effect by economists. The final impact of increased productivity is to raise the return to human capital, which induces households to invest in the quality of their children as opposed to their quantity. The complexity of the relationship which determines the fertility rate means that empirical evidence is required to fully understand it. For example, Lehr (2009) shows that the response of fertility to productivity differs according to the stage of development. Thus, the results provide support for a regime in which productivity and fertility are positively related in the early stages of development whilst the reverse is true in the later stages.

In order to fully address the failure of the Malthusian model to explain the increases in both population and

[2]The assumptions made in the UN projections regarding the mortality rate are not discussed here in detail because they have no bearing on the difference between low, medium, and high projections. In short, the projections assume that life expectancy increases at a rate which decreases with current life expectancy. This assumption is modified in countries where HIV/AIDS is prevalent.

income that have characterized most (if not all) developing economies, it is necessary to reinstate the link between population and economic growth, which Becker et al. (1960) argue is absent in the neo-classical models of growth that are in the tradition of Harrod and Solow. Becker et al. (1990) develop a model in which fertility is determined endogenously. The model assumes that when fertility is high the current population is less altruistic toward individuals in the future generation than when fertility is low. This effect arises because the current generation is less inclined to invest in one particular individual when it means depriving others of the same opportunity. Human nature is such that parents of an only child devote considerable attention to the future prospects of that child whilst parents in large families will spread their attentions more thinly. The result of this is that high fertility tends to encourage low levels of investment in human capital. More radically, it is assumed that the benefit of investing in the development of human capital is *positively* related to its existing level. The argument behind this assumption is essentially that education requires educated people to start with. The positive relationship between the return to investment in human capital and its level creates a positive feedback to investment in human capital. The combined effect of the increasing altruism that accompanies lower fertility and the increasing returns on human capital is to create a situation in which Becker et al. (1990) are able to show that there are two possible steady states. One has high levels of fertility, and little or no investment in human capital, and the other has low fertility and increased levels of investment in human capital.

The two steady states predicted by Becker et al. (1990) resonate well with a world in which some countries seem to be caught in a Malthusian trap of static income and population whilst others have demonstrated a sustained increase in per capita income and population. The model has little to say about the large number of countries that are somewhere between the two states, and this is addressed by the model presented by Galor and Weil (2000). Their model presents a unified model of growth across the phases of the demographic transition and it captures many aspects of both the Becker and neo-classical models of growth.

The main contribution of the Galor and Weil (2000) model is that it explains *both* how an economy can escape the Malthusian trap and undergo a demographic transition in which birth rates fall. The key to the former is that the rate of technological progress is assumed to increase with population because there is a larger supply and more rapid diffusion of new ideas. Technological progress acts on fertility through both an income and a substitution effect. The income effect arises as the budget constraint relaxes and more resources can be devoted to raising children. The substitution effect arises because more advanced technology demands higher skill levels and the return on human capital increases which leads to parents substituting quality for quantity in children. The two effects act in opposite directions. The income effect raises fertility and the substitution effect lowers it. Galor and Weil (2000) argue that in the early stages of growth the first effect dominates and the rate of population growth accelerates. As growth proceeds the emphasis moves toward the substitution effect and the demographic transition to low fertility rates occurs.

Galor and Weil (2000) thus provide a rationale for a three-phase population growth process in which the increasing size of the population plays a crucial role in the economy escaping from the Malthusian phase. In the Malthusian phase, population and per capita incomes grow very slowly and the rate of population growth is negatively related to per capita income. In the second phase, both population and per capita incomes grow rapidly and there is a positive relationship between population growth and income. In the final phase, the relationship between population growth and output returns to being negative as in the Malthusian model whilst population and incomes increase more rapidly than the Malthusian case. Crafts and Mills (2009) investigate the Galor and Weil (2000) model empirically, using data for the UK. They find that some aspects of the model are supported whilst there is less support for others. In particular, the constant real wage that is observed up to the Industrial Revolution is supportive of a Malthusian phase. The preventative and positive checks that underlie the Malthusian model are found to be absent for much of this period, however. Moreover, evidence of the positive feedback from population to the rate of technological progress is found to be absent. Pointing out that these may not be decisive objections, Crafts and Mills (2009) highlight the role played by urbanization in the development process and suggest that focusing on the rapid growth in urban populations may provide the evidence of a link between population and the rate of technological progress.

The literature that has been reviewed above focuses on the role of population growth in economic development. In considering food security, another important strand of the literature, which contributes to our understanding of economic growth, analyses the contribution that agriculture makes to economic growth through its underpinning of growth in a non-agricultural sector. In this literature, the economy comprises two sectors, one agricultural and the other industrial or urban. The seminal paper is Lewis (1954). A number of mechanisms act to transfer the benefits of technological progress in the agricultural sector to the industrial sector. The first is the release of resources.

Improvements in productivity mean that labor is released from agriculture and transferred to the industrial sector. In a similar vein, agriculture can supply the capital necessary to finance industrial development or the provision of public goods by the state. The transfer of capital from agriculture to the industrial sector remains important because, in spite of the liberalization of capital markets, it is well established that for a large majority of countries, investment relies primarily on domestic savings (Ventura 1997). In addition to this direct transfer of resources away from agriculture, output growth in agriculture is also likely to result in a decrease in the price of food, which is a wage good, and hence to induce economic growth through two mechanisms. A relatively low price of food allows industrialists to pay low wages, which boosts the profitability and competitiveness of the industrial sector. Furthermore, a decline in the price of food effectively increases the real income of net purchasers of food, and the resulting disposable income can help stimulate demand for non-agricultural products. Becker et al. (1999) extend the Becker et al. (1990) model to reflect the fact that the creation of an urban sector may be necessary to give the increasing returns to human capital that were assumed in the Becker et al. (1990) model. This modification reinforces the low-income, low-population growth equilibrium, and emphasizes the importance of urbanization for the achievement of the low-fertility, high-income growth phase.

Reasons for Optimism

The lessons from economic history regarding the veracity of the Malthus model are clear. The empirical evidence is strongly against the fact of us being caught in a trap in which population and incomes are constrained by the laws of biology and economics which lead to catastrophe when the "natural" capacity is exceeded. Beyond this, the literature that has been discussed above offers some insights into how our resources will act to limit population. These resources extend beyond those with which we are endowed naturally to include resources that are created including population, capital (both human and physical), and technology. The argument is that mankind does not inhabit a global Petri dish in which the population grows until such time as the dish reaches its carrying capacity when the population will be checked. Rather, we live in a world in which individuals make decisions which collectively have an impact on the size of the global population. Decisions on fertility are clearly central, but also important are decisions over other factors which will increase carrying capacity, such as investment in physical and human capital and technological progress. The theory, albeit with limited empirical evidence, which has been discussed above suggests that countries tend to follow a three-phase process of population and income growth where the first phase is characterized by limited growth of both, the second by rapid growth of both, and the third in which population growth slows but incomes continue to rise. This phased view of the transition in a developing economy is echoed by Tiffen (2003) who provides a narrative account of development to address her concern that formal mathematical models of development are unable to capture adequately the differing features of the phases in development. The phases of development identified in both the formal and informal models confirm the patterns discussed in the section above on empirical evidence but, as noted by Lee (2011), these forecasts do not incorporate the formal models discussed in the section on post-Malthusian theory to any degree. It is clear, however, that the model of, for example, Galor and Weil (2000) potentially provides a rigorous framework supporting the patterns exhibited by the forecasts.

We have argued that it is important that we do not see the process by which we develop new technology to meet the food security challenge as somehow detached from the process of population growth. This highlights the fact that the challenge is not merely to develop the technology to feed 9 billion people in 2050 in a detached way. More accurately, scientific discovery and technological development respond and contribute to a process of economic development of which a growing population is one manifestation. We are participants in this process, not the invisible hand which acts to increase the supply of food or to check population growth. If the arguments of Galor and Weil (2000) are accepted, the process of population growth is in fact an essential component of the growth of economies which will allow them to produce sufficient food. Crudely, parents will only make the decision to invest in the human capital of their children once their incomes have increased and initially at least, the income growth may lead to an increase in fertility. This increase in fertility, however, brings about the increase in the urban population that fuels the increases in human capital that allows an economy to escape the Malthusian trap.

Addressing the challenge of ensuring that the planet is able to feed itself is therefore not simply confined to matching food supply to food demand. It is also about understanding and encouraging the other features which accompany a growing population. This entails a consideration of how we facilitate the change made by parents from high levels of fertility to high levels of investment in human capital. Furthermore, consideration should be given to how best to ensure the quality of life of urban populations, and to encourage investment in human and physical capital. Once population growth is seen as one of the essential elements of the transition to a developed, high-income

economy, calls for population growth to be curtailed in for example sub-Saharan Africa are seen as unduly alarmist. It is crucial, if these parts of the world are to develop and feed themselves, that they should be allowed to follow patterns of development which include population growth.

References

Becker, G. S., J. S. Duesenberry, and B. Okun. 1960. Pp. 225–256 *in* An economic analysis of fertility. Columbia University Press, New York. Available from http://www.nber.org/chapters/c2387

Becker, G. S., K. M. Murphy, and R. Tamura. 1990. Human capital, fertility and economic growth. J. Polit. Econ. 98:S12–S37.

Becker, G. S., E. L. Glaesner, and K. M. Murphy. 1999. Population and economic growth. Am. Econ. Rev. 89:145–149.

Crafts, N., and T. C. Mills. 2009. From Malthus to Solow: how did the Malthusian economy really evolve? J. Macroecon. 31:68–93.

Galor, O., and D. N. Weil. 2000. Population, technology, and growth: from Malthusian stagnation to the demographic transition and beyond. Am. Econ. Rev. 90:806–828.

Lam, D. 2011. How the world survived the population bomb: lessons from 50 years of extraordinary demographic history. Demography 48:1231–1262.

Lee, R. 2011. The outlook for population growth. Science 333:569–573.

Lehr, C. S. 2009. Evidence on the demographic transition. Rev. Econ. Stat. 91:871–887.

Lewis, W. 1954. Economic development with un-limited supplies of labour. Manch. Sch. 22:139–191.

Romer, P. M. 1990. Endogeneous technological change. J. Polit. Econ. 98:S71–S102.

Solow, R. 1956. A contribution to the theory of economic growth. Q. J. Econ. 70:65–94.

Tiffen, M. 2003. Transition in sub-Saharan Africa: agriculture, urbanization and income growth. World Dev. 8:1343–1366.

United Nations. 2011. World population prospects: the 2010 revision, highlights and advance tables, Working paper, United Nations, Department of Economic and Social Affairs, Population Division.

Ventura, J. 1997. Growth and interdependence. Q. J. Econ. 112:57–84.