Basic Needs, Government Debt and Economic Growth

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Abstract

This paper investigates the relationships between basic needs and economic growth where the interactions between output, health, nutrition and education are explicitly simultaneous. We find a unidirectional relationship that improving basic welfare contributes strongly to labour productivity change, but a clear reverse causation only from growth to nutrition. There are substantial differences in the patterns of simultaneous interactions at different income and welfare levels. There are strong self-reinforcing effects of literacy and debt service on poverty, making it difficult for poor countries to rectify their situation. Channelling resources towards improving health, education and nutrition could bring dramatic economic returns.

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1. Introduction

The process of development is associated with the need to satisfy basic physical contributors to the quality of life (Knowles, 1993). Welfare and productivity are related as improvements in basic needs fulfilment enhance people's strength, agility and stamina which can stimulate productivity (Grossman, 1972; Leibenstein, 1957) and higher levels of output typically result in a greater pool of resources from which investments in basic needs fulfilment can be sourced. One major reason why the health and welfare of a population improves as a country develops is because the relationship between health and economic growth tends to be simultaneous.

This paper presents an investigation into the relationships between basic needs and economic growth where the interactions between output, health, nutrition and education are explicitly simultaneous. In addition to updating and extending the work of Wheeler (1980) to analyse multiple waves of data from 1970 to 2000, we augment his model to include two streams of literature that are now considered important contributory factors for economic development: a) womens' education and b) the ratio of government debt service to GDP.

Consistent and relatively efficient parameter estimates are obtained using three-stage-least-squares estimation techniques. Our results suggest changes in basic needs are important determinants of productivity changes and vice versa, with differences in the patterns of simultaneous interactions at different levels of income and welfare. The direction of causality seems to run more strongly from basic needs fulfilment to economic growth than the other way round. Although the point is often mooted that third world debt has made it increasingly difficult for developing countries to put resources into basic needs such as health, education and food subsidies, our results suggest that the effect of debt on basic needs indicators is rather more ambiguous, although there is a negative and strongly significant effect of debt service burdens on economic growth, which suggests we should first get the human needs right, and growth will follow, rather than the other way round. Women's education is shown to have a significant positive impact on health, suggesting that development policies in the less-developed world should not be gender-blind.

We are also left with a depressing picture for poor countries' prospects of convergence with the developed world in income per capita; we cannot expect the operation of the market alone to enable developing countries to grow their way out of poverty; their poor levels of health and education, and the debt burdens with which they are saddled will continue to hold them back compared to the already-developed nations.

This paper has the following structure: Section 2 reviews the literature on the interaction between basic needs and productivity growth; Section 3 extends and augments the empirical model of Wheeler (1980) and describes the dataset; Section 4 presents the results; policy implications are assembled in Section 5 and conclusions are collated in Section 6.

2. Basic needs and productivity growth

Basic needs are goods and services, such as education, health and nutrition, which enhance wellbeing and are essential regardless of their effects on productivity. However there is a growing literature (going back at least to Schultz, 1961, and Becker, 1962) which illustrates that the fulfilment of basic needs can also be seen as an investment in human capital and this is believed to stimulate productivity and economic growth; and economic growth in turn may be one important way that a minimum level of basic needs can be surpassed. However, since Wheeler (1980), there has been few if any attempts to explicitly model and estimate the two-way nature of this relationship. We follow Wheeler (1980) and Streeten (1979) by investigating the simultaneous relationships between education, health, nutrition (basic needs) and economic growth. Here we briefly discuss some of the recent literature on the relationships between basic needs and economic growth.

Education

It has long been known that better educated people are more flexible to technological innovations and more likely to invent;[1] typically they are more productive, earn higher wages (Strauss and Thomas, 1998), are more geographically mobile[2] and seem to cluster in high growth industries.[3] Despite asymmetries in the relative and absolute amounts spent on education across countries, the variations in the rates of returns to education across countries may well be due to three contributory factors: quality, externalities and inequalities. It is evident that richer countries spend more and achieve higher quality inputs into the educational process (textbooks, computers, teacher quality, etc.) which may result in asymmetries on efficiencies across countries when educating students.

Meanwhile the effect of educational externalities also may be substantial across countries. For instance, Weir and Knight (2000) found that more than half of the benefit of an individual's going to school for another year in Ethiopia actually accrues to people other than the person attending the school. Such externalities increase the importance of education, especially in less developed countries and particularly so if education leads to economic growth.

Inequalities of educational opportunities exist within and across countries. Inequalities within developing countries create asymmetries in the ability to pay to attend fee-paying schools; but even where schooling is free in the poorest countries, child labour is often pervasive and can be a necessity for many families, constraining children's educational attainments (Amin *et al*., 2006). For all these reasons, a lack of availability of tertiary (which Knowles, 1997, identifies as having the greatest economic impact on output), often secondary and sometimes primary education may be the reason why economic growth is stunted in some less developed countries.

Health

Grossman's (1972) study into health capital often forms the theoretical microeconomic foundations for macroeconomic studies of the effect of health on economic growth[4] while the Preston curve (Preston, 1975) provides an empirical starting-point for analysing the relationship between health and national wealth. The latter shows life expectancy rising sharply with income across countries at low levels of GDP per capita, then much more slowly at higher levels, with a clear 'kink' at a fairly low level. Deaton (2006) shows this effect remains robust, with a 'millennium Preston curve' showing much the same pattern.

In spite of these important contributions, there are two major issues here: the direction of causation and the need to an accurate health capital proxy. The Preston curve tells us little about the nature and direction of the causal relationship, if any, between health and output. It is possible that nutrition is a key transmission mechanism, especially at very low levels of GDP per capita, underlying the need for multi-directional analyses. Deaton (2006) finds that the causal relationship from economic growth to health improvements is actually quite weak; while there is a weak but significant correlation (over 10-year country-periods) between GDP per capita growth and the *rate of change* in infant mortality, there is no such correlation with the actual level of change in infant mortality; the explanation is that there is a negative correlation between the *level* of infant mortality

[1] A lack of human capital can restrict the adoption of new technologies which will constrain economic growth. It can result in some areas of the world remaining technologically excluded (Sachs, 2000) and in a low-growth cycle.

[2] Brain-drain issues related to the movements of relatively high skilled workers from less-developed countries to higher-paying, more developed countries is sometimes touted as a reason why less-developed countries cannot compete on the international stage for the supply of high-growth goods to international markets. Nevertheless all is not lost if these higher-wage workers send remittances back home and are then spend in the local economy.

[3] A wealth of recently published empirical literature presents estimates of the spatial differences in the rates of return to education (Brown and Sessions, 2006; Girma and Kedir, 2005; Gyimah-Brempong, 2006; Psacharopoulos, 1994; Webbink, 2007) and most studies find positive rates of returns.

[4] Recent empirical growth studies have explored the effect of health on economic growth, including Barro (1991), Barro and Sala-i-Martin (1995) and Bhargava *et al*. (2001). All of these find health human capital to have a significant positive effect on economic growth.

and the growth rate. Deaton suggests that there may be unobserved institutional factors at work, with countries that are good at keeping their population healthy also being good at generating economic growth. He concludes that we cannot rely on economic growth to generate health improvements in and of itself.

Our ability to accurately measure the level of health within a country is hindered with the observation that the level of expenditure on health care is not necessarily strongly related to the health of a nation. The level of expenditure on health may be better seen as a health *input* rather than an output. Moreover a long run relationship exists between health care expenditure and real per capita income though the relationship is probably non-stationary (Blomqvist and Carter, 1997).

Use of life expectancy to capture the level of healthiness across countries is quite common and the literature that discusses the relation between longevity and growth has been developing in recent years. However the effect of schooling on output could be clouded because it is correlated with unobservables that are related to health (Sander, 1995) and because schooling improves the choice of health inputs by improving individual's health knowledge (Kenkel, 1991). In this vein, Ehrlich and Lui (1991) and Zhang *et al*. (2001) argued that rising longevity promotes growth by raising investment in children's education,[5] while de la Croix and Licandro (1999) and Boucekkine *et al*. (2002) argued that rising longevity allows individuals to devote more time to schooling which can increase their productivity. Furthermore, Knowles and Owen's (1995, 1997) findings suggest that variations in life expectancy across countries may have an important role in explaining international differences in standards of living while the importance of education has been overstated. However, this debate is on going as Webber (2002) finds the opposite result when he proxies health by the extent of under-nutrition. Webber argues that the use of life expectancy seems inappropriate when attempting to quantify 'healthiness' as it measures symptoms and not underlying causal factors and it seems problematic to formulate appropriate policy based on this measure.[6] Nonetheless, the case can be made that it is appropriate given the underlying heterogeneities between countries and that life expectancy is affected by various factors including the percentage of people with access to clean water, the ratio of inhabitants to doctors and nurses, daily nutritional intake and educational attainment (Carrin, 1984) and the importance of public health services (Lichtenberg, 2004; Aísa and Pueyo, 2006), many of which are the result of policy formulated at the national level.[7]

Other interrelationships are known to exist between health and education. For instance, healthier students tend to have lower absenteeism and higher cognitive function, and therefore receive a better education for a given level of schooling (Weil, 2005).[8] Similarly, Hanushek and Dongwook (1995) and Shultz (1999) suggest that health improves an individual's mental and intellectual capabilities, leading to better educational outcomes. Rising longevity is known to raise both the amount of time a person spends studying and the rate of economic growth (Zhang and

[5] There is a scarcity of literature that accurately portrays a causal impact of *child* health and nutrition on school performance. Closely linked is the work by Glewwe *et al*. (2001) who find that better nourished children start school earlier and repeat fewer exams in the Philippines, while Alderman *et al*. (2001) find that malnutrition decreases the probability of a child attending school, and this is particularly strong for girls.

[6] Another reason why life expectancy might be a problematic measure of healthiness is from a statistical standpoint. Average life expectancy for women seems to have increased at a steady pace of almost 3 months per year for the last 160 years (0.22% increase per year for men) and does not appear to be approaching a maximum (Oeppen and Vaupel, 2002). From this perspective there may not be a maximum level of healthiness. There is also a data issue: Deaton (2006) notes that many developing countries do not have the capacity to provide reliable life expectancy statistics, and that the published figures for life expectancy are extrapolated from infant mortality figures.

[7] An alternative measure if 'healthiness' may be the prevalence of HIV/AIDS, which is now the fourth-biggest killer worldwide (UNAIDS/WHO, 2001). MacDonald and Roberts (2006, p. 245) find that "a substantial proportion of the apparently poor economic performance of many of these [mainly African] economics over the past 10 to 20 years can be attributable to the HIV epidemic".

[8] Mayer-Foulkes (2005) emphasise the substantial and possibly increasing returns to children's health in the acquisition of education.

Zhang, 2005).[9] Therefore, the effect of education on productivity could be capturing, at least in part, the enhancing effect of health.

Nutrition

Nutrition is different from health *per se*. Schultz (1961) argued that food in poor countries should initially be regarded as a producer's good, which diminishes in its effect on production as its consumption rises, until it becomes a pure consumer's good. Nevertheless, better health *and* nutrition can increase productivity with the effect being realised to a greater extent with a substantial lag, as better-nourished, healthier children became more productive adults (Haddad and Bouis, 1991). In the other direction, Subramanian and Deaton (1996) found that the elasticity of calorie consumption with respect to income is in the region of 0.3 to 0.5.

Some studies have investigated the relationship between income and calorie intake and found evidence that increases in income will have little effect on nutrient intake (Behrman and Deolalikar, 1987; Bouis and Haddad, 1992; Bouis, 1994). Whatever the true effect, we must note that there may be a problem with using calorie data in growth models due to potential endogeneity.

In spite of this strong reservation, nutrition is perhaps the most basic of needs and is still insufficiently fulfilled for much of the world's population. For instance, Rosen and Shapouri (2001) note that 774 million people suffered from malnutrition in 1999.[10] Highly developed countries have a different problem with nutrition. In the UK, 24% of women in Britain were obese in 2001 (ONS, 2004). An attempt has been made by Fogel (1997) to quantify the contribution to economic growth of improved nutrition between 1780 and 1980 for the UK. He suggests that improved nutrition raises output in two ways: i) by bringing people into the workforce who would otherwise have been too weak to work at all and ii) by allowing the people who were working to work harder. His results suggest that improvements in nutrition raised output by an average of 0.33% per year, which is almost 29% of the average overall growth rate for this entire time period.[11]

Women's role in the development process

Inequality in education in less-developed countries is often related to gender.[12] Hill and King (1995) emphasise that enrolment ratios of girls lag behind those for boys at all levels of education in much of the developing world, largely due to cultural expectations of gender roles.[13] For instance, both Strauss (1990) and Wolfe and Behrman (1987) found that mother's education is strongly related to children's nutritional status. This strand of literature essentially suggests that better educated women are more able to understand, appreciate and implement means which achieve higher levels of health, nutrition and welfare for the family. Accordingly, Knowles *et al*. (2002) find female education to be important in raising labour productivity in the long run.

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[9] One of the many interesting points emphasised in Zhang and Zhang (2005) is that the estimated effects are non-linear: rising life expectancy has a large and diminishing effect on schooling and economic growth.

[10] 2004 estimates from the Food and Agriculture Organisation indicate that 852m people were undernourished worldwide in 2000-2002, while over 6 million children die each year from hunger-related causes (Food & Agriculture Organisation, 2004).

[11] Using the US longitudinal socio-economic survey, Zagorsky (2005) found that a one unit change in body mass index away from the normal target of 22.5 is associated with a reduction in wealth by 1,306 US$ or 8%.

[12] UNICEF (2006) suggests that gender equality will not only empower women to overcome poverty, but also their children, families, communities and countries making it pivotal to human progress and sustainable development. They also observe that in many developing countries, girls are more likely than boys to miss out on a secondary education.

[13] Hill and King's (1995) stance is that the formal labour market understates the benefits of education to women with many beneficial effects on social wellbeing operating through greater productivity in the home that can increase family health and the returns to investments in children's human capital. This is supported by Behrman and Rosenzweig (2002) and by Behrman *et al*. (1999) who find evidence to suggest that a component of the positive relationship between maternal literacy and child schooling reflects the productivity effect of home teaching.

Several studies illustrate that women's educational background is associated with healthier children. One reason for this is that better educated women tend to choose to have a lower fertility rate, and this permits more resources to be distributed across fewer children.

Government debt

One factors that has severely constrained the ability of many developing countries to meet the basic needs of their populations (and possibly their economic growth) is their unsustainable foreign debt burdens built up largely over the 1970s and 1980s. Hanlon (2000) noted that developing country debt stood at \$2.4 trillion, with 38 countries classified by the World Bank as "severely indebted low income" having debt to GNP ratios averaging 31% in 1980, 139% in 1990, and the same level in 1999. For the 41 African countries studied by Greenhill and Blackmore (2002), an average of 18% of government revenues was being spent on debt service in 1999. This has been widely seen by NGOs, governments, international organisations and academics as causing widespread human suffering and economic damage. IMF-imposed programmes to enable countries to maintain repayments have often involved the removal of food subsidies and the introduction of user fees for health and education services, creating potentially a direct link with basic needs fulfilment. Hanlon (2000) notes that even after debt relief, Mozambique was spending more on debt service than on health. He estimates that \$600bn of debt would need to be written off for 71 of the poorest and most indebted countries to be able to meet minimum standards of social spending (especially health and education).

Conversely, there is evidence that global efforts to write off or reduce the debt of the poorest countries under the HIPC initiative have led to genuine welfare gains. Greenhill and Blackmore (2002) for example show that debt relief has led to large increases in health and education spending in Africa.

3. Model and data

Wheeler (1980) was the first to provide information about the enhancing effects of the fulfilment of basic needs on output using a system of equations. He identified that better literacy rates enhance life expectancy, higher life expectancy enhances productivity, and higher productivity rate enhances literacy. He found that better nutrition did not enhance life expectancy but it did enhance productivity. This complex set of interrelationships illustrate that the satisfaction of basic needs requirements are vital for developing countries if they are to pull themselves out of a poverty-related trap. However further complex circular arguments in the relationships should be considered because more recent research has identified further interrelationships as highlighted in Section 2. It can be seen, therefore, that basic needs fulfilment may be both the cause and the result of improvements in productivity and economic growth. There may be significant, multi-directional linkages between these different aspects of basic needs fulfilment.[14] These theoretical and empirical concerns suggest that a simultaneous relationship is the correct estimation technique, and that the estimates generated by reduced from ordinary least squares estimates may be biased. In what follows we take full account of the simultaneity and endogeneity implied by these arguments, and employ a non-reduced form set of equations which require simultaneous estimation.

The interrelationships between education, health and nutrition are complex, often non-linear and can vary across countries. We follow Wheeler (1980) in choosing to estimate a simultaneous four-equation model of productivity and welfare determination whose general form (for country *i* during time period *t*) is given by:

[14] Another important problem with estimating growth models in that expenditure on human capital is often endogenous and can be cointegrated with GDP (Gerdtham and Lothgren, 2000).

$$Q_{it} = Q_{it}[K_{it}, L^{*}_{it}(L_{it}, H_{it}, N_{it}, E_{it}), A_t] \quad (1a)$$
$$N_{it} = N_{it}(Q_{it} / P_{it}) \quad (1b)$$
$$E_{it} = E_{it}(Q_{it} / P_{it}, G_{Eit}) \quad (1c)$$
$$H_{it} = H_{it}(Q_{it} / P_{it}, N_{it}, E_{it}, G_{Hit}) \quad (1d)$$

where Q_{it} = output; P_{it} = population, K_{it}, L_{it} = the use levels of capital and labour services, L^{*}_{it} = the use level of 'effective labour' (i.e. the measure of labour which accounts for productivity improvements), H_{it}, E_{it}, N_{it} = measures of general levels of health, education and nutrition respectively, G_{Eit}, G_{Hit} = measures of capacity levels for the provision of public education and health services respectively, and A_{it} = some measure of the general state of production technology during period *t*. Wheeler treats A_{it} as wholly exogenous; however, in a model where the aim is to explore the interlinkages between growth, education, health and nutrition, endogenising all variables, this seems quite limiting. We therefore treat the *change* in technology as a function of the *level* of education, E_{it}. We take the first differentials of these equations to give a model in growth rates.

Simultaneous equation models necessitate the explicit specification of causality. In this case we specify that national output, health, education and nutrition are endogenously determined and this is in line with the model specified by Wheeler (1980). The model presented by Wheeler is extended here with respect to the predetermined variables, those reflecting policies which are not systematically related to contemporaneous values of the endogenous variables. Specifically, we include two new variables relating to issues that have risen to prominence in the development discourse largely since the publication of Wheeler's paper; first, the change in the proportion of girls amongst primary school enrolments, reflecting the growing recognition of the importance of gender in development, and the role women in particular can play in promoting development.[15] This is included in the literacy and life-expectancy equations.[16] Second, we include the average share of debt service in GDP in all four equations; the rising problem of third world debt has made it increasingly difficult for developing countries to put resources into basic needs such as health, education and food subsidies. It is also possible that a high debt service burden may restrict resources available for productive investments.

Ideally, such a model might be estimated by panel data methods; however, data for many of the variables, such as literacy rates, are only available at roughly 10-year intervals from sources such as the World Bank (2001). We therefore estimate a model using 10-year growth rates in the dependant variables, with the growth rate over a ten-year period for each country being the basic unit of observation. We use three periods for each country: 1970-80, 1980-90, and 1990-2000. The system of four equations is estimated simultaneously using Three-Stage Least Squares.

Specification of the equations

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[15] It is recognised that as an economy grows the economic benefits of children tends to fall while the cost of raising children rises; it might be the case that the women's education effect is capturing a fertility effect. We have tried including fertility rates, but they were not significant.

[16] Typically in less-developed countries, there are i) no sources of old-age support available (social security or pensions), ii) few schemes encouraging people to save for their old age (if they were able to save) and iii) many jobs to do around the home. These factors could encourage the production of children, and this effect will increase with life expectancy. It can act as a further disincentive to educate women. This line of argument suggests that there could be a very complicated multi-directional interaction between growth, literacy, life-expectancy and female education – but in trying to capture this we have a problem of a lack of genuinely exogenous variables. Since everything affects everything else, we found it difficult to identify a starting point.

Deriving a suitable empirical model of GDP growth is actually quite problematical. For relative ease of estimation, we assume a Cobb-Douglas type production function for the determination of national GDP:

$$Y_{it} = A_{it} K_{it}^{\alpha} (L_{it}^{*})^{\beta} \tag{2}$$

where A is a measure of technology, K is capital, and L^* is human-capital adjusted labour, $L_{it}^{*} = L_{it} E_{it}^{\gamma 1} H_{it}^{\gamma 2} N_{it}^{\gamma 3}$.

This leads to a simple trans-log function for the change in GDP:

$$\Delta \ln Y = \Delta \ln A + \alpha \Delta \ln K + \beta \Delta \ln L + \beta \gamma_1 \Delta \ln E + \beta \gamma_2 \Delta \ln H + \beta \gamma_3 \Delta \ln N \tag{3}$$

where $\Delta \ln A$ = f(E), although the appropriate functional form for this is not clear.

The standard approximation, used by Wheeler (1980), of $\Delta \ln X \approx \Delta X/X$ = growth rate of X is questionable when we are dealing with changes over a 10-year period, when the magnitude of the growth rate is not always small (e.g. literacy doubling in some cases). Either formulation poses few problems in respect of most of the variables, but without any reliable measure of capital stock for most countries, finding a suitable linear or log-linear proxy for $\Delta \ln K$ is notoriously awkward.

If we allow the dubious approximation that $\Delta \ln K \approx \Delta K/K$, make the further dubious assumption of no depreciation so that we can use investment in place of ΔK, and the truly heroic assumption (Wheeler, 1980, p.442) that the capital-output ratio is similar for all countries, then we derive $\Delta K/K = q^* I/Y_0$, where q is the common capital utilisation ratio, I is investment during the period in question, and Y_0 is the initial level of GDP. This is a fairly standard procedure, and is used by Wheeler (1980), but is especially problematical in this context, for several reasons:

(i) As noted above, the approximation $\Delta \ln K \approx \Delta K/K$ is much weaker over a 10-year period
(ii) Depreciation is a much more serious problem over a 10-year period, and indeed investment near the end of the period will have a much greater influence on ΔK than that at the start
(iii) We must assume a common capital/output ratio not just across countries, but across the three separate ten-year periods used.

There is no easy theoretical fix for these difficulties, any of which could lead to significant bias in the estimated coefficients. We followed Wheeler in using the ratio of average investment over each 10-year country-period to initial GDP as a proxy for the growth rate of capital, and using growth rates in the other variables, but ran a number of robustness tests to check if the problems described above have a serious impact on the results:

a) We tried an alternative specification in the change in logarithms of the variables (with log of investment share of GDP as the capital proxy, though this lacks a clear theoretical justification)
b) We weighted the investment over each period using varying annual depreciation rates of 0%, 5%, 10% and 15%
c) We included period-slope dummies for the investment share times dummies for the different 10-year period to allow for possibly varying capital-output ratios across time; and a slope-dummy for investment share times a "developed country" dummy to allow for differing capital-output ratios between developed and developing countries. We also considered regional slope-dummies.

In the case of a) and b), the alternative specifications produced remarkably similar results. In the case of c), the slope-dummies were all insignificant, except for South East Asia and South Asia where there appears to be a stronger positive effect of investment on growth; however the effect is not very large, and most other results remain more or less the same (results including this slope-dummy are included for comparison, in table 2 model 3). This suggests that, while the specification of the investment-growth relationship may be inexact, it is not clear that this creates a serious or systematic distortion of the results, or that a better specification can be readily constructed. We therefore stick with Wheeler's specification using average growth rates of each variable, and the ratio of average investment over a period to initial GDP.

When compared with Wheeler (1980) we drop a dummy variable accounting for the presence of substantial manufacturing investment by multinational firms, as both the industrial structure of many countries and the nature of FDI have changed in a non-linear fashion since he estimated his equations. There is uncertainty regarding the role that this will play.[17]

Basic needs equations

For the basic needs equations, we use adult literacy rates, average daily calorific intake per person, and life expectancy at birth as proxies for education, nutrition, and health. The left hand-side of these equations is the average growth rate (for a 10-year country-period) of the variable in question.

For the literacy equation, we include on the right-hand side the growth rates in: real GDP per capita, the proportion of primary school enrolments out of the primary school-age population, and the share of females in primary school enrolments as factors likely to increase literacy. We include the average level of debt service as a share of GDP over the 10-year period as a possible retarding factor. Also included, after some thought, is the growth rate in life expectancy. At first sight, one might expect a positive relationship, if any, on the basis of some sort of virtuous cycle between good health and good education. However, further thought suggests a possible *negative* impact: as most countries have been increasing their levels of literacy throughout the thirty year period, and as, amongst the adult population, mortality disproportionately affects older people, improvements to life expectancy are likely to mean that older adults from less literate generations are surviving longer, thus reducing the adult literacy rate![18]

For the nutrition equation, we include growth in GDP per capita and debt service as the right-hand side variable. For the health equation, we include 10-year average growth rates of the following variables: GDP per capita, number of doctors per 1,000 population, level and change in literacy (to allow for both health technology and information dissemination effects), calorific intake and female share of primary enrolments. We also include the average level of debt service over each 10-year period. The doctors variable is included as an admittedly somewhat weak proxy of health capacity inputs.[19] Female education is included in the health equation as well as the life expectancy equation on the basis that education of women may be crucial in terms of issues relating to womens' fertility and sexual health, which in turn could have a significant impact on life expectancy, contraception, sexual diseases, pregnancy and childbirth, female genital mutilation, etc.

[17] We tried using the average share of FDI in GDP in the growth equation, but this proved insignificant.

[18] It might be the case that families in less-developed countries spend the same proportion of their incomes on their children, but as they are income constrained their ability to pay for them to go to school is limited at lower absolute levels of income. Song *et al*. (2006) find evidence to suggest that the demand for female schooling is more income elastic than that for male schooling and that maternal education has a stronger effect on primary school enrolments and on educational expenditure than paternal education in rural China. We do not have data on this for a cross section of countries over time, but poverty may well be an important factor preventing families from sending their children to school, especially where there are user fees. Enabling a government to provide free education can be a result of debt relief. For example, in Tanzania debt relief has allowed more free schooling, leading to an increase in enrolments. Bhaumik (2005) found that the impact of the World Bank's loans and grants on the youth literacy rate is positive.

[19] Wheeler (1980) includes a variable for the number of nurses per 1,000 population. We exclude this due to lack of data.

Female education may also enable women to promote the health of their whole family. More generally, female education may act as a proxy for womens' position in society; it is not unreasonable to suppose that where women have very low status in society they will be more vulnerable to death through disease and violence.

We follow Wheeler (1980) in allowing for possible non-linearities in the relationships between the variables. As that paper points out, literacy has an asymptote of 100%, so that it is likely that further increases in literacy are harder to obtain, the higher the initial level of literacy. Thus we include interaction terms for those right-hand side variables in the literacy equation expected to have a *positive* effect: GDP per capita growth, growth in primary school enrolments, and growth in the proportion of female enrolments in primary education, obtained by multiplying the growth rates of these variables by the log of the initial level of literacy, to allow for a non-linear specification. Hence the literacy equation includes on the right-hand side terms such as:

$$(\beta_1 + \beta_2 Ln(LIT_{init}))GYPC$$

where LIT_{init} denotes the initial level of literacy over a ten-year period, and *GYPC* the growth rate in GDP per capita. We therefore expect a *positive* coefficient for β_1, and a *negative* coefficient for β_2, which would mean that growth in GDP per capita will have more of an impact on literacy when literacy levels are initially low. The same applies to the other variables involving interaction terms.

We do not include interaction terms for debt service and life expectancy in the literacy equation, as these are anticipated to have negative impacts and a 'diminishing returns' type argument is not appropriate. In the case of nutrition, people who have reached a satisfactory level of calorific intake are unlikely to spend additional income on more calories; hence, we create an interaction term in the nutrition equation equal to the growth rate in GDP per capita times the log of the initial calorific intake for the ten-year period.

In the case of life expectancy, Rodgers (2002) for example suggests a similar effect for the relationship with income, with life expectancy rising concavely towards an asymptote as income rises (for a given level of medical technology, etc.). However, with the inclusion of a variety of variables in this equation (including literacy and nutrition), the nature of the interaction is not *a priori* obvious. In principle, one might specify a model to allow for the presence of multiple interactions between the different explanatory variables. In practice however, this would risk creating an unmanageable degree of multicollinearity between the variables. We therefore once again interact the (growth in) income, literacy, nutrition, doctors, and female education variables with the log of the initial level of life expectancy. Again, we do not interact the debt term.

The model uses a pooled dataset, where three periods are considered for each country, where available: 1970-1980, 1980-1990, and 1990-2000. In each period, the average growth rate in each of real GDP, literacy, calorie intake and life expectancy are regressed on the relevant endogenous and exogenous variables using Three-Stage Least Squares. This pooling may create heterogeneity bias, and T is too small (=3, smaller for some countries) for it to make much sense to introduce, for example, a fixed effects model; however, period dummies are included, to allow at least for heterogeneity between the different decades; and the problem of omitting country-specific effects may be ameliorated by the fact that the dependant variables are all expressed as growth rates rather than levels. In effect, we are viewing the dataset as three separate cross-sections, estimated with period-specific effects, rather than as 100 or so separate time series. In total, there are 175 country-periods, from 74 countries.

Finally, a developed-country dummy is included in the literacy equation, as developed countries had little or no improvements in basic literacy to make during the periods concerned. The full set of equations to be estimated is given below, where dots over the variables indicate average growth rates over a ten-year period, and the subscript "*in*" denotes the level of the variable at the start of the period:

$$\dot{Y} = \alpha_0 + \alpha_1 \dot{l} + \alpha_2 I + \alpha_3 \dot{e} + \alpha_4 \dot{h} + \alpha_5 \dot{n} + \alpha_6 D + \alpha_7 D70 + \alpha_8 D90 + \varepsilon_1 \quad (4a)$$

$$\dot{e} = \beta_0 + (\beta_1 + \beta_2 \ln(e_{in}))\dot{y} + (\beta_3 + \beta_4 \ln(e_{in}))\dot{pri} + (\beta_5 + \beta_6 \ln(e_{in}))\dot{fem} + \beta_7 D + \beta_8 \dot{h} + \beta_9 Dev + \beta_{10} D70 + \beta_{11} D90 + \varepsilon_2 \quad (4b)$$

$$\dot{n} = \gamma_0 + (\gamma_1 + \gamma_2 \ln(n_{in}))\dot{y} + \gamma_3 D + \gamma_4 D70 + \gamma_5 D90 + \varepsilon_3 \quad (4c)$$

$$\dot{h} = \xi_0 + (\xi_1 + \xi_2 \ln(h_{in}))\dot{y} + (\xi_3 + \xi_4 \ln(h_{in}))\dot{doc} + (\xi_5 + \xi_6 \ln(h_{in}))\dot{e} + (\xi_7 + \xi_8 \ln(h_{in}))\dot{n} + (\xi_9 + \xi_{10} \ln(h_{in}))\dot{fem} + \xi_{11} D + \xi_{12} D70 + \xi_{13} D90 + \varepsilon_4. \quad (4d)$$

where:

Y = GDP
y = GDP per capita
l = Labour force
I = Average investment share of GDP
e = Adult literacy rate
n = Average daily calorific intake
h = Life expectancy at birth
D = Average debt service as a share of GDP
pri = Proportion of primary enrolments amongst primary school-age children
fem = Proportion of girls in primary enrolments
doc = Doctors per 1,000 of population
Dev = Dummy for developed countries
D70 = Dummy for period 1970-1980
D90 = Dummy for period 1990-2000

The GDP per capita change variable is declared to be endogenous, although it is not one of the four left-hand side variables. The four equations are all clearly identified. Full details of variables are provided in Table 1.

{Insert Table 1 about here}

A first look at the data

Figures 1-4 below display the trajectories of adult literacy, life expectancy, nutrition and GDP per capita for the maximum, minimum, mean, median and upper and lower quartiles at the sample at 10-year intervals from 1960-2000. Although the picture shows a general improvement in all measures, there are some noticeable differences. In the case of literacy, for example, there has been a steady closing of the gap between the best and worst, with the strongest improvements coming towards the bottom end of the sample. No 10-year period saw a fall in literacy for any country in the sample. Even looking at the bottom quartile, the number of countries with less than 50% literacy fell from 21 in 1970 to 16 in 1980, 10 in 1990 and just 6 in 2000.

Life expectancy shows a gloomier picture. Despite continued increases in the top quartile over the period, with little signs of a slow-down, gains to average life expectancy almost petered out altogether for the sample over the 1990s. There is clearly a sharp downturn for the bottom country after 1980, and looking more closely, 14 countries saw their life expectancy fall over the 1990s; of these, 13 were in sub-Saharan Africa (the other being Guyana), all but three of those are in our sample.[20]

For nutrition, the picture is more confused, as falls in calorific intake are not necessarily undesirable for developed countries. However, over the 1980s, 10 sub-Saharan African countries saw their nutritional intake fall. The trajectory of real GDP per capita also saw a significant widening, with the ratio of the upper to the lower quartile increasing steadily from 9 to 21 between 1960 and 1990, although this remained more or less constant up to 2000. In the 'lost decade' for development of the 1980s, 28 countries in the sample, all in the developing world, saw falls in real GDP per capita over the decade.

{Insert Figures 1-4 about here}

Thus both economic growth and improvements in basic needs, while generally positive over the past 40 years, have been highly uneven and, with the exception of literacy, have seen a worsening at the bottom end over the last two decades of the last century. If, as seems *a priori* likely, there is a two-way feedback between growth and basic needs, this does not offer an optimistic prognosis for the future.

4. Empirical results

Initial model

The initial empirical results appeared to support many of the predictions of the model, with evidence of a two-way relationship between growth in GDP per capita and fulfilment of basic needs. However, there were a number of severe problems with the results.

The life expectancy equation performed poorly, with many variables (such as the doctors) insignificant, and in some cases even of the wrong sign (literacy in both initial level and change were negative, while debt service was positive.) This was not entirely unexpected, as other studies have found difficulty in producing a meaningful estimation of a life expectancy equation.

More worryingly was the effect of literacy on economic growth, namely that the change in literacy had a negative coefficient. The initial level was positive, but the two were highly collinear, with a strong negative impact of literacy change on economic growth if the initial level is left out. This result seems hard to interpret.

Finally, the results appeared to lack robustness; the inclusion or exclusion of an apparently insignificant variable in one regression could lead to major changes – including of the sign on significant variables – in other equations. All these factors led us to suspect some serious misspecification was present.

After some thought, we tried adding the *initial level* of literacy to the equation for literacy change, replacing the developed country dummy; the reasoning being that it is hard to achieve growth in literacy when the level is already high. This had so far only been accounted for in the interaction term of initial level of literacy with economic growth, but it seemed plausible that this effect would operate independently of economic growth. The effect of this was dramatic, with the initial level of literacy highly significant and negative in the change in literacy equation. What is more, all other variables in the literacy equation became insignificant, including economic growth, primary school enrolments, female education and all interaction terms. Investigating further, it transpired that the initial level of literacy accounted for 87% of the variance in the literacy growth

[20] A list of the countries that are included in our sample appears in the appendix.

rate looking at a single linear equation for this variable on its own. This seemed to account for the lack of robustness in the equations, the multicollinearity between literacy level and growth, and the opposite effects of these on the economic growth rate when considered separately. This result calls for further investigation and interpretation. It would suggest that literacy growth follows, on average, a similar time path for all countries, independent of the general performance of the economy.

Remodelling with literacy being exogenous

Given the insignificance of economic growth – and all other explanatory variables in the model – in explaining literacy growth, it occurred to us that the model might be better specified by treating literacy as *exogenous*, removing the literacy equation from the model. Given the lack of impact of other variables on literacy, this should not create endogeneity bias. Due to the high multicollinearity between initial literacy and change in literacy, we decided to include just the initial level in the growth equation; this also removes any potential endogeneity problem from an (albeit insignificant) influence of growth on the change in literacy. However in the health equation, we decided to include both the initial level and the change in literacy (along with interaction terms with the log of initial life expectancy), as these are picking up very different effects, which are in particularly likely to vary in importance between developing and developed countries: a high initial level of literacy may increase developments in health technology in developed countries at or near the technological frontier, while an improvement in literacy in developing countries may facilitate the dissemination of existing technology and health-related knowledge.

The results of the 3-equation estimation are summarised in Table 2. Model 1 shows the full model, Model 2 shows the results with some insignificant variables deleted, while Model 3 shows the results with the regional investment dummies for SE Asia and S. Asia included. Generally speaking, there is little qualitative difference between the results for the three models, for those variables common to all three.

{Insert Table 2 about here}

Growth Equation

The results offer considerable support to the hypothesis of a positive interaction between growth and basic needs fulfilment, as measured by life expectancy and calorific intake. Both of the latter have a strongly significant and positive impact on GDP growth, as does the initial level of literacy, although the effect is relatively small. These results are consistent with those provided by Wheeler (1980). Our first model suggests that a country with an initial level of literacy 10% higher than average will enjoy a roughly 2% greater *total* growth rate in GDP over a 10-year period.

A high debt service burden will retard a nation's growth, to a rather more significant degree: a country with a 7.27% debt service burden – the developing country median in the 1980s – would grow more slowly by 8% over the decade than one without such a burden. The literacy and debt service results together suggest a strong self-reinforcing effect of poverty, making it very difficult for poor countries to climb out of their situation. However the results for life expectancy and nutrition suggest that if such resources as are available are channelled towards fulfilling such basic health and nutrition needs, there could be dramatic economic returns, as well as the obvious direct benefits to human well-being from such policies.

Nutrition Equation

Turning to the nutrition equation, growth in real GDP per capita has a strongly positive impact on growth in calorific intake. There is a non-linear relationship, whereby the positive effect of real income growth diminishes as the initial level of calorific intake increases. In all three models, the size of the coefficients on the GDP growth and the interaction terms suggests that the positive impact of real income growth operates up to a starting calorific level of 3,000 calories per day, the recommended daily intake for an adult. Pleasingly, debt servicing does not appear to have a strong effect on reducing undernutrition.[21]

Life Expectancy Equation

The life expectancy equation, in common with this equation in many of the other studies considered in section 2, is quite problematic, with many variables having the opposite sign to expectations. The GDP per capita growth variable is significantly negative, with a significantly positive interaction term with initial life expectancy. This implies a negative impact of real income growth on improvements in life expectancy where the initial level is low (up to between 55 and 59, from the size of the coefficients in the three equations), and a positive effect when the initial level is high. This is the opposite of what was expected, where real income growth was expected to have a greater impact on life expectancy at low initial levels, as it is at these levels that growth in income might be expected to make the most difference through access to basic healthcare and sanitation.[22]

In the case of the initial level of literacy, the non-linear relationship is of the expected shape (negative coefficient on the main variable, positive interaction term), but the size of the coefficients are such that the overall effect would always be negative, for all initial levels of life expectancy.[23] For the change in literacy, the non-linear relationship is also of a negative-then-positive shape, which this time is contrary to our priors. The actual impact is negative, for all initial life expectancies up to around 100.

On the other hand, there is a positive impact of improved nutrition on life expectancy, with the expected shape of non-linear relationship, though the positive impact only holds for initial life expectancy levels up to 61, beyond which the impact becomes negative. The one ambiguously (expected) positive impact is of increases in the proportion of girls in primary school enrolments, which is strongly positive and significant. This supports the hypothesis that educating a woman will lead to improvements in health for her whole family, and lower infant mortality, etc.

The coefficient on debt service is positive and significant (albeit small), which is again contrary to common sense. The doctors variables are individually insignificant but jointly significant, again with a negative overall sign at lower initial life expectancies (up to an estimated value of 75), and positive above that level. This again is not exactly what the doctor ordered.

Summary

Overall, it is hard to make much sense of these results for life expectancy. However this appears to be not unusual in the literature on basic needs; life expectancy seems to be a quantity that is hard to estimate. It may be that the primary determinants of life expectancy growth are variables that are intrinsically hard to measure, or it may be that the implied *dynamics* of the relationships are mis-specified – there may be longer lags between changes in other variables and changes in life expectancy. In fact, there is a strong positive relationship between the *level* of life expectancy and the levels of doctors per head, literacy and nutritional intake (although GDP per capita is insignificant alongside these other variables), which does indeed suggest that the problem is arising in the dynamic relationship.

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[21] Of course, this figure will be subject to significant standard errors, as it is constructed from the coefficients of two variables.

[22] It should be noted that this only measures the direct effect of real income growth – there is also an indirect effect via nutrition, which will be positive in the case of low initial life expectancy, unless this is (implausibly) accompanied by high levels of nutrition. At an initial life expectancy of 50 and daily calorific intake of 2,500, for example, the overall effect would be very slightly positive. Still, this is not a particularly encouraging result.

[23] In the first model, initial life expectancy would have to reach 1,922 before higher initial literacy levels started to have a positive effect!

The problems with the life expectancy equation mean that the results as a whole need to be treated with some caution; however the other two equations appear to be quite robust, and the presence of the life expectancy equation at least means that that variable is being instrumented with exogenous variables that have predictive power even if they lack explanatory power.

The results prove robust with respect to deletion of insignificant variables, inclusion of the slope dummies for investment, different specifications of the investment variable (i.e. applying depreciation rates of 5, 10 and 15% to annual investment levels in calculating the investment share in GDP), and use of logs of variables instead of levels and growth rates, as well as various other minor changes to specifications. This is in contrast to the picture with the four-equation model.

5. Discussion and policy implications

Looking at the overall picture, an interesting feature is that there seems to be a much stronger relationship from basic needs fulfilment to growth than the other way round – except in the case of nutrition, where there is a clear mutual positive relationship. Growth does not appear to have a significant effect on the rate of improvement of literacy, and the effect on life expectancy is ambiguous. This may suggest that economic growth *on its own* is not sufficient to guarantee improvements in basic human welfare, but that the resources made available by economic growth need to be specifically directed towards these objectives. Furthermore, the evidence from the growth equation is that such efforts will receive a strong payoff in terms of economic growth as well. This presents a strong case for encouraging policies that direct resources towards these areas, and against policies that have often been espoused by the IMF for example, of requiring reduced support, introduction of user-fees, etc., to enable countries to maintain debt repayments in a context of macroeconomic stability. These results present a case for saying that one must first get the human needs right, and growth will follow, rather than the other way round.

Although the effects of debt on basic needs do not emerge clearly from these results, there is a clear negative impact on economic growth. Considered alongside the strong positive impact of basic needs fulfilment – needs which are insufficiently met in developing countries – we are left with a depressing picture for poor countries' prospects of convergence with the developed world in income per capita; we cannot expect the operation of the market alone to enable developing countries to grow their way out of poverty; their poor levels of health and education, and the debt burdens with which they are saddled will continue to hold them back compared to the already-developed nations.

While it is an obvious point that increasing income creates more resources that may be spent by government and/or individuals on health, education and food, it should be pointed out that this does not guarantee they *will* be spent on these areas. Moon and Dixon (1992) for example argue that higher rates of economic growth do not improve a nation's ability to meet the basic needs of it population. The extent to which this potential two-way feedback between economic growth and basic needs fulfilment exists is something to be determined, not assumed, in the model.

If this cycle of deprivation is to be broken, a more interventionist approach may be required. Firstly, efforts to reduce or cancel the debt of third world nations need to be redoubled and accelerated. Second, basic education and health provision need to be given a higher priority in terms of national resource allocation. If this is to be achieved within countries' own resources, rather than though increased international aid, then clearly this must come through some combination of the proceeds of debt relief, reduced spending in other areas – such as the military, where evidence of the impact on economic growth is at best neutral if not negative, or higher taxation on those able to pay. The latter is usually frowned upon by mainstream economists due to the potential growth-retarding effects on incentives, but it is possible that this might be outweighed by the growth-enhancing effects of well-directed spending. Of course, this assumes that money raised is well-spent, and not dispersed or misappropriated through corruption and clientelism.

6. Conclusion

This paper presents an investigation into the simultaneous and multiple interlinkages between economic growth and basic needs fulfilment, using data from 1970 to 2000. We introduce female education and debt burden into an explicitly endogenous relationship. The results suggest different roles for basic needs variables, and an asymmetric relationship with economic growth. There is strong evidence that literacy, life expectancy and nutrition all make strong contributions to economic growth, but only a strong reverse relationship in the case of nutrition. There is some evidence of a positive impact of growth on life expectancy, but the effect is quite week. Literacy growth appears, surprisingly, to be independent of economic growth, and to depend overwhelmingly on the initial level – although there is a wide dispersion in literacy growth rates for countries at low starting points. It is possible that the strong linkage from growth to nutrition, but not so much to health and education, is a reflection of the nature of these goods; nutrition depends on access to essentially private goods, while health and education are both characterised by significant degrees of publicness, or at least strong public externalities, and which are usually at least partially the subject of public provision. General growth in income provides no guarantee of improvements in health and education unless backed by policies which specifically channel resources to these areas.

The idea that improvements in basic human needs are significant contributors to growth is strongly supported; the implication of which is that targeted action on these areas is required if there is to be any hope of reducing the gap between rich and poor countries, as well as on debt relief which is found to have a negative impact on economic growth. By contrast, it cannot be assumed that poor countries can win life-changing improvements to human welfare by going for growth alone, without specific attention to health and education in particular.

Appendix:

Countries included in the sample: Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Belize, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Cameroon, Chile, China, Colombia, Costa Rica, Denmark, Ecuador, Egypt (Arab Rep.), El Salvador, Finland, France, Ghana, Greece, Guatemala, Guyana, Honduras, Hong Kong, China, Hungary, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Korea (Rep.), Lesotho, Malawi, Malaysia, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, United Kingdom, United States, Uruguay, Venezuela, Zambia and Zimbabwe

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Table 1: Variable List (173 observations, sample for model 1 in Table 2)

Variable Name	Definition	Mean	St. Dev	Skewness	Kurtosis
ΔRGDP	Average annual % change in GDP over the 10-year period in question (1970-80, 1980-90, or 1990-00)	0.036	0.022	0.528	3.75
ΔRGDPpc	Average annual % change in GDP per capita over the 10-year period	0.019	0.021	0.194	3.53
InvShare	$\frac{\text{Average investment}}{\text{Initial real GDP}}$	0.299	0.131	2.280	12.50
InvShare SEA	Investment share * dummy for S.E. Asian countries	0.046	0.137	2.980	11.00
InvShare SA	Investment share * dummy for S. Asian countries	.0151546	.0642072	4.172646	19.1941
ΔLab	Average annual percentage change in labour force	0.020	0.012	-0.265	1.73
ΔLiteracy	Average annual % change in adult literacy	0.009	0.011	1.480	4.69
$\text{Literacy}_{\text{initial}}$	Initial level of adult literacy at the start of each 10-year period	76.237	24.487	-0.876	2.59
ΔCalories	Average annual % change in daily calorific intake	0.004	0.008	0.260	2.96
ΔPrimaryAll	Average annual % change in primary school enrolment rate	0.006	0.016	2.210	10.30
ΔLifeExp	Average annual % change in life expectancy	0.004	0.007	-3.420	18.90
ΔPrimaryGirls	Average annual % change in proportion of girls amongst primary school enrolments	0.002	0.004	1.940	8.44
ΔDoctors	Average annual % change in doctors per 1,000 population	0.034	0.054	3.710	29.70
Debt service	Average ratio of debt service to GDP	4.440	5.030	1.970	9.59
LITinter	Log ($\text{Literacy}_{\text{initial}}$)*RGDPPCCH	0.082	0.092	0.261	3.53
CALinter	Log(Initial daily calorific intake)*RGDPPCCH	0.149	0.168	0.191	3.50
LEinter	Log(Initial life expectancy)*RGDPCCH	0.079	0.089	0.224	3.56
PRIinter	Log($\text{Literacy}_{\text{initial}}$)*PRICH	0.023	0.059	1.620	7.03
DOCinter	Log(Initial life expectancy)*DOCCH	0.143	0.222	3.790	30.60
LELITinter	Log(Initial life expectancy)*LITCH	0.037	0.042	1.390	4.35
LECALinter	Log(Initial life expectancy)*CALCH	0.015	0.031	0.243	2.88
FEMEDinter	Log(Initial literacy)*FEMEDCH	0.048	0.197	-0.117	5.24
LEFEMEDinter	Log(Initial life expectancy)*FEMEDCH	0.078	0.237	1.510	7.08
1970s	Dummy variable for period 1970-80				
1990s	Dummy variable for period 1990-2000				

Source for all variables: World Bank (2001)

Table 2: Regression results for 3-stage least squares estimations

Dependent Variable	RGDPCH			CALCH			LECH		
Model	1	2	3	1	2	3	1	2	3
N	173	173	173	173	173	173	173	173	173
RGDPPCCH				6.98*** (4.13)	6.01*** (3.96)	5.73*** (3.76)	-5.80*** (-3.43)	-6.08*** (-3.88)	-3.16* (-1.80)
LCH	0.704*** (4.96)	0.708*** (4.65)	0.636*** (4.92)						
INVSHARE	0.0847*** (7.62)	0.0864*** (6.20)	0.0688*** (6.84)						
INVSHARE SEA			0.0315*** (3.24)						
INVSHARE SA			0.0276* (1.68)						
LITERACY Initial	0.000215*** (2.89)	0.000253*** (2.70)	0.000145** (2.20)				-0.000676 (-1.65)	-0.000264*** (-4.05)	-0.00124** (-2.56)
LECH	2.07*** (3.94)	3.01*** (3.64)	1.11** (2.52)						
LEINTER							1.44*** (3.52)	1.51*** (3.98)	0.790* (1.86)
CALCH	0.798*** (4.02)	0.753*** (3.00)	0.753*** (4.69)				29.8*** (4.40)	30.0*** (4.45)	19.6*** (2.94)
CALINTER				-0.875*** (-4.05)	-0.752*** (-3.88)	-0.715*** (-3.67)			
LECALINTER							-7.24*** (-4.40)	-7.29*** (-4.45)	-4.76*** (-2.94)
DEBTSERVAV	-0.00109*** (-3.59)	-0.00126*** (-3.32)	-0.000976*** (-3.91)	-0.000189 (-1.43)		-0.000133 (-1.06)	0.000469*** (4.18)	0.000421*** (3.69)	0.000441*** (3.53)
LITCH							-4.22*** (-2.64)	-3.99*** (-2.62)	-3.13* (-1.71)
LELITINTER							0.912** (2.32)	0.871** (2.34)	0.662 (1.44)
LELITINTER2							0.0000894 (0.95)		0.000229** (2.07)
DOCCH							-0.422 (-1.51)	-0.400 (-1.54)	-0.317 (-0.9)
DOCINTER							0.0978 (1.46)	0.0926 (1.49)	0.0736 (0.87)
FEMEDCH							4.08*** (3.16)	4.07*** (3.38)	2.694* (1.89)
LEFEMEDINTER							-0.0669*** (-2.95)	-0.0678*** (-3.22)	-0.0424* (-1.68)
PERIOD1	0.000317 (0.08)	-0.000836 (-0.17)	0.00406 (1.22)	0.0304** (2.01)	0.00370** (2.55)	0.00320** (2.17)	0.00511*** (2.90)	0.00497*** (2.64)	0.00366** (1.97)
PERIOD3	0.00933** (2.38)	0.0131** (2.48)	0.00601* (1.89)	0.00203 (1.62)	0.00211* (1.70)	0.00201 (1.64)	-0.00375*** (-3.34)	-0.00354*** (-3.00)	-0.00433*** (-3.53)
Constant	-0.0291*** (-3.18)	-0.0361*** (-2.99)	-0.0162* (-1.93)	0.00202 (1.46)	0.000866 (0.87)	0.00133 (1.01)	0.0256*** (4.44)	0.0225*** (3.96)	0.0251*** (3.69)
RMSE	0.0185	0.0223	0.0152	0.00723	0.00709	0.00703	0.0100	0.0101	0.00784
Pseudo R^2	0.283	-0.0389	0.517	0.0653	0.101	0.117	-1.24	-1.280	-0.373
Chi^2	164 [0.0000]	109 [0.0000]	243 [0.0000]	57.8 [0.0000]	52.4 [0.0000]	59.5 [0.0000]	112 [0.0000]	105 [0.0000]	72.8 [0.0000]

Figure 1: Adult literacy rate over time

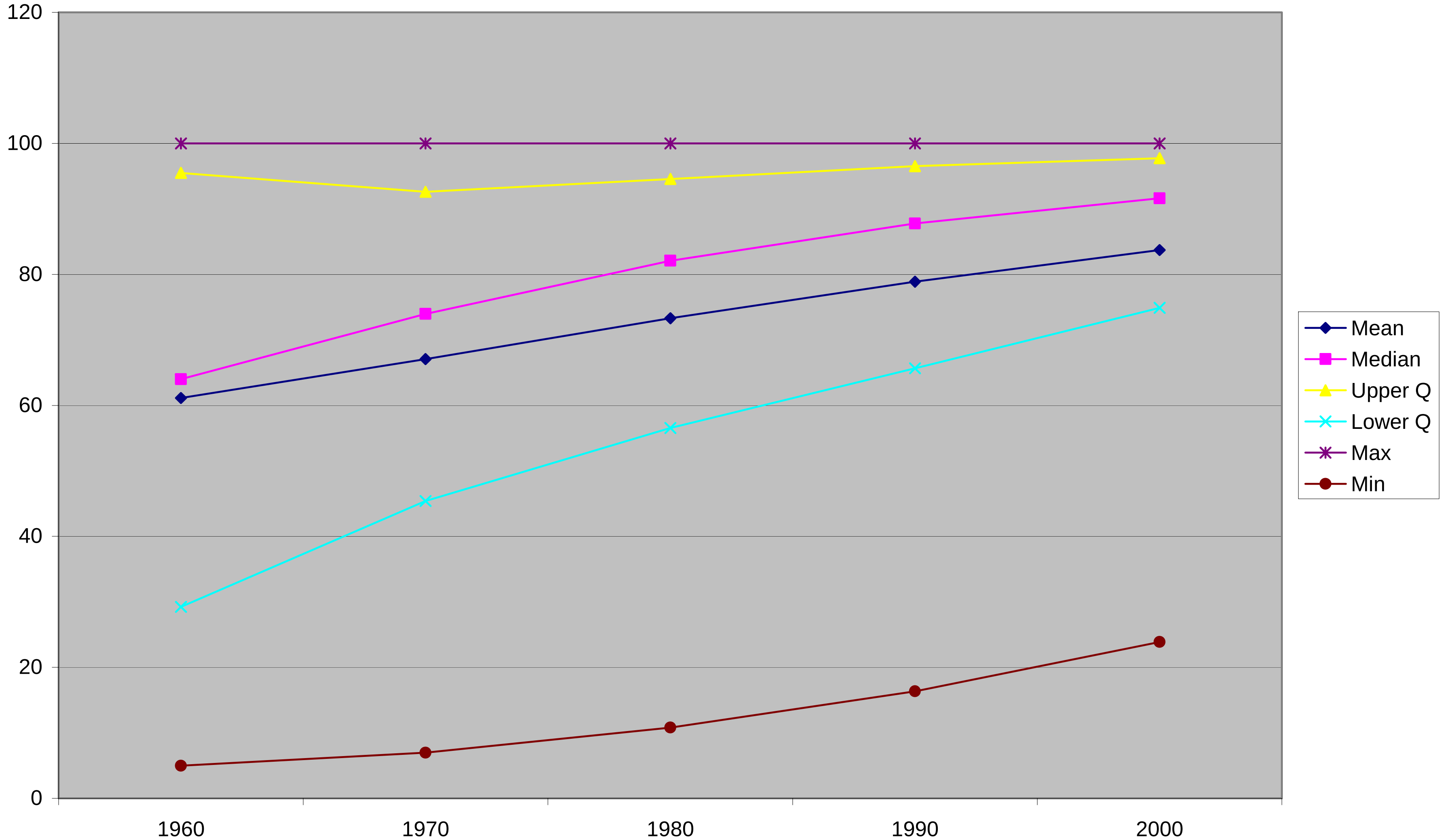

Figure 2: Life expectancy over time

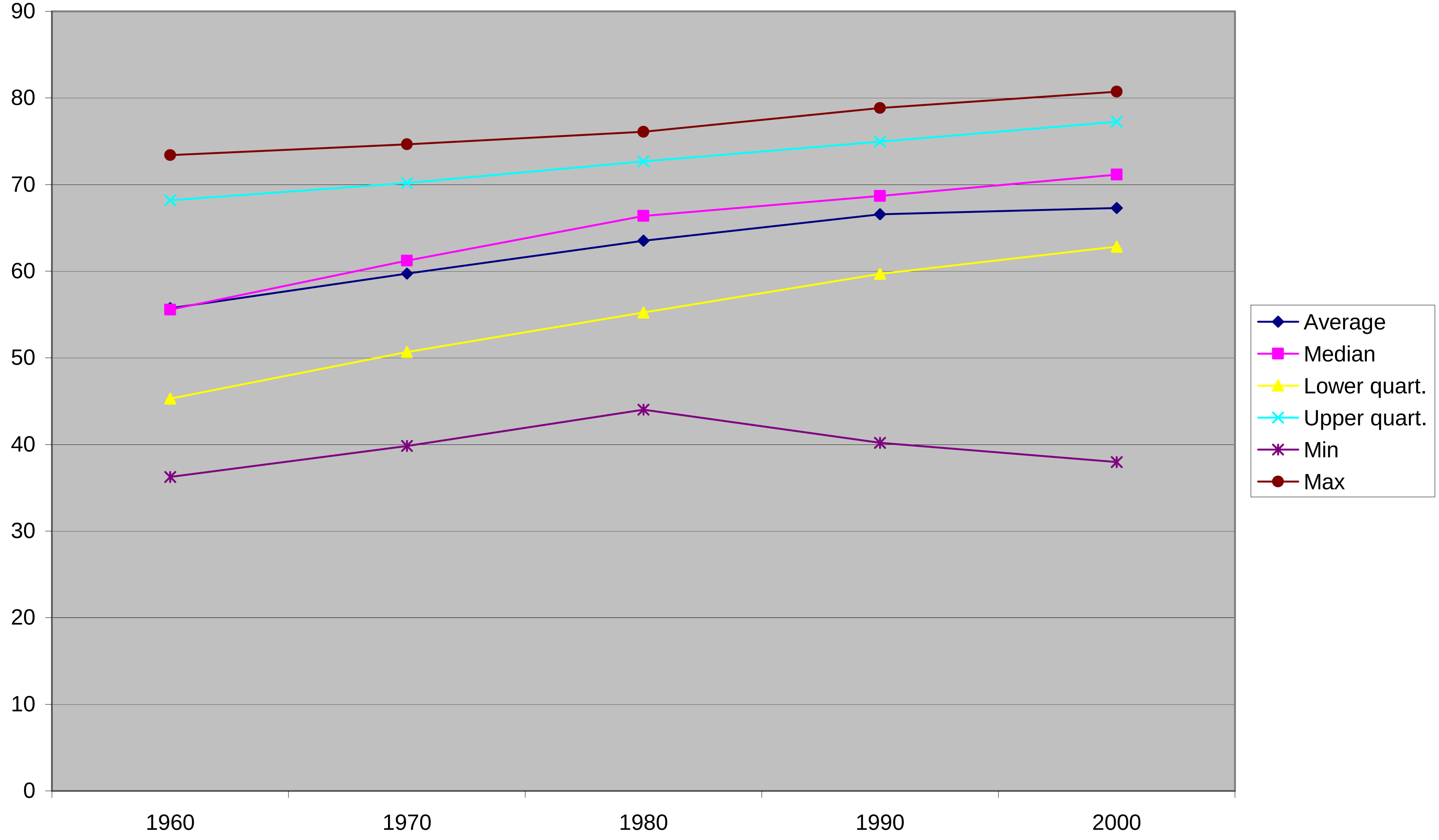

Figure 3: Nutrition over time (average adult calories per day)

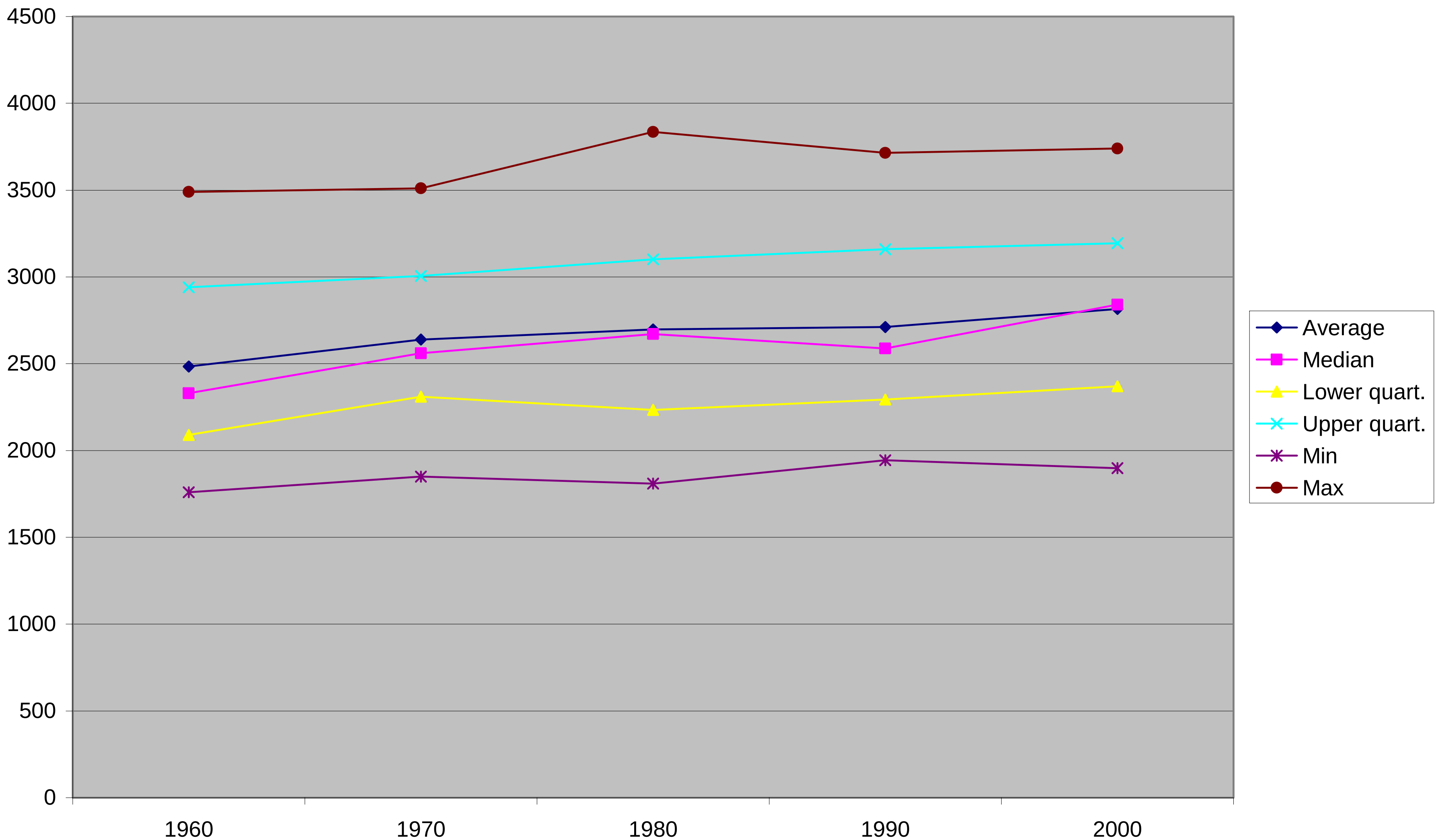

Figure 4: Real GDP per capita over time ($2000)