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# A CONTRIBUTION TO THE EMPIRICS OF WELFARE GROWTH

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# A Contribution to the Empirics of Welfare Growth

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**Abstract**

This paper compares the determinants of economic growth and welfare growth. Our main result is that determinants may differ or have different impact on welfare outcomes as compared to economic outcomes. Human capital plays a bigger role in determining the former, so that policies targeting human capital can have a greater effect on the welfare of societies than one would think by looking at their impact on economic growth alone. Institutions also have a greater effect on welfare growth compared to their impact on economic growth, consistent with the importance of government stability for the uninterrupted provision of health-related inputs and information. Finally, initial income has a greater impact on welfare growth than on real income per capita growth, implying even faster convergence than in Becker, Philipson, and Soares (2005) after adding a number of economic, health-related, institutions-related, and geographic variables. We conclude that there exist systematic differences for the impact of a number of factors on economic relative to welfare outcomes.

**Keywords:** economic growth, welfare, full income.

**JEL Classification:** O50, O11, I0

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# 1 Introduction

The macroeconomic growth literature has typically used real per capita income as a proxy for economic conditions and quality of life across countries. This fails to capture other aspects of welfare. For example, recent improvements in health and life expectancy are not taken into account. Becker et al. (2005) introduce a welfare-corrected 'full' income measure that incorporates the value of gains in life expectancy in addition to real income per capita, consistent with Becker (2007).[1] In this paper, we look at the determinants of the growth rate of this welfare measure. Our purpose is to compare the impact of economic, geographic, institutional, and health-related variables on 'full' income growth versus income per capita growth, and identify factors that have differential impact on these two measures of growth. Such differential impact would then suggest that greater use of some existing policies or the use of different policies might be appropriate if the target is to improve welfare rather than the income component of welfare alone.

A number of papers have asked whether international health outcomes are a by-product of economic growth or whether non-income factors are in part responsible. The latter argument is made by Preston (1975, 1980, 1996) and more recently by Becker, Philipson and Soares (2005), Soares (2007a, 2007b), Papageorgiou, Savvides, and Zachariadis (2007), and Ricci and Zachariadis (2009). Our paper is in line with this body of work. It is precisely when there are non-income determinants of health outcomes, that one can consider health as a separate component of welfare. If income was the sole determinant of health, then studying economic growth across countries would suffice to characterize the path of cross-country health outcomes and broader welfare growth. In contrast, if there are non-income determinants of health then factors driving welfare growth might well be different from those relevant for economic growth, with important policy implications.

Our benchmark is the empirical model from Mankiw, Romer, and Weil (1992). To this basic framework, we add institutions, health-related, and geography-related variables in addition to purely economic explanatory variables. Using a cross-section of 74 countries for the period from 1960 to 2003, our main result is that determinants may differ or have different impact on welfare

[1] Becker (2007) concludes that "changes in life expectancy across different countries should be added to the growth in per capita incomes by weighting improvements in life expectancies by the willingness to pay appropriate to a country's income level."

outcomes as compared to economic outcomes.

We find that human capital in the form of secondary education completion rates, plays a more significant role in determining welfare growth than in determining economic growth. This suggests that policies targeting human capital might have a much greater effect on the welfare of societies than one would think by looking at their impact on economic growth alone. Moreover, measures of institutions like government stability have a larger effect on 'full' income growth compared to their impact on economic growth suggesting that continuity in governance is conducive to the long-run maximization of welfare, likely through the uninterrupted provision of health-related inputs, public infrastructure, and public health-related information. The quality of health institutions also has a greater and significant effect on welfare growth that is statistically different than the smaller and typically insignificant effect of health institutions on economic growth. Based on panel estimation, the same finding about the relative impact on welfare versus economic growth holds for nutrition and physical investment. Finally, the finding from Becker et al. (2005) regarding convergence in a bivariate setting, is confirmed and shown to be robust and implied convergence much faster in the presence of a variety of economic, geographic, institutions-related, and health-related variables.

In the next chapter we describe and justify the empirical concepts utilized in this application, and the data used to construct these. In chapter 3, we motivate our empirical specification, describe the estimation, and present our results. The last chapter briefly concludes.

## 2 Empirical concepts

The construction of the welfare-corrected GDP measure is based on Becker et al. (2005). These authors calculate the value of increases in life expectancy and add this to real GDP per capita. The welfare component is derived as follows. Consider a country at two points in time with lifetime income and survival function denoted by $(Y^1, S^1)$ and $(Y^2, S^2)$ respectively. We are interested in $W(S^1, S^2)$ that would give a person in this country the same utility level observed in the second period, $V(Y^2, S^2)$, but with the mortality rates observed in the first. This utility level is given by: $V(Y^2 + W(S^1, S^2), S^1) = V(Y^2, S^2)$. The growth rate in 'full' lifetime income that values gains in longevity in addition to gains in material income is then given by: $G = \frac{Y^2+W(S^1,S^2)}{Y^1} - 1$.[2] For the cross-sectional applications, the 'full' income growth rate is constructed for 93 countries using real GDP per capita in 1960 and 2003 taken from the Penn World Tables volume 6.2 (PWT), and life expectancy for 1960 and 2003 taken from the World Development Indicators (WDI). The life expectancy variable is reported sporadically in the following pattern: 1960, 1962, 1967, 1970, 1972... up until 2002, for 175 countries. Thus, based on the availability of the life expectancy data, the welfare and income variables are constructed in four intervals: 1962-1970, 1972-1980, 1982-1990 and 1992-2000, for panel estimation purposes.

The standard Solow model explanatory variables considered include initial income per capita and the investment share in GDP both taken from the PWT, and population size data used to construct population growth rates obtained from the WDI. Our primary measure of human capital is the percentage of population with completed secondary education aged 15 and over, taken from the Barro and Lee (2000) dataset. These data are reported every five years starting from 1960 until 2000. Increased educational status affects economic outcomes but can also affect health improvements by two separate channels, consistent with Becker (2007). First, increases in education lead to an increase in expected wealth and thus in health spending which as a result increases survival rates. Second, educated individuals can make more efficient use of given health inputs by acquiring better health information and health related habits, thus increasing their survival probability. Kenkel (1991) emphasizes better information on health, and Grossman (1972) better decision-making by more educated individuals. In line with this, the aggregate level of education in the economy can be thought of as improving the quality of health services offered within a country, consistent with greater absorptive capacity for health-related technology and ideas[3].

Health-related variables are obvious candidates as determinants of the life expectancy compo-

[2]It should be noted that although this accounts for improvements in home-produced or nonmarket health, it still leaves out other factors that can affect welfare like the value of leisure and other non-market goods, much like real GDP per capita.

[3]Soares (2007a) states that "[*t*]echnologies related to individual-level inputs used in the production of health seem to be subject to the effectiveness with which individuals can use these inputs" so that "more educated individuals have higher survival advantage in diseases for which medical progress has been important." Similarly, Cutler, Deaton and Lleras-Muney (2006, p. 115) write that "the differential use of health knowledge and technology [*is*] almost certainly [*an*] important part of the explanation" as to why "[*t*]here is most likely a direct positive effect of education on health."

nent of our measure of 'full' income, and are also possible determinants of economic growth to the extent that life expectancy affects economic growth consistent with Arora (2002) and Weil (2007). The health-related variables being considered include the number of physicians per thousand people, a health institutions quality index, and the number of AIDS cases per 100,000 people. The number of physicians is taken from the WDI database and data are available for the whole period under consideration[4]. The health institutions quality index is taken from the World Health Organization's (WHO) World Health Report (2000). Finally, the AIDS variable is taken from the WHO's Global Health Atlas (2007) and covers the period between 1979 and 2001[5]. These three variables are likely to be important determinants of the general health status of each country.

Physicians act as a rival input into the health production function but are also associated with the spread of new non-rival medical-related ideas and are complementary to the use of new medical technology. The number of physicians per thousand persons is highly correlated with other health indicators so that it appears to capture well the overall availability of health care in each country[6]. It is also positively associated with the education level in each country. The correlation coefficient between average years of secondary education and physicians is 81 percent. This is plausible, since if education participation is higher then the number of health care professionals completing their studies should also be higher. This collinearity should then affect the estimated coefficient for education and its interpretation when physicians availability is added in the regression specifications along with the percentage of population with completed secondary education.

The Health Institutions Quality Index is a measure of efficiency of National Health Systems. The index is used to assess the performance of countries in terms of achieving a broad set of health outcomes[7].The index takes into account the level of health (using Disability Adjusted Life

[4]For most countries this is reported on a five or ten year interval basis.

[5]The earliest observation available for the AIDS variable is in 1979 while regular observations for most countries start from the mid-1980's.

[6]The correlation coefficient of the number of physicians with the number of hospital beds per thousand persons is 73 percent, 88 percent with improved water conditions and -77 percent with malaria prevalence.

[7]The construction of the index is described in detail in Evans et al (2000b) and in a publication by the WHO in 2000.

Expectancies[8]), health inequality, responsiveness[9], responsiveness inequality, and fairness of financial contribution[10]. The resulting composite index is a weighted average of these five categories, i.e., health with weight 25%, health inequality with weight 25%, level of responsiveness with weight 12.5%, distribution of responsiveness with weight 12.5% , and fairness of financing with weight 25%. A more detailed description of this index as well as its subcomponents can be found in WHO (2000) and Evans et al. (2001).

Inclusion of AIDS is needed to capture the devastating effect of this pandemic during the last twenty-five years. It should be noted that the effect is greater in Sub-Saharan Africa where a steady reduction in life expectancy has been observed over the past decade or so. Due to its prevalence in Sub-Saharan Africa which faces a broader range of economic problems and diseases, AIDS can have a more general interpretation proxying for a number of bio-geographic factors affecting health outcomes. Moreover, the effect of AIDS is associated with the failure of public institutions and the lack of proper education to react and take measures to reduce it.

Another factor that relates to health but is likely to affect both income and health status, is nutrition (average dietary energy consumption.) A student which is well fed is more able to acquire knowledge and train herself to become a productive worker. A worker with a better diet is more likely to work harder and longer, and as a result produce more output. More importantly an individual with a balanced diet has an increased probability of survival. These facts are stressed in the work of Fogel (1994). The nutrition variable is taken from the World Food Organization (FAO) Statistical Yearbooks. It is reported as an average for 1969-71, 1979-81, 1990-92, 1995-97, and 2001-03. These data are generally available for 141 countries.[11]

[8]The number of dissability days is estimated using three pieces of information, birth and death rates, the prevelance of each type of disability at each age, and the weight assigned to each type of disability. These days are used to adjust the Life Expectancy for each country and provide a more accurate view of health because people live part of their lives in less than full health.

[9]The responsiveness measure assesses "how the system performs relative to non-health aspects, meeting or not meeting a population's expectations of how it should be treated by providers of prevention, care or non-personal services." (WHO 2000 p.31). The measure takes into account two broad categories of variables. The first is related to the respect that the system pays to persons (includes respect for the dignity of the person, confidentiality etc), and the second the system client orientation (includes prompt attention, amenities of adequate quality etc).

[10]This measure assesses the ability of the health system to distribute fairly across households the burden of health financing. Under this metric, the "health system is perfectly fair if the ratio of total health contribution to total non-food spending is identical for all households, independently of their income, their health status or their use of the health system" (WHO 2000 p.26).

[11]This is the case for all sub-periods except for the last when the data become available for 173 countries, including

The measures used as proxies for the institution status in each country are government stability and contract variability/risk of expropriation. Woodruff (2006) argues for the use of variables measuring both formal and informal institutions, and suggests that government stability and risk of expropriation serve this dual goal. It should thus be noted that the measures of government stability and risk of expropriation we use in this application capture both differences in formal but also informal institutions between countries, unlike measures of the type of electoral rule, legal system structure, and judicial independence which capture only formal institutional structure.

Government stability captures "government's ability to stay in office and carry out its declared programs depending upon such factors as the type of governance, cohesion of the government and governing parties, approach of an election, and command of the legislature. It is created from three subcomponents: government unity, legislative strength and popular support. This index is taken from the International Country Risk Guide (2008) dataset made available by the Political Risk Service (PRS) group, and is reported on a monthly basis from 1984 to 2003 for at least 140 countries in any one month. This index is given on a scale between zero and 12, with 12 amounting to very high degree of Government stability. The minimum and maximum values across countries in our sample are 3.5 and 11.2 respectively. In our estimation exercise, we consider the natural log of this variable.

Contract variability/risk of expropriation assesses the factors affecting the risk in investment and broad property rights. It is used as a proxy for the quality of institutions in a given time period. It is made available by the PRS database on a monthly basis from 2001 to 2003 for at least 90 countries on a scale between zero and 4. These data are used in conjunction with the series previously used by Knack and Keefer (1995) and more recently by Acemoglu et al. (2001) covering the earlier period between 1985 and 1995. A high value amounts to very high Risk of Expropriation. In the regressions, we utilize the natural logarithm of these values plus unity.[12]

The last group of variables utilized here as potential determinants of income and full income

29 countries that used to belong to the Warsaw Pact or came about from the dissolution of the USSR, Yugoslavia, and Czechoslovakia.

[12] The Knack and Keefer (1995) data are available on a 0-10 scale. For estimations reported in Table 2, data from both sources are first rescaled in the 0-100 interval and the average of the two periods is constructed. For Table 3, the natural log of the Risk of Expropriation for 1985-95 from Knack and Keefer (1995) is used.

relates to geography, including climate and natural resources. For example, countries with adverse weather conditions might be less productive than countries where workers face better weather conditions. Climate might also influence health status in a country. For example, tropical climates are conducive to the development of diseases like malaria or tuberculosis. Following Acemoglu et al. (2001), four different groups of geography variables are identified: namely temperature, humidity, soil quality and natural resources. These data are obtained from Parker (1997) and were assembled in the early 1990's.

Temperature variables include: average temperature, minimum "monthly high", maximum "monthly high", minimum "monthly low"[13], and maximum "monthly low", all of them in degrees Fahrenheit. In the regressions, we include two of these variables: maximum "monthly high" and minimum "monthly low" that are meant to capture the effect of extreme temperatures on final output and on health. Humidity variables include: morning minimum, morning maximum, afternoon minimum, and afternoon maximum in percentage points. Among these, we consider afternoon maximum humidity as the one most likely to have an effect on economic and health outcomes. Soil quality variables include: dummies for steppe low latitude, steppe middle latitude, desert middle latitude, desert low latitude, dry steppe wasteland, desert dry winter, and highland. We construct a variable that sums up all of these adverse soil characteristics, which is then expected to have an adverse effect on economic and health outcomes. National resources variables include: number of minerals present in a country (ranging between zero and 37 for the countries in our sample), oil resources in thousands of barrels per capita, and percent of world reserves of gold, iron, and zinc. Each of these three natural resources variables is expected to have a positive impact on economic and health outcomes. Overall, we consider seven geography-related variables in natural logs. Namely, these are: maximum "monthly high" and minimum "monthly low" temperature, afternoon maximum humidity, a variable capturing adverse soil characteristics related to desert-type, steppe-type and highland morphology, and natural resources in the form of oil, number of minerals, and percent of world reserves of gold, iron and zinc.[14]

[13]Minimum monthly low has negative values for 12 countries. Thus, before taking the natural log, we add to all observations the absolute value of the minimum observation plus one.

[14]Alternatively, we considered the full set of 21 geography-related variables used in Acemoglu et al (2001) pertaining to temperature, humidity, soil quality, and natural resources as listed above. The estimates for the other variables

Our sample includes 74 countries, appearing in Table 1, with data averaged over the period 1960-2003[15] or the earlier period from 1960 to 1979, subject to availability of each variable. Since we need a data set that includes sufficient variation, it is desirable to consider developing countries as well as industrialized economies. This comes at the cost of the time dimension of the sample since quite a few of the variables we consider are exceedingly sparse over time, especially so for developing countries. Focusing on long-run time averages in levels seems more appropriate due to the inherent long-run nature of the relation under study. Moreover, averaging over long periods helps alleviate potential measurement error problems. This greatly improves the reliability of the education data used as shown in previous work by Topel (1999) and Krueger and Lindahl (2001).

We also exploit the panel dimension of the data, considering changes over each decade for the dependent variables as described earlier, and decade-averages for the explanatory variables as described below. Investment, physicians, and the population growth rate $(h+g+\delta)$ are constructed by averaging over the periods 1960-1968, 1970-1978, 1980-1988, and 1990-1998. The initial income variable for the income equation is estimated using the log income in the start of each interval of the dependent variable, that is: 1962, 1972, 1982, and 1992. For explaining welfare growth, the log welfare income is used for 1972, 1982 and 1992. For 1962, log income is used due to lack of availability of welfare income in the beginning of the sample. To construct the education variable, the observations for 1960 and 1965 are used to calculate the mean for the first interval, 1970 and 1975 for the second, and similarly 1980 and 1985, and 1990 and 1995 are used for the third and fourth intervals respectively. For AIDS, since this is first observed in 1979, we assume zero incidence for all countries prior to that date. The nutrition variable is constructed using the 1969-71 survey for the first panel interval, the 1979-81 survey for the second, the 1990-1992 survey for the third, and the 1993-95 and 1995-97 surveys for the last interval of our panel. Finally, we note that certain variables cannot be included in the panel estimation framework, since they are not available over time. For example, government stability is reported only after 1984. Similarly, risk of expropriation is available only as an average for the period 1985-1995 and annually for 2001 to 2003.

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were qualitatively unchanged after including these mostly insignificant geography-related variables, relative to the estimates obtained using the shorter set of seven sometimes significant geography variables.

[15]The period over which we construct the dependent variables is somewhat different for three of the countries. For Canada and Israel we consider the available data from 1960 to 2002, and for Tunisia from 1962 to 2003.

# 3 Empirical Estimation and Results

## 3.1 Motivation for Empirical Specification

The benchmark regression model used here is based on the framework proposed in the seminal paper of Mankiw, Romer and Weil (1992). Starting from the basic Solow (1956) growth model, they provide an estimable equation which relates income per capita with investment, education, and population growth. As the Solow model implies a capital share of about 0.6 which is higher than the conventional value of about one third, Mankiw, Romer and Weil (1992) considered an augmented version of the Solow model where human capital enters as a factor in the production function. The estimation of this augmented model yielded results closer to the actual value of the income share of investment. The Cobb-Douglas production function assumed is:

$$Y_t = K_t^a H_t^b (A_t L_t)^{1-a-b}, L_t = L_0 e^{\eta t}, A_t = A_0 e^{gt}, \dot{K} = sY_t - \delta K_t \tag{1}$$

where $H$ is the stock of human capital, $Y$ is output, $L$ is labor, $A$ is the level of technology, and $(a, b)$ are the share of capital and labor. Solving for the steady-state income per capita one obtains:

$$\ln\left(\frac{Y}{L}\right) = \ln A_0 + gt + \frac{a}{1-a-b}\ln s_k + \frac{a+b}{1-a-b}\ln(\eta+g+\delta) - \frac{b}{1-a-b}\ln s_h \tag{2}$$

Technology varies across countries and it is assumed to equal $\ln A_0 = c + \epsilon_i$, with $c$ a constant and $\epsilon_i$ a white noise random error. The term $g+\delta$ is assumed constant across nations and set equal to 0.05. The term $gt$ is eliminated because the equation is estimated on a cross section of countries. The estimable equation is:

$$\ln\left(\frac{Y}{L}\right)_i = \beta_0 + \beta_1 \ln s_i + \beta_2 \ln(\eta+g+\delta)_i + \beta_3 \ln h_i + \epsilon_i \tag{3}$$

where $\frac{Y}{L}$is income per capita, $s_i$ is investment, $\eta$ is the population growth rate, $g$ is the rate of technological growth, and $\delta$ is the depreciation rate of capital.

We use this formulation because it is parsimonious and can easily be extended to include additional sets of explanatory variables like health inputs which can be thought of as yet an other dimension of human capital. Bernanke and Gurkaynak (2001) show that the framework proposed by Mankiw et al. (1992) is not just specific to the Solow growth model but to all models that admit a balanced growth path.

Additional inputs that might be expected to affect the determination of income can be included to the basic specification described by equation (3). For example, *health* could play an important role in determining income. Countries experiencing high levels of investment in health are expected to have a healthier labor force with increased longevity and as a result produce more output. Possible factors that determine the level of health in each country and can be used to analyze its impact on income and welfare, include the number of medical staff and nutritional levels. Another important factor likely to affect income and welfare is the quality of *institutions*. For instance, the presence of strong institutions in a country is conducive to government and broader stability which can have a positive impact on long-term economic and broader welfare outcomes. Finally, *geography* can be expected to matter for economic and welfare growth independently or indirectly through its impact on health and institutions. The extended model that will be used to evaluate the importance of the additional factors affecting income is thus given by:

$$\begin{aligned} \Delta \ln\left(\frac{Y}{L}\right)_i &= \ln\left(\frac{Y}{L}\right)_i - \ln\left(\frac{Y}{L}\right)_0 = \beta_0 - \ln\left(\frac{Y}{L}\right)_{i,0} + \beta_1 \ln s_i \\ & +\beta_2 \ln(\eta + g + \delta)_i + \beta_3 \ln h_i + \underline{\gamma} X_i + \underline{\zeta} \Omega_i + \underline{\lambda} \Phi_i + \epsilon_i \end{aligned} \tag{4}$$

In addition to the usual Solow variables, the set of health-related variables $X$ will be included, followed by the set of institutions-related variables $\Omega$, and geography-related variables $\Phi$. In each of the last three cases, we estimate a number of coefficient estimates $\underline{\gamma}$, $\underline{\zeta}$, and $\underline{\lambda}$ that relate to the impact of individual health-related, institutions-related, and geography-related variables respectively. We estimate the above model for the growth rate of real income per capita, $\Delta \ln\left(\frac{Y}{L}\right)_i$, and for the growth rate of 'full' income as given by $G$, defined in the first paragraph of the previous section.

### 3.2 Results

Table 2 presents results for the case in which all explanatory variables are averaged over the whole period under study i.e. from 1960 to 2003, subject to availability of each variable over time.[16] We present estimates with real income per capita growth as the dependent variable in odd-numbered columns and estimates with welfare growth as the dependent variable in even-numbered columns. In columns (1) and (2), the basic empirical model given in equation (4) is estimated without the additional explanatory variables (i.e. $\underline{\gamma} = \underline{\zeta} = \underline{\lambda} = 0$). In columns (3) and (4), we add health inputs in the form of AIDS and physicians imposing $\underline{\zeta} = \underline{\lambda} = 0$, and in columns (5) and (6) we consider an additional health-related variable regarding nutrition status. In columns (7) and (8), we allow for institutions-related variables in the form of government stability and risk of expropriation, imposing $\underline{\lambda} = 0$ on equation (4). Finally, in columns (9) and (10), we relax all constraints and allow for geography-related variables in addition to economic, health-related, and institutions-related explanatory variables. All variables utilized in the specifications presented in Table 2 are in natural logarithms so that our estimates can be interpreted as elasticities.

In general, the main variables have the expected effect. Initial income has a negative impact, and education, physicians, and government stability have a positive impact on both the rate of economic growth and welfare growth. We note, however, that the magnitude of the impact of these explanatory variables typically differs across the two measures of growth.

The estimated impact of initial income on the growth rate of real income per capita ranges from -0.51 in column (1) to about -0.7 in column (7). This impact is always lower in absolute terms than that on the growth rate of 'full' income which ranges from about -0.6 in column (2) to -0.77 in column (8). This difference suggests faster convergence for 'full' income than for real income per capita, consistent with life expectancy catching up faster than income in less developed countries relative to developed countries. This resembles the main empirical finding in Becker et al. (2005). In that paper, a bivariate regression of each of the two income measures growth rate on initial income was used to show that convergence has been much more rapid for 'full' income relative to income

[16] For example, the institution measures are available only since 1984, geography measures typically have no time variation, and AIDS prevalence is not relevant prior to the late 1970's.

growth rates, a finding that can be attributed in part to the relatively fast technology diffusion for medical knowledge documented in Papageorgiou, Savvides, and Zachariadis (2007). The coefficients of the regression of income and full income to initial income in Becker et al. (2005) are -0.13 and -0.26 respectively (shown in their Table 3) and statistically significant in both cases.[17] Here, this relative convergence finding based on a bivariate relation, is confirmed and found to be robust to adding a number of additional economic, health-related, institutions-related, and geographic variables. A test of the hypothesis that the coefficient of initial income for each regression pair is equal, is overwhelmingly rejected at the one percent level of statistical significance. Furthermore, the implied convergence rate is found to become faster as more explanatory variables are added. The absolute impact of initial income and the implied convergence rate increase monotonically as we control for additional groups of variables going from left to right in Table 2, except for the last two columns at which point we include an additional seven geography-related variables.

Turning our attention to secondary education completion, this also appears to be more important for 'full' income than for real income per capita growth. The elasticity of income per capita with respect to education ranges from as high as 0.29 in column (1) to a low of 0.10 and statistically insignificant in column (9). The elasticity of 'full' income with respect to education ranges from a high of 0.36 in column (2) to a low of 0.12 and marginally insignificant (p-value equal to 10.2 percent) in column (10). Excluding the observation for Zambia which appears to be an outlier in this case,[18] the estimate for the impact of education on welfare growth for the specification in column (10) changes to 0.16 and significant with p-value equal to 0.037 (0.14 with p-value 0.056 for economic growth.) We also note the insignificant impact of physicians on both economic and welfare growth, controlling for secondary education. Since the two variables are closely related conceptually (countries with higher secondary education completion rates would be expected to also have a greater number of graduates out of medical school) and highly correlated empirically, it is to be expected that including both in the same regression somewhat weakens the individual

[17] Their sample consist of 96 countries. Our sample is quite smaller because some observations are not available for all the explanatory variables that we use.

[18] This is the most influential observation in terms of affecting the estimated coefficient for each of our main explanatory variables: education, health institutions quality index, and government stability, for the specifications estimated for columns (9) and (10) of Table 2.

significance of each of these variables, rendering the impact of physicians insignificant in this case.

The conclusion is that human capital in the form of secondary education completion rates has a greater effect on welfare growth than on economic growth. This conclusion holds for every single pair of specifications comparing the impact on income versus 'full' income growth. Testing the null hypothesis that the coefficient of education in each regression pair is equal, the null is rejected at the one percent level for columns (1) and (2), at the five percent level for columns (5) and (6), at the ten percent in columns (3) and (4) and columns (7) and (8). For columns (9) and (10) the associated p-value is 0.125 (or 0.102 once the Zambia outlier is excluded). We note that the effect of education is reduced as we add additional groups of variables. This is the case since education might matter in part indirectly through some of the other included variables or because of the associated collinearity problem between education and other included variables. For example, a more educated person is less likely to contact AIDS[19] and countries with a good educational system are more likely to provide education, training, and information on health issues.

Similarly to secondary education, the health institutions quality index has a positive effect that differs in magnitude for income and 'full' income. The estimated income elasticity of the health institutions variable ranges from 0.44 and statistically insignificant in column (7) to 0.61 in column (9). The estimated 'full' income elasticity of health institutions is as high as 0.73 in column (10) and as low as 0.56 in column (8). Moreover, the estimated impact of the health institutions quality index on welfare growth is always statistically significant, even when we include an additional seven geography variables in column (10). The quality of health institutions has a greater effect on welfare growth than on economic growth. This conclusion holds for every single pair of specifications in columns (3) to (10) comparing the impact on income versus 'full' income growth. Testing the null hypothesis that the coefficient of health institutions quality in each regression pair is equal, the null is rejected at the one percent level for columns (9) and (10), and at the five percent level in columns (3) and (4), columns (5) and (6) and columns (7) and (8).

From the discussion in the above three paragraphs, we infer that human capital and health institutions have a usefulness for the welfare of nations that is not captured in standard economic

[19]The unconditional correlation of education with AIDS is -32.7 percent.

growth regressions. The same can be said for a number of other factors. Notably, this is the case with the institutions-related variable of government stability. While conducive to a good economic environment, the stability and continuity of governance has an even bigger effect on welfare when one accounts for its impact on life expectancy. It appears that the willingness and ability of governments to provide an uninterrupted flow of health-related inputs and information pertaining to long-run maximization of society's overall welfare, is related to the absence of discontinuities in governance that may distract the provision of health-related services and the planning and construction of public infrastructure in the long-run. The estimated impact of the stability of government on 'full' income growth is equal to 1.01 in column (8) while its impact on economic growth is 0.85 and insignificant as shown in column (7). Once we include geography variables, the impact of government stability on 'full' income growth in column (10) is now 1.17, while its impact on economic growth in column (9) is 0.99. For both comparisons, the null that the impact of government stability on welfare growth is equal to its impact on economic growth can be rejected with p-values that are below ten percent in the first case and below five percent in the second case.

Finally, we note that two of the seven geography-related variables included in the specifications for which results are reported in columns (9) and (10), have a significant impact on both income and 'full' income growth. The number of minerals found in a country is positively associated with income and welfare growth, while adverse soil quality characteristics related to the presence of desert-type, steppe-type, and highland morphological conditions in a country, are found to have statistically significant negative effects on both income and 'full' income growth. Furthermore, the presence of precious metals is found to have a positive impact which is significant at a ten percent level for income per capita growth.

*Instrumental Variables estimation*

Explanatory variables may be endogenous to the income variables we set out to explain so that the IV methodology might be called for. The use of predetermined values of explanatory variables could alleviate the endogeneity problem to the extent that future values of income variables do not affect previous values of explanatory variables, so that initial values of variables could be used as predetermined instruments for the value of explanatory variables during the whole period. As the evidence for endogeneity appears strong (the null hypothesis that the specified variables can be treated as exogenous is rejected in four out of five cases for the 'full' income variable and in two out of the five cases for the income variable), we use an instrumental variables approach to address this issue. The null hypothesis that our instruments have no impact in the endogenous variables is strongly rejected with p-values lower than the 0.01 level in the regressions of each endogenous variables on all predetermined or exogenous variables. The strong rejection of the hypothesis is important for the finite sample properties of the IV estimator, as indicated by Wooldridge(2002).

In Table 3, we present estimates based on equation (4), utilizing now averages of lagged values of the explanatory variables as instruments for the average of the whole period. The available sample of countries for these estimations is now down to 65 countries.[20] The initial period average value for the explanatory variables is taken over the period 1960-1979 or the earliest available sample.[21] The variables considered as potentially endogenous in columns (1)-(4) are education, investment and $\eta+g+\delta$ , in columns (5)-(6) the nutrition variable is added, and in columns (7)-(10) the government stability and risk of expropriation variables are included in the set of possible endogenous variables.

The estimated coefficients are qualitatively similar to those for Table 2. Once again, the main variables have the expected effect: initial income has a negative impact, and education, health institutions quality, and government stability have a positive impact on the rate of economic growth and on the rate of welfare growth. Moreover, the magnitude of the impact of these variables typically differs across the two outcome measures, with the impact on welfare growth always statistically different and greater than the impact on economic growth.

The impact of initial income on the growth rate of real income per capita ranges from -0.5 in column (1) to -0.74 in column (7). This impact is lower in absolute terms in each comparison relative to the impact of initial income on the growth rate of 'full' income which ranges from -0.6 in column (2) to -0.79 in columns (9) and (10). This difference suggests faster convergence for 'full'

[20]This is the case since, nine countries are excluded from the sample of 74 countries shown in Table 1, because of lack of availability of education, physicians, or the nutrition variable between 1960-1979. These are Korea, Belgium, Denmark, Finland, Ireland, Italy, Spain, Mexico, and Congo Republic.

[21]The specific sample period for each lagged variable used as an instrument is as follows: investment, $\eta+g+\delta$, and physicians are averaged over 1960-1979, education is averaged for 1960, 1965, 1970, and 1975, nutrition is constructed using the 1969-1971 and 1979-1981 surveys, government stability is averaged over 1984-1995, and risk of expropriation over 1985-1995.

income than for real income per capita. A test of the hypothesis that the coefficient of initial income for each regression pair is equal, is overwhelmingly rejected at the one percent level of statistical significance for all columns. Furthermore, the implied convergence rate of 'full' income is found to become faster as more explanatory variables are added.

Secondary education completion is again shown to be more important for 'full' income than for real income per capita growth. The elasticity of income per capita with respect to education ranges from 0.35 in column (1) to a low of 0.13 in column (9). The elasticity of 'full' income with respect to education ranges from a high of 0.45 in column (2) to a low of 0.18 in column (10). The estimated impact of education is significant in all cases. Moreover, the null hypothesis that the estimated impact of education on economic and welfare growth is equal, is rejected at the one percent level in all cases. The conclusion that human capital in the form of secondary education completion rates has a greater effect on welfare growth than on economic growth, holds for every single pair of specifications being considered.

The estimated income elasticity of physicians ranges from 0.17 and statistically significant at the five percent level in column (9) down to 0.106 and statistically insignificant in column (5). Similarly, the estimated elasticity of physicians with respect to 'full' income ranges from 0.195 and statistically significant at the five percent level in column (10) down to 0.104 and statistically insignificant in column (6). We note that once we control for institutions and geography, the effect of physicians on welfare is bigger than the effect of physicians on income, with an associated p-value of 0.06 for the test that these estimated effects are the same. The elasticity of 'full' income per capita with respect to the quality of health institutions ranges from a high of 0.64 in column (4) to a low of 0.49 in column (8), and remains statistically significant in all cases. The elasticity of income per capita with respect to the health institutions quality index is significant (at the ten percent level) only in column (9) where it equals 0.44, and is as low as 0.34 in column (7). The null hypothesis that the coefficient estimate for the impact of health institutions on economic and welfare growth is equal, is rejected for each regression pair at the one percent level in every case except for columns (3) and (4) where it is rejected at the five percent level (with p-value equal to 0.012).

Stability and continuity of governance has a bigger effect on welfare than on economic growth. This effect is 1.45 in column (8) and 1.61 in column (10), while the corresponding effect on economic growth is 1.18 in column (7) and 1.34 in column (9). The null that the impact of government stability on welfare growth is equal to its impact on economic growth can be rejected with a p-value of 0.02 for columns (7) and (8),and with a p-value of 0.015 for the comparison between columns (9) and (10). Finally, geography matters. Adverse characteristics of soil quality have a significant negative effect on income as in Table 2 and a marginally insignificant negative effect on 'full' income (with p-value equal to 0.114). Moreover, oil reserves matter positively and significantly for 'full' income growth. Surprisingly, maximum afternoon humidity has a positive significant impact on welfare growth once we control for the impact of maximum "monthly high" temperature and minimum "monthly low" temperature.

*Panel estimation*

In Table 4, we present estimates based on a panel consisting of 66 countries[22] and four subperiods, as described in the data section. We estimate the relation between welfare growth or economic growth with a number of economic, health-related, and geographic variables as before. We present estimates based on pooling the data including only time dummies in columns (1)-(2), (5)-(6), (9)-(10) and (13)-(16), and estimates that account for both fixed country[23] and time effects in the remaining six columns of Table 4.

When pooling the data for the estimations reported in columns (5)-(6) and (9)-(10), we consider a single geography-related variable pertaining to adverse time invariant soil characteristics[24]. In columns (13)-(16), we replace soil characteristics with the presence of metals as measured by the percentage of world reserves of gold, iron, and zinc. Including these time invariant cross-sectional variables is a parsimonious alternative to including fixed country effects, allowing more degrees of

[22]A total of thirteen countries (China, Korea, Belgium, Denmark, Finland, France, Ireland, Italy, Spain, Mexico, Egypt, Cameroon and Congo Republic) are exluded from the sample of 74 countries shown in Table 1, because of lack of availability of the physicians and education variables over time. Moreover, five countries (Barbados, Benin, Lesotho, Mauritius and Rwanda) can now be added since the institutions-related variables are not included in the panel regressions.

[23]The null that the random and fixed effects estimates are the same was rejected in favor of the fixed effects alternative.

[24]This sums up adverse soil characterisics related to desert, steppe and highland-type morphology.

freedom.[25] Nevertheless, the explanatory power for models with fixed country and time effects is greater than for the pooled models, as can be seen by comparing the adjusted R-squared. This suggests the presence of a number of omitted time invariant variables that are not accounted for in any of the pooled models. Finally, we opt to present estimates based on regression models that always control for the time dimension of the panel, in order to allow for the presence of a number of unobservable time-varying characteristics over these four decades. However, we note that estimates for the fixed effects model without time effects or the pooled model without time dummies are qualitatively similar to those presented in Table 4.

The qualitative results for initial income and education are remarkably similar to those for the cross-sectional analysis with both variables estimated to matter more for welfare growth than for economic growth. The estimated coefficients are now smaller in both cases as compared to the cross-sectional ones. On the other hand, the density of physicians considered in columns (9)-(12) and (15)-(16) of Table 4, does not appear to matter.[26] Finally, our inference regarding the investment and nutrition variables differs as compared to the cross-sectional results. These variables are estimated to have a significantly different and higher impact on welfare growth as compared to their impact on economic growth. A detailed description of the panel estimation results follows in the next couple of paragraphs.

The impact of initial income on welfare growth ranges from -0.49 in column (8) for the model with both time and country fixed effects, to about -0.11 in column (13) for the pooled model with time dummies and a single cross-sectional geography variable. The impact of initial income on income per capita growth is also significant and negative in all cases but always smaller in absolute terms relative to its impact on welfare growth. The hypothesis that the impact of initial income on welfare and economic growth is the same, is rejected for all eight pairs of comparisons beyond the one percent level of statistical significance. Similarly, investment is now estimated to have a

[25] We experimented with including (one-at-a-time) other geography-related variables such us maximum "monthly high" temperature, minimum "monthly low" temperature, humidity, and number of minerals found in the country. In each case, these were estimated to have an impact statistically indistinguishable from zero, while leaving the remaining estimates unchanged. Oil reserves was also used and it had a positive and significant effect on both income and welfare (at the five percent and ten percent level respectively), leaving other estimated coefficients unchanged.

[26] The health institutions quality index is not included in the analysis, because it is available only once during the period used in our study.

significantly greater impact on welfare growth as compared to economic growth. Its impact on welfare growth ranges from 0.14 in column (4) down to 0.093 in column (10). The same finding regarding relative impact on welfare growth as compared to economic growth appears to be the case for population growth and predictably so for AIDS prevalence, as shown in the second and fifth rows of Table 4 respectively, although the effect of AIDS is never significant.

The impact of education is again estimated to be greater for welfare growth as compared to economic growth. Its impact on welfare growth is as high as 0.097 in column (4) but down to 0.062 in column (16). This is significantly higher than the impact of education on economic growth, with p-values for the null that this impact is the same lying below the one percent level of significance. Moreover, nutrition is found to be more important for welfare growth than for economic growth. Its impact on welfare growth ranges from 0.37 in column (16) to 0.51 in column (12). The null that this is similar to the impact of nutrition on economic growth is rejected with p-values much lower than one percent. Finally, the presence of precious metals appears to matter for economic but not welfare growth in this panel of countries for the period under study. Overall, the estimates presented in this section are consistent with the presence of systematic differences for the impact of a number of economic and other factors on economic growth as compared to welfare growth. These panel results suggest, for example, that policies encouraging education and nutrition are likely to have a greater impact on welfare than one would think by examining just their impact on economic growth.

## 4 Conclusion

In this paper, we have assessed the determinants of welfare growth as a concept closely related but distinct from economic growth, and offered empirical evidence about this being a potentially important distinction in terms of future policy and theoretical modelling alike. We considered a number of economic, health-related, geographic, and institutions-related potential determinants, and showed that determinants may differ or have different impact on welfare outcomes as compared to economic outcomes.

Human capital in the form of secondary education completion rates was shown to play a more important role in determining welfare growth than in determining economic growth, consistent with the notion that this factor is important for a broader concept of welfare growth that goes beyond the standard notion of economic growth. Thus, our paper offers a new approach towards answering the "...significant open question ... whether the social returns to human capital investment substantially exceed the private return" (Topel, 1999, p. 2973), raised by economists going back to Becker (1975) and Heckman and Klenow (1997). Our work implies that when assessing social returns, health status should be treated as a separate component of welfare in addition to income.

We also show that initial income has a greater impact on 'full' income growth than on real income per capita growth, implying faster convergence in terms of welfare growth. These estimates are substantially greater than those in Becker et al. (2005). Moreover, based on estimation for a cross-section of countries, the quality of health institutions and political institutions were shown to have a greater effect on welfare growth compared to their impact on economic growth, consistent with the importance of government stability for the uninterrupted provision of health-related inputs and information. The same conclusion holds for nutrition as well as for physical investment, based on panel estimation.

Overall, we conclude that there exist systematic differences for the impact of a number of economic, health-related, institutions-related, and geographic factors on welfare outcomes as compared to their impact on economic outcomes. For example, human capital can be important for welfare even when it has been shown to matter less or not at all for real income per capita growth.[27] The same goes for informal institutions as measured by government stability. These are likely even more important for the process of development than previously thought.

The above conclusions have important policy implications for the welfare of societies. For instance, our findings suggest that investing in human capital and certain other factors might be crucial for welfare growth even if the effect on economic growth was small or non-existent. Clearly, our work suggests that there is further scope for studying the determinants of welfare growth, treating it as a potentially distinct concept than economic growth.

[27]In the same spirit, Acemoglu and Johnson (2007), acknowledge that "[health] interventions have considerably improved overall welfare" (p. 4) even though they "exclude any positive effects of life expectancy on GDP per capita" (p. 3).

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Table 1: Cross-section of countries in sample

| East Asia & Pacific | Europe & Central Asia | America | Middle East & North Africa | South Asia | Sub-Saharan Africa |
|---|---|---|---|---|---|
| Australia | Austria | Argentina | Algeria | India | Cameroon‡ |
| China‡ | Belgium†,‡ | Bolivia | Egypt‡ | Pakistan | Congo, Rep.†,‡ |
| Indonesia | Denmark†,‡ | Brazil | Iran | Sri Lanka | Gambia |
| Japan | Finland†,‡ | Canada | Israel | | Ghana |
| Korea, Rep.†,‡ | France‡ | Chile | Jordan | | Guinea-Bissau |
| Malaysia | Greece | Colombia | Syria | | Kenya |
| New Zealand | Ireland†,‡ | Costa Rica | Tunisia | | Malawi |
| Philippines | Italy†,‡ | Dominican Rep. | | | Mali |
| Thailand | Netherlands | Ecuador | | | Mozambique |
| | Norway | El Salvador | | | Niger |
| | Portugal | Guatemala | | | Senegal |
| | Spain†,‡ | Honduras | | | South-Africa |
| | Sweden | Jamaica | | | Tanzania |
| | Switzerland | Mexico†‡ | | | Togo |
| | Turkey | Nicaragua | | | Uganda |
| | United Kingdom | Panama | | | Zambia |
| | | Paraguay | | | Zimbabwe |
| | | Peru | | | |
| | | Trinidad & Tobago | | | |
| | | United States | | | |
| | | Uruguay | | | |
| | | Venezuela | | | |

Notes: † Countries that are not included in the estimations reported in Table 3. ‡ Countries that are not included in the estimations reported in Table 4.

Table 2: Explaining period-averages of income and full income.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare |
| Income | -0.508*** | -0.595*** | -0.638*** | -0.718*** | -0.694*** | -0.770*** | -0.697*** | -0.771*** | -0.688*** | -0.768*** |
| | (0.067) | (0.084) | (0.096) | (0.101) | (0.092) | (0.101) | (0.089) | (0.097) | (0.091) | (0.101) |
| $\eta + g + \delta$ | -0.481*** | -0.453*** | -0.407*** | -0.368*** | -0.284*** | -0.254** | -0.225** | -0.201* | -0.229* | -0.194 |
| | (0.099) | (0.107) | (0.090) | (0.093) | (0.099) | (0.105) | (0.107) | (0.111) | (0.131) | (0.125) |
| Investment | 0.250* | 0.218 | 0.194 | 0.166 | 0.175 | 0.149 | 0.212 | 0.190 | 0.186 | 0.145 |
| | (0.143) | (0.154) | (0.141) | (0.148) | (0.145) | (0.153) | (0.134) | (0.142) | (0.131) | (0.142) |
| Education | 0.289*** | 0.364*** | 0.174** | 0.196** | 0.176*** | 0.198*** | 0.151** | 0.171** | 0.102 | 0.120 |
| | (0.059) | (0.064) | (0.072) | (0.074) | (0.065) | (0.067) | (0.064) | (0.065) | (0.070) | (0.072) |
| Physicians | | | 0.111 | 0.123 | 0.050 | 0.066 | 0.088 | 0.109 | 0.065 | 0.104 |
| | | | (0.073) | (0.079) | (0.075) | (0.081) | (0.079) | (0.085) | (0.073) | (0.083) |
| AIDS | | | -0.003 | -0.026 | 0.008 | -0.015 | 0.005 | -0.018 | 0.002 | -0.018 |
| | | | (0.023) | (0.024) | (0.022) | (0.023) | (0.024) | (0.025) | (0.021) | (0.022) |
| Health Institutions Index | | | 0.590 | 0.722** | 0.520 | 0.657* | 0.435 | 0.561* | 0.610** | 0.729** |
| | | | (0.368) | (0.360) | (0.339) | (0.335) | (0.316) | (0.305) | (0.273) | (0.281) |
| Nutrition | | | | | 1.366*** | 1.272*** | 0.904* | 0.740 | 0.923* | 0.714 |
| | | | | | (0.442) | (0.464) | (0.479) | (0.492) | (0.542) | (0.563) |
| Government Stability | | | | | | | 0.852 | 1.007* | 0.992* | 1.173** |
| | | | | | | | (0.527) | (0.563) | (0.517) | (0.556) |
| Risk of Expropriation | | | | | | | -0.046 | -0.038 | 0.045 | 0.048 |
| | | | | | | | (0.047) | (0.049) | (0.055) | (0.054) |
| Temperature (Max Monthly High) | | | | | | | | | 0.082 | 0.250 |
| | | | | | | | | | (0.438) | (0.449) |
| Temperature (Min Monthly Low) | | | | | | | | | 0.024 | 0.036 |
| | | | | | | | | | (0.046) | (0.048) |
| Afternoon Max Humidity | | | | | | | | | 0.249 | 0.494 |
| | | | | | | | | | (0.306) | (0.308) |
| Metals (Gold, Iron Ore, Zinc) | | | | | | | | | 4.099* | 3.395 |
| | | | | | | | | | (2.223) | (2.247) |
| Oil | | | | | | | | | 0.005 | 0.008 |
| | | | | | | | | | (0.010) | (0.011) |
| Number of Minerals | | | | | | | | | 0.111* | 0.118* |
| | | | | | | | | | (0.058) | (0.062) |
| Soil (Dessert, Steppe or Highland) | | | | | | | | | -0.259** | -0.212* |
| | | | | | | | | | (0.112) | (0.122) |
| Constant | 4.359*** | 5.054*** | 3.145** | 3.329** | -6.924* | -6.047 | -4.494 | -3.367 | -7.429* | -7.758* |
| | (0.435) | (0.500) | (1.414) | (1.467) | (3.516) | (3.746) | (3.572) | (3.748) | (3.935) | (3.890) |
| Observations | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 |
| Adjusted $R^2$ | 0.564 | 0.555 | 0.640 | 0.674 | 0.677 | 0.700 | 0.688 | 0.713 | 0.725 | 0.744 |
| Test Income | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |
| Test Education | [0.000] | | [0.066] | | [0.044] | | [0.062] | | [0.125] | |
| Test Health Institutions Quality Index | | | [0.029] | | [0.015] | | [0.015] | | [0.010] | |
| Test Government Stability | | | | | | | [0.086] | | [0.042] | |

Notes: *** p-value $< 0.01$, ** $< 0.05$, * $< 0.10$. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.

Table 3: Explaining period-averages of income and full income using instrumental variables estimation.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare |
| Income | -0.501*** | -0.596*** | -0.679*** | -0.756*** | -0.724*** | -0.781*** | -0.743*** | -0.793*** | -0.735*** | -0.794*** |
| | (0.062) | (0.082) | (0.098) | (0.115) | (0.101) | (0.121) | (0.098) | (0.109) | (0.096) | (0.105) |
| $\eta + g + \delta$ | -0.448*** | -0.408*** | -0.398*** | -0.359*** | -0.298** | -0.302** | -0.159 | -0.191 | -0.096 | -0.124 |
| | (0.119) | (0.131) | (0.102) | (0.106) | (0.119) | (0.129) | (0.187) | (0.199) | (0.213) | (0.216) |
| Investment | 0.104 | 0.050 | 0.033 | -0.015 | 0.023 | -0.021 | 0.155 | 0.123 | 0.169 | 0.114 |
| | (0.181) | (0.196) | (0.181) | (0.192) | (0.185) | (0.194) | (0.154) | (0.157) | (0.134) | (0.134) |
| Education | 0.353*** | 0.446*** | 0.270*** | 0.328*** | 0.281*** | 0.334*** | 0.221** | 0.278*** | 0.129* | 0.183** |
| | (0.068) | (0.079) | (0.086) | (0.091) | (0.084) | (0.088) | (0.087) | (0.087) | (0.078) | (0.078) |
| Physicians | | | 0.149* | 0.129 | 0.106 | 0.104 | 0.144* | 0.147* | 0.170** | 0.195** |
| | | | (0.083) | (0.094) | (0.080) | (0.092) | (0.077) | (0.081) | (0.080) | (0.085) |
| AIDS | | | 0.023 | 0.002 | 0.033 | 0.008 | 0.028 | 0.005 | 0.030 | 0.016 |
| | | | (0.028) | (0.029) | (0.027) | (0.030) | (0.028) | (0.030) | (0.024) | (0.025) |
| Health Institutions Index | | | 0.482 | 0.640* | 0.454 | 0.624* | 0.343 | 0.489* | 0.442* | 0.600** |
| | | | (0.350) | (0.352) | (0.329) | (0.339) | (0.298) | (0.295) | (0.260) | (0.269) |
| Nutrition | | | | | 0.940* | 0.535 | 0.368 | -0.163 | 0.325 | -0.338 |
| | | | | | (0.533) | (0.589) | (0.642) | (0.702) | (0.715) | (0.809) |
| Government Stability | | | | | | | 1.180* | 1.445** | 1.340** | 1.611** |
| | | | | | | | (0.640) | (0.656) | (0.613) | (0.638) |
| Risk of Expropriation | | | | | | | -0.107 | -0.077 | -0.074 | -0.048 |
| | | | | | | | (0.137) | (0.138) | (0.156) | (0.157) |
| Temperature (Max Monthly High) | | | | | | | | | 0.561 | 0.845 |
| | | | | | | | | | (0.529) | (0.550) |
| Temperature (Min Monthly Low) | | | | | | | | | 0.080 | 0.073 |
| | | | | | | | | | (0.055) | (0.060) |
| Afternoon Max Humidity | | | | | | | | | 0.341 | 0.570** |
| | | | | | | | | | (0.278) | (0.280) |
| Metals (Gold, Iron Ore, Zinc) | | | | | | | | | 3.327 | 2.877 |
| | | | | | | | | | (2.313) | (2.293) |
| Oil | | | | | | | | | 0.015 | 0.021* |
| | | | | | | | | | (0.011) | (0.011) |
| Number of Minerals | | | | | | | | | 0.080 | 0.078 |
| | | | | | | | | | (0.052) | (0.052) |
| Soil (Dessert, Steppe or Highland) | | | | | | | | | -0.219** | -0.168 |
| | | | | | | | | | (0.097) | (0.106) |
| Constant | 4.624*** | 5.408*** | 4.171*** | 4.208*** | -2.809 | 0.230 | 0.029 | 3.465 | -4.835 | -2.580 |
| | (0.530) | (0.624) | (1.381) | (1.550) | (4.344) | (4.795) | (4.578) | (5.002) | (4.470) | (4.828) |
| Observations | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 |
| Adjusted $R^2$ | 0.533 | 0.532 | 0.587 | 0.622 | 0.613 | 0.633 | 0.634 | 0.663 | 0.677 | 0.707 |
| Endogeneity Test | [0.051] | [0.026] | [0.114] | [0.037] | [0.055] | [0.009] | [0.157] | [0.094] | [0.347] | [0.210] |
| Test Income | [0.000] | | [0.000] | | [0.004] | | [0.004] | | [0.001] | |
| Test Education | [0.000] | | [0.000] | | [0.001] | | [0.000] | | [0.000] | |
| Test Health Institutions | | | [0.012] | | [0.004] | | [0.006] | | [0.001] | |
| Test Government Stability | | | | | | | [0.021] | | [0.015] | |

Notes: *** p-value $< 0.01$, ** $< 0.05$, * $< 0.10$. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.

Table 4: Panel regressions for income and full income.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare | Income | Welfare |
| Initial Income | -0.072*** | -0.111*** | -0.353*** | -0.424*** | -0.103*** | -0.150*** | -0.397*** | -0.489*** | -0.108*** | -0.170*** | -0.379*** | -0.478*** | -0.107*** | -0.153*** | -0.116*** | -0.176*** |
| | (0.023) | (0.025) | (0.062) | (0.066) | (0.023) | (0.028) | (0.061) | (0.070) | (0.030) | (0.036) | (0.057) | (0.069) | (0.023) | (0.028) | (0.030) | (0.036) |
| $\eta + g + \delta$ | -0.096** | -0.142*** | -0.034 | -0.122** | -0.074* | -0.117*** | -0.046 | -0.139*** | -0.075* | -0.122*** | -0.052 | -0.142*** | -0.091** | -0.134*** | -0.093** | -0.138*** |
| | (0.042) | (0.028) | (0.088) | (0.054) | (0.040) | (0.025) | (0.081) | (0.046) | (0.041) | (0.026) | (0.077) | (0.045) | (0.040) | (0.026) | (0.040) | (0.027) |
| Investment | 0.092*** | 0.117*** | 0.093 | 0.142** | 0.079*** | 0.097*** | 0.075 | 0.117* | 0.078*** | 0.093*** | 0.067 | 0.113* | 0.084*** | 0.101*** | 0.082*** | 0.096*** |
| | (0.024) | (0.027) | (0.061) | (0.063) | (0.025) | (0.028) | (0.060) | (0.061) | (0.026) | (0.030) | (0.061) | (0.062) | (0.025) | (0.028) | (0.026) | (0.030) |
| Education | 0.050** | 0.080*** | 0.067* | 0.097** | 0.045** | 0.067*** | 0.053 | 0.075* | 0.044** | 0.063*** | 0.062* | 0.080** | 0.044** | 0.067*** | 0.042* | 0.062** |
| | (0.022) | (0.026) | (0.037) | (0.041) | (0.022) | (0.024) | (0.035) | (0.038) | (0.022) | (0.024) | (0.037) | (0.040) | (0.022) | (0.025) | (0.022) | (0.024) |
| AIDS | | | | | -0.004 | -0.024 | -0.013 | -0.033 | -0.003 | -0.021 | -0.020 | -0.036 | -0.007 | -0.026 | -0.006 | -0.023 |
| | | | | | (0.017) | (0.020) | (0.019) | (0.026) | (0.018) | (0.020) | (0.019) | (0.026) | (0.018) | (0.020) | (0.018) | (0.020) |
| Nutrition | | | | | 0.309*** | 0.412*** | 0.392* | 0.491** | 0.304*** | 0.390*** | 0.431** | 0.514** | 0.285*** | 0.391*** | 0.278*** | 0.366*** |
| | | | | | (0.105) | (0.119) | (0.197) | (0.215) | (0.106) | (0.118) | (0.199) | (0.216) | (0.103) | (0.118) | (0.104) | (0.117) |
| Soil (dessert, ...) | | | | | -0.025 | -0.029 | | | -0.024 | -0.025 | | | | | | |
| | | | | | (0.024) | (0.024) | | | (0.024) | (0.024) | | | | | | |
| Metals | | | | | | | | | | | | | 0.478** | 0.272 | 0.495** | 0.322 |
| | | | | | | | | | | | | | (0.214) | (0.304) | (0.221) | (0.310) |
| Physicians | | | | | | | | | 0.006 | 0.022 | -0.060 | -0.035 | | | 0.009 | 0.026 |
| | | | | | | | | | (0.019) | (0.022) | (0.044) | (0.051) | | | (0.019) | (0.022) |
| Time Affects | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | |
| Country Effects | No | | Yes | | No | | Yes | | No | | Yes | | No | | No | |
| Constant | 0.392*** | 0.611*** | 2.674*** | 2.982*** | -1.697** | -2.180*** | 0.004 | -0.266 | -1.609** | -1.822** | -0.499 | -0.565 | -1.528** | -2.040** | -1.388* | -1.634* |
| | (0.127) | (0.146) | (0.512) | (0.549) | (0.719) | (0.800) | (1.532) | (1.669) | (0.769) | (0.836) | (1.546) | (1.690) | (0.721) | (0.803) | (0.767) | (0.842) |
| Observations | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 | 264 |
| Adjusted $R^2$ | 0.573 | 0.612 | 0.659 | 0.700 | 0.584 | 0.631 | 0.667 | 0.714 | 0.583 | 0.632 | 0.670 | 0.714 | 0.585 | 0.630 | 0.583 | 0.631 |
| Test Income | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |
| Test Investment | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |
| Test Education | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |
| Test Nutrition | | | | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |

Notes: *** p-value $< 0.01$, ** $< 0.05$, * $< 0.10$. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.