INVESTIGATING THE ROLE OF
HEALTH: IS IT REALLY AN
INTANGIBLE RESOURSE FOR
ECONOMIC GROWTH?

by

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Abstract

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by Tamara Konoreva

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In this study I investigate the empirical evidence of health factor influence on economic growth in different country groups. A particular attention is paid to the research of health peculiarities in the countries with transition economies. Based on the PCA method I construct four different health indices including eight health factors that could proxy for health. Extending production function model of economic growth by constructed health indices I examine the influence of health factor on the real output. The main finding is that under majority of specifications health indices were found to be positive and significant. The influence of health on productivity growth in transition countries does not differ much from the health influence on productivity in the other countries groups. Under stochastic frontier estimation approach, in terms of coefficients the health influence on output was also found to be positive and significant. The main findings provide the grounds to claim that health is an important factor for the output growth, and the governments should consider for the nexus between health and productivity when deciding for different policy implications.

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GLOSSARY

IV	Instrumental Variable
Immunization DPT	Immunization from Diphtheria, Pertussis, Tetanus
CIS	Commonwealth of Independent States
EU	European Union
FSU	Former Soviet Union
GDP	Gross Domestic Product
GNI	Gross National Income
PCA	Principal Component Analysis
ROW	Rest of the World

Chapter 1

INTRODUCTION

The idea that a healthy person is likely to be more productive, more able to be educated and more effective than one with poor health is not a new one. Moreover, the most recent research provides a clear evidence of economic benefits of better health. It has already been investigated that healthy people get better jobs and are able to earn more than unhealthy people do (Bliss and Stern, 1970; Ross and Mirovsky, 1995). This means that general health improvements, given the same level of combination of skills, physical capital and technological knowledge, should increase a country's productivity, which in its own turn is an important factor of a country's economic growth (Howitt, 2005).

In modern economic theory two approaches are applied for investigating the influence of health on productivity at both micro- and macro- levels. The first type of research is concentrated at the level of households and individuals, investigating the interdependence between people's health and their productivity and income. The second one is a comparison of economic performance of different countries over time, using proxy indicators for health such as life expectancy, total fertility rate and GDP. I am going to focus my research on the second one. Motivation for investigating this question is that in transition countries there is no such a strong correlation between education and productivity, as large amount of population even with higher education show low income and productivity, in this case health might better explain human capital and be significant for explaining growth. The second reason is that for now there are no empirical studies on the impact of health capital on economic growth in CIS countries considering for peculiarities in determinants of economic growth and health systems, including such factors as structural economical changes, CO_2 pollutions, immunizations, quality of political institutions, physicians per 1000 people, increase in tobacco and alcohol consumption due to stress of uncertainty etc.

. While doing my research I am going to apply two approaches.

Considering for the estimation of health influence on economic growth proposed by Bloom (2001) I'll try to model the proxy determinants of economic growth with the emphasis on variables that approximate health. The novelty of my research at this step will be that for modeling health index I will apply the Principle Component Analysis that will allow constructing a health index considering for eight different factors that could possibly proxy for health. In order to compare the influence of health on productivity in transition countries versus the other countries groups the model specification including dummy variables for transition countries are estimated.

In most cases it is difficult to sort out the nature of the relationship between health and income. If income is very low, health suffers, sometimes to the point of death and vice versa, a person in a very poor health may have no capacity to create wealth. The same trend can be observed on the level of countries, wealthy countries are always found to be healthier than poor ones, and of course the poor countries are both less healthy and as a result less productive. At this point it is difficult to determine what initially causes what, and as a result the problem of endogeneity arises. Finding of an appropriate instrumental variable can allow for a possible solution to this problem.

The second approach will consider for the importance of health factor in explaining the efficiency in production function for the countries in transition vs the ROW countries classified by income. I am going to estimate the stochastic frontier of the production function of different countries at the first step without health variable, and at the next step considering for the health variables. This will give the evidence, how important health can be in terms of explaining the inefficiencies.

This paper will consist of several parts.

The next chapter is literature review of the papers already written on the subject and general conclusions found for most countries investigated, including those in transition.

In the third chapter the data description is be presented with short variables description and summary statistics on each of the variables, which are included in the empirical model.

In the fourth chapter the metodology is analyzed .The main dscription of the model, advantages and disadvantages of both applied in the estimation part methods.

The fourth chapter is dedicated to empirical estimations on the basis of model. The results received are analyzed and compared to the expected; basically in this part I check for the hypothesis on the importance of health factor in economic growth of countries with transition economies.

In the conclusive chapter the results obtained are discussed, possible policy implementations are provided, and of course questions of interest for future investigations in this area are formulated.

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C h a p t e r   2

LITERATURE REVIEW

Nowadays the idea of health as one of the most important factors in human capital is quite spread in the scientific world. The identity of being "healthy is successful" or "health is wealth" is a key one in cultures of most countries. No doubt that health is important on both individual and overall nation's levels. In a global survey prepared for the Millennium Summit of the United Nations a good health was ranked as the number one desire of men and women around the world. For any individual health is an important asset for personal development and future prosperity. It is the basis of the capacity to learn at school, of the ability to grow intellectually and physically; moreover it's one of the cornerstones of an individual economic productivity. The health of the population is determined by the health of separated households or individuals, so in the long run this fact makes possible to treat health as the inevitable factor for economic development at the scale of whole nation. The same logic can be applied in case of alternative approach – economic costs of being ill. Sickness decreases the annual income of the society, diminishes the lifetime income of the individuals, and causes the slow downs in economic growth, which expressed in money equivalent, could be equated to the hundreds of billions of US dollars (Gwatkin, 2000).

Taking into consideration the multidirectional influence of health, the literature devoted to this topic can be classified into two basic directions micro- oriented, which considers health impact at the individual and household level, and macro-oriented which estimates the contribution of health on the economy overall.

The studies devoted to the economic impact of health at the *individual(micro) level* usually consider such questions as the impact of health on wages, earnings, the amount of hours worked, labor force participation, personal education, early retirement and labor supply and the importance of physiology in earnings and wages. The key questions of the *macro effects* are aggregated effect of the abovementioned factors on the country level in terms of GDP or the GDP growth rate. This research is mostly concentrated on the macro level questions, particularly I apply the principle component analysis in order to model the health index, including different health factors that can influence the health on the country level and then investigate the influence of constructed health index on economic growth of different countries groups with particular analysis of the Eastern Europe transition countries.

The interest to the relationship between health and economic growth is not a new one in the literature, but the new wave of discussion in considerable extent was raised by The World Bank report on health 1993 (World Bank 1993). The studies in this area can be examined in two aspects: including either theoretical and empirical analysis or just empirical one.

Papers Considering both Theoretical and Empirical Research

In a *theoretical basis*, Grossman (1972) developed the model that set health capital formation as a capital good, which was able to produce domestic goods and to earn money. His model assumes health as initial endowment, depreciating with age and growing with investment in health. The basic conclusions of the model are that the productive nature of health is when a good state of health allows for a more effective performance in the job and study. He considered demand for medical services and main determinants of health capital accumulation to be determined by wages, age and level of education.

The Nobel laureate Robert Fogel was among the pioneers in developing models that included health capital specifically. Fogel (1994) examined the contribution of health improvement to the economic development of several countries over one or two centuries. His investigations gave an explanation to the relationship between body size and food supply and showed it to be critical for long-term labor productivity (Report of the Commission on Macroeconomics and Health, WHO, 2001). Fogel states that increase in the amount of calories available for work over the past 200 years in Europe have been importantly boosted by the increased availability of calories in the diet, as well as by advances in public health and medical technologies, which in its own case resulted in huge productivity growth (Fogel, 1994).

Sorkin (1977) was the first one to conclude that health in terms of reduction in mortality had a significant effect on economic growth at the beginning of the 20th century. Sorkin separated the influence of health on the economy in developing and developed countries. He found that improvement of health status of the developed countries population would have insignificant influence on economic growth, while in developing countries the expected result is vice versa.

The majority studies that examine the effect of health on economic growth widely use theoretical framework that underlies the specification of the conditional convergence model developed by Barro and Sala-i-Martin (1995). Common empirical estimation based on this theoretical framework focuses on the cross-section of countries. The standard approach is to regress the rate of growth income per capita on the initial level of health, which is typically proxied by life expectancy or adult survival rate. The possible problem that can arise underlies in the idea that countries can be very different in income level, so to control for the initial level of income and for some other factors that could possibly influence steady state income levels different authors include various policy variables such as institutions (Knack and Keefer(1995)), measure of openness to trade, which in its own turn also depends on country-specific market institutions (Sachs and Warner (1995)), measure of ethno-linguistic fractionalization (Easterly and Levine (1997), variables that control for geographical factors that possibly influence the productivity and trading opportunities (Gallup, Sachs et al.) etc.

Hamoudi and Sachs (1999); Bloom and Canning (2000); Bloom, Canning and Graham (2003) consider different ways through which health improvements can influence the pace of income growth influencing the changes on worker productivity, labor market participation, investments in human capital, saving, population and age structure. Empirical approach peculiar to the previously considered papers for studying the health impact on economic growth is based on above mentioned Barro and Sala-i-

Martin theoretical framework. All these studies differ in terms of functional forms, data definitions and configurations, country samples, time trends etc., but important is the fact that the results of these papers in terms of parameter estimates of life expectancy and age structure on economic growth are quite comparable.

Also following Barro and Sala-i-Martin theoretical framework Bloom, Canning and Sevilla (2001) extend production function model of economic growth in order to account for to fundamental components of human capital from the point of view of microeconomics such as work experience and health. In previous works health in form of life expectancy was widely used in many cross country regressions, and in most papers it was found to have significant and positive effect on economic growth, but before it was not clearly indicated whether health directly influences growth or it is just a proxy for the other possible missing factors. To test for the existence of a true effect of health on labor productivity and to estimate its strength Bloom et al include health and experience in a well specified production function. The variable experience, along with political institutions and geography function is included to avoid the problem of overestimation of contribution of health variable. In result the authors found that "a one year improvement in population's life expectancy contributes to a 4 per cent increase in output", when experience and experience squared were found to be insignificant. The other aspect of the model used is that it "considers for the efficiency with which the inputs are used", by other words it considers for the total factor productivity, estimating it under assumption that steady state TFP levels are the same in every country. In my research I would estimate a production function model of economic growth, keeping the specification as close as possible to that of Bloom, Canning and Sevilla (2001) in order to facilitate the comparison between estimates obtained in my model to the result obtained by the authors. To improve the model instead of life expectancy as a proxy for health I will construct a health index including 8 different factors which influence health both on the individual and country level and aggregated could be considered as a more efficient proxy for health. To consider for the efficiency with which the different country groups use their inputs I would apply the other different from the Bloom et al (2001) method, in particular Simor and Wilson (2005) efficiency estimation. Applying the Simor and Wilson (2005) method to the same specified production function I would estimate how much of the inefficiency of the production frontier of different country groups can be explained in terms of health. The second approach allows alternatively estimate the influence of health factor on countries' growth productivity, which can also be considered as advantage. Along with considering on health index and applying the alternative estimation approach I would also consider peculiarly for the transition countries in terms of including dummy for this particular group. The interest to this particular country group is motivated by to reasons: 1) the research of health factor on productivity growth considering for this counties group has not been done yet and is not considered in above mentioned paper, this fact can be explained by poor data availability because of historical and political peculiarities of these countries; 2) education in the Eastern Europe transition countries do not correlate so much with income as it does in other countries of the world, which can be explained by the fact that higher education was free of charge and available almost for everybody, and now there are many people who have higher education and do not have job or have low level of income.

Bhargava et al. (2001) applied different approaches to modeling the proximate determinants of economic growth with emphasis on variables that approximate health of the population. They developed an analytical framework within which issues of human development, capital formation, and demographic transition can be discussed. The models developed include stochastic properties of GDP series and consider for data limitations. For investigation of stochastic properties of the GDP series from Penn World Table and World Development Indicators the authors applied fixed effect framework and dynamic random effects models. Average growth rates at 5 years intervals were modeled via using model similar to Barro (1997) but allowing for some simultaneity and interactions between dependent variables. The results in estimated models showed that in spite of the rough approximation of individual's health in national averages there is significant effect of adult survival rate on economic growth for low-income countries. A novelty of the paper was in the ability of authors to estimate the threshold point beyond which adult surviving rate had negligible effect on growth rates; confidence intervals estimated for the net impact of adult surviving rate on economic growth proved the asymmetries for poor and rich countries. The main drawback of given research rather unevenly available data for poor, middle and high income countries. Analyses based on more complicated and precise data sets would allow sharper insights into the influence of health on economic growth.

Bloom and Canning (2005) "compare the size of macroeconomic estimates of the effect of health on worker productivity with the microeconomic estimates of the effect of health on wages. The authors estimated that one percentage point increase in adult survival rates increases labor productivity approximately by 2.8 per cent. The results obtain go along with the results received by Weil (2001), which basically are that health factor is strongly significant for the explanation in the cross-country differences of the income level per worker. Bloom and Canning conclude that judging by the estimation results, there is a strong evidence of larger role for health than for education.

Empirical Papers

Early *empirical research* of the impact of health on economic growth belongs to Malenbaum (1970). He investigated how the influence of health factor on output could be larger compared with other economic and social variables. To get the result he used a step wise regression equation with macroeconomic data of poor countries, where independent variable was agriculture output and dependent variables were social, economic and health data.

Mankiw et al. (1992) enlarged the Solow growth model by adding human capital as a determinant variable for economic growth. They showed that the augmented Solow model provides an excellent description of the cross-country data. Improved model explains 80% of the international variation in income per capita. The estimated influences of physical capital accumulation, population growth and human capital accumulation confirm the model's prediction.

Following a Ramsey scheme, Barro (1996) developed a growth model, which included physical capital inputs determined by health capital, level of education and the number of worked hours. The result of the first order condition demonstrated the diminishing marginal returns to investment in health and found out that "increase in health indicators raises the incentives to invest in education and raise in health capital lowers the rate of depreciation of health" (Aguayo-Rico et al., 2005). In particular, Barro received a significantly positive effect of health (measured by life expectancy) on economic growth, and the size of effect appeared to be bigger than the effect of education. But in this case he noted the problem of reverse causality. "Better health tends to enhance economic growth in various ways. At the same time, economic advance encourages further accumulation of health capital"

Based on the idea that people in rich countries are on average healthier than people in poor countries, Weil (2005) evaluates the extent to which these gaps in health can help explain the income gaps. The problem of endogeneity of health variable almost excludes the possibility of using aggregated data for estimation of structural effect of health on income. Besides, Weil applies a kind of novelty in estimation approach; basically he takes "microeconomics estimates of the health effect based on individual outcomes for constructing macroeconomic estimates of the proximate effect of health on GDP per capita" or by other words he uses microeconomic results for answering macroeconomic question of the magnitude in income variation among countries could be explained by health. The effect of health on income estimated via such methodology is quite large and significant. So, using the adult survival rate for man as one of possible measures for health, Weil found that 22.6% of log GDP variance per worker is explained by health, and which is more important that decresing of health gaps among poor, middle and high developed countries would decrease the variance of log GDP by 36.6%. Such a result again verified the thought that health is one of the central determinants of income variation. The drawback of methodology is that it gives an opportunity to estimate only proximate effect of health. Moreover there exist a number of indirect channels through which health influences country-level output, that are not envisaged by the model (Weil, 2005).

The majorities of the authors investigating the problem base their research mostly on the data of poor African and high-developed European countries. For now there is relatively small number of the researches concerning the influence of health on and macro-economical level of countries in transition, despite there are some considering the micro-level.

Papers Including Transition Countries

Ivaschenko et al. (2002) tried to investigate the returns to health in the Ukrainian labor market. For getting more precise estimation, the author tested three different models: influence of health on wages; impact of health on labor supply, dependence of health on economic and social factors. The estimation results showed that health status had a significant effect on earnings in a way that a 1 per cent improvement in individual's health on average increases the labor income by 1.1 and 1 percentage points for men and women respectively. Moreover, the authors found that the effect of health on labor income depends mostly on the type of job performed. The results of the paper are important not only for Ukraine but also for the countries of the former Soviet Union, as the labor market of these countries has very much in common with Ukrainian one.

Nazarova (2003) analyzed the individual behavior in respect of one's health. The results of the research showed that there is no strong dependency between income and self reported health level. Health is mostly affected by structural indicators of social and economic inequality. In a way that smoking, alcohol consumption, body mass and lifestyle on average are much less significant than job of a person, income and residence characteristics.

Tapilina (2004) conducts a quantitative and qualitative analysis of the dependence between health and income in Russia. The results obtained are quite controversial. She found both straight and inverse dependency between various health indicators and different economic statuses. The deviations on the following factors where investigated: objective economic status, age, number of years of education, frequency of alcohol and coffee consumption, overweight, environmental pollution. The strong evidence of relationship between health status and education level was not found.

As it can be concluded from the literature mentioned above, for the case of countries with transition economies there is quite much space to investigate. There are almost no researches that investigate the influence of health factor on aggregated macroeconomic level. That's why the main goal of this paper is to determine some special features of the health factor construct a health index and then estimate the influence of health index on economic growth applying two different approaches. The next section will further proceed with data and methodology description.

Chapter 3

DATA DESCRIPTION

For the purpose of empirical estimation of health factor influence on economic growth I construct a panel of 135 countries observed yearly from 1988 to 2003. As both stages of estimation are based on the Cobb-Douglas function I will need data on nations' output, labor, physical capital and human capital consisting of health and education variables. Output data (GDP) are obtained from the WDI 2005 (World Development Indicators).by multiplying real per capita GDP measured in 2000 international PPP dollars by national total population.

Total population and labor force are taken from the database of International Labour Organization. Following the definition of International Labour Organization total labor force "comprises people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed. While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector".

Proxy for capital stock for each time period is constructed applying the the perpetual inventory method [1]. The initial level of capital stock is calculated basing on the gross fixed capital formation, which is the same as gross domestic fixed investment in terms of SNA terminology of 1968. Gross fixed capital formation is taken as a proxy for the value of the first observed investment level. To calculate the initial level of capital stock, I apply the following formula:

[1] Summers and Heston, (1991) methodology

$$K_0 = \frac{I_0}{(\varepsilon + \varphi)},$$

where

- I_0 is the value of the first observed investment level,
- ξ is calculated as the average geometric growth rate of the investment series,
- φ – the depreciation rate, which is assumed to be 0,07 following Summers and Heston (1991) methodology for all countries observed.

The average growth rate over n periods is calculated as $r = \left[\prod_{t=1}^{n} r_t\right]^{\frac{1}{n}} - 1$, where $r_t = \frac{I_t}{I_{t-1}}$ is calculated for each country. Similar to the exponential growth rate, it does not take into account intermediate values of the series.

To calculate the stocks of capital in each following period the formula

$$K_T = (1-\varphi)^T * K_0 + \sum_{t=o}^{T} I_t * (1-\varphi)^{T-t}$$

is used for any t in the sample.

Human capital would be proxied in terms of education and health. The life expectancy, total fertility rate (births per woman), death rate crude (per 1000 people), birth rate crude(per 1000 people), immunization DPT (% of children under 12 months), immunization of measles (% of children under 12 months), physicians (per 1000 of people), CO_2 emissions (kt per 1000 people) variables are taken from the WDI 2005 and via application of principle component analysis will be used for constructing a health index, which in its own turn will be taken as the proxy for health. For education literacy rate , adult total (% of population ages 15 and above) will be included. For quality of political institutions two variables will be considered, trade (% of GDP) and listed domestic companies, total. The intuition behind this variables is that the higher their value the better the quality of political institutions. So that if the country has good institutions it would definitely have more trade partnership. Listed domestic companies follow the same intuition.

All the data series mentioned would be used in the estimation of the health influence on economic growth of different groups of countries. Besides, as it was previously mentioned in my research I am going to pay special attention to the transition countries of the NIS group as the problem of health influence in this particular group has not been studied yet.

To estimate empirically the influence of health factor on economic growth in this particular group I am going to use the yearly data of 24 NIS countries from which 15 are former CIS countries (Belarus, Moldova, Russia, Ukraine, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Estonia, Latvia and Lithuania) and other 9 countries which belonged to the socialist camp (Czech Republic, Slovakia, Poland, Hungary, Slovenia, Croatia, Albania, Bulgaria, Romania) for the period 1988-2003. Considering the problems data on transition countries usually suffers from, I'll try to use along with WDI 2005 huge and publicly available databases like "Health for All" (HFA) from World Health Organization and TransMONEE database from UNISEF. The advantage of HFA is that it contains detailed data on different socioeconomic indicators for most countries in transition, but the drawback is that for some of the countries of post USSR the data especially on some macroeconomic indicators is evidently overestimated. To double-check the reliability of the source I'll use TransMONEE database, which contains quite reliable data for macroeconomic indicators. Some data like GDP per capita, and life expectancy as it was previously mentioned would be taken from the WDI 2005..

Specifically for Ukraine Derzhkomstat (State Committee of Statistics) and the Ministry of Health statistical yearbooks are very helpful source of information, and inspite their reliability for some series is a bit questionable they can serve as a benchmark for double-checking. For some problems connected with the transition processes in countries mentioned there are some gaps in data for 1989-1991 years, which if not random could result in unbalanced panel and possible estimation biases. One of the solutions of that kind of a problem could be including smaller number of observations or trial of some other proxies.

The empirical analysis will involve different variables that will proxy determinants of economic growth with particular interest to health proxy determinants. The idea is to construct several health indexes that would help to find optimal proxy for health particularly and determine their influence on economic growth of the countries that belong to the different groups, with particular interest to those in transition.

In the Appendix to this paper there are tables, which are basically the gist of my empirical part of the paper. One table contains the variables I am going to use in my empirical part of paper with short description and links to the sources mentioned. The other includes summary statistics, basically mean and standard deviation on each of the variables that would be included in model estimation.

Chapter 4

METHODOLOGY

In this chapter I will try to analyze theoretical set up of the methods, which I use for the empirical estimation of the influence of health factor on economic growth. At the very first stage, I am going to construct a health index, which would consider for different factors that directly or indirectly influence the health on personal and overall country level. Constructing of such index could lead to the multicollinearity problem and as a result future inconsistent OLS estimators. To control for this problem I aplly Principle Component Analysis (PCA), that allows concurrently considering for different factors and avoiding possible multicollinearity problem.

PCA is a non-paramentric method of extracting relevant information from confusing datasets. In most cases it provides a roadmap for how to reduce a complex data set to a lower dimension one[2]. Basically, this method implies that "a set of correlated variables would be transformed into the set of uncorrelated variables, which are ordered by reducing variability. The uncorrelated variables are linear combinations of the original variables and the last of these variables can be deleted with the minimum loss of real data." The other advantage of the method is that it reduces the dimensionality of a data set while retaining maximum possible information. The method implies that the first principle component is the combination of variables explains the greatest amount of variation. The second defines the next largest amount of information. Theoretically, it can be as many principle components as there are variables. For calculating the Principle Components several algorithms can be applied. As the purpose of my research is other that the PCA method investigation, I simply will apply the algorithm proposed by tha statistical package STATA. 8.2.

[2] Shlens, J. Tutorial on Principal Component Analysis: Derivation, Discussion and Singular Value Decomposition, Princeton, March 2003

Based on the health indexes obtained by PCA implication and on methodology proposed by Bloom (2001) I investigate the existence of the effect of health on labor productivity and measure its strength in a way of including health in a well-specified production function. In next steps of estimation I'll follow the method proposed by Bloom et al. (2001).

1) "Construct an aggregate production function, which will include a multidimensional human capital", or by other words the variable, which would be expressed in 2 dimensions: education and health, where health would be proxied by a constructed health index and schooling by literacy rate as a percentage of literate population aged above 15.

2) Estimate all the parameters of the production function using panel data for transition countries for a period from 1989 till 2003 and find measure of the relative contribution of each of the inputs to economic growth.

The interesting fact is that most of the studies connected with growth theory are mostly cross-sectional not panel studies, though in my research I am going to use panel data. This could be explained by 2 reasons:

One of the novelties of this research is that I am going to investigate health influence on economic growth of countries with economies in transition. The novelty is good, but the problem is in the number of time periods. For today it's about 16 or even 14, which is not enough for estimation long-run growth. The most optimistic number is 27, but this is also unreal number from the point of accessibility view. We have immediately to exclude Bosnia-Herzegovina, Macedonia and Yugoslavia from the sample as all these countries went through several years of civil war, so their health indicators would be very much disfigured.

The other problem, which may arise, is a lack of degrees of freedom. In this case again possible solution is a cross section for a huge sample of countries, where transition countries would be included via special dummy. In case data is available "panel data models at close to business cycle frequences". 7-10 years panel datasets model can be very good at solving the problems of endogeneity and omitted variables in case good instrumental variables would be found. So, considering for the previously mentioned reasons in this particular case panel data would produce more efficient estimators than the cross section model would do.

Assume world is a Cobb-Douglas, then the aggregate production function, which models output as the function of inputs will look like:

$$Y = AK^{\alpha} L^{\beta} e^{\varphi_1 * S + \varphi_2 * health\_index} \quad (1)$$

where, Y – Gross Domestic Product or output;

A – stands for TFP;

K – capital (to be calculated, method is still indefinite);

L – labor force, proxied by population from 18-59 years old;

The last component stands for complicated human capital expressed in terms of education, s – stands for years of schooling, health_index stands for health index, including different health variables from 4 main determinants of health defined by European Commission of Public Health: socioeconomic determinants, lifestyles, physical environment ,health system . Considering for PCA applied for different health determinants along with applying it to the transition countries will be novelty to the methodology proposed by Bloom (2001).

To derive an equation for the log of output in country i at time t the next step would be taking logs of the aggregate production function:

$$\ln Y_{it} = \ln A + \alpha \ln L_{it} + \beta \ln K_{it} + \eta_1 S + \eta_2 Health\_index + \varepsilon_{it}, \quad (2)$$

where lnYit, lnLit, lnKit are the logs of output, labor and capital respectively, health_index and schooling would are not in log form because of assumed production function, ε_{it} - error term.

The regression obtained on equation (2) as it stands will be definitely suffering from reverse causality or endogeneity problem. While I am interested in measuring the contribution of health on output growth, output growth itself can cause the better health conditions and overall health improvement. For instance, the better the country performs in terms of growth, the larger investments can be done in improvement of people's health. In statistical terms, reverse causality would cause correlation between "health" (independent variables) and the error term ε_{it}, which would result in the inconsistency of ordinary least square estimates of the coefficients.

For example, suppose the economy of some country i is influenced by some positive shock $\varepsilon_{it} > 0$, that would increase the output, following the mechanism described above it will also influence health as an input variable. So observing increase in both parts of equation, the growth in output would be explained via growth in health input, when in reality the relationship could be exactly the opposite. To distinguish between the influence of health impact on economic growth or the effect of economic growth on health improvement the instrumental variable technique can be applied.

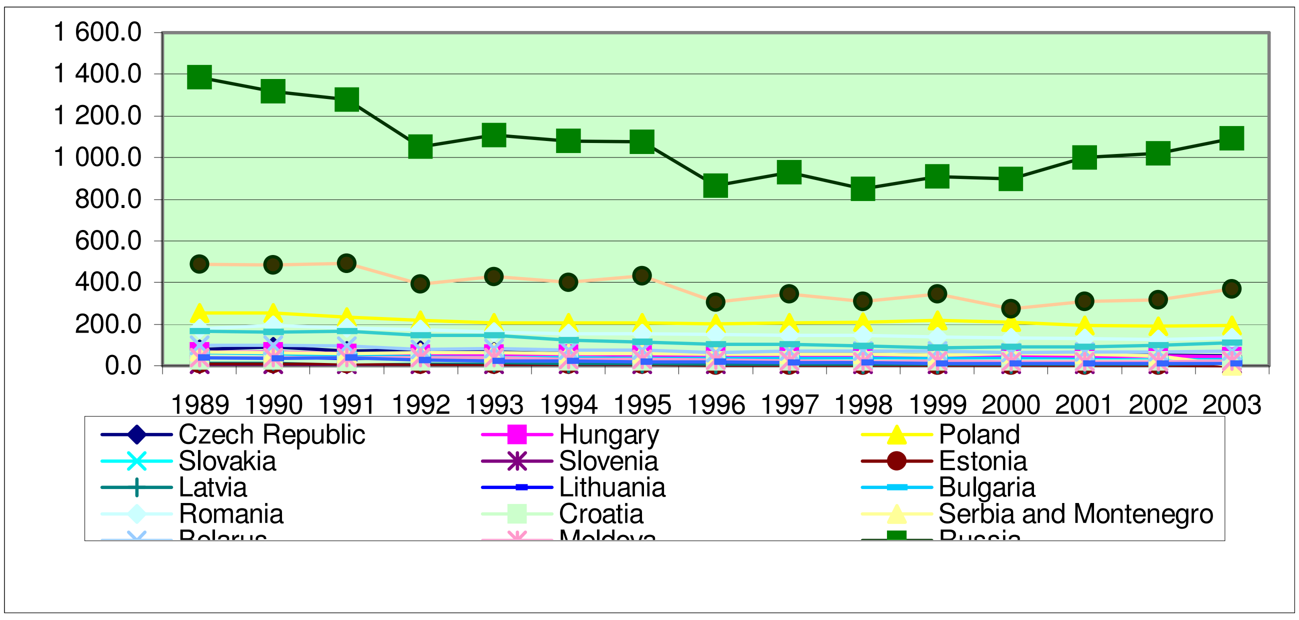
Based on the Wooldridge (2002) candidate for instrumental variable should satisfy two basic criteria. First, it should be correlated with the independent variables, in my case I am interested in health proxy index. Second, along with the previous restriction it should be uncorrelated with the error term ε_{it}.

First restriction implies that in case of existence of such an IV variable, any fluctuations in it would lead to fluctuations in independent variables. The second, in its own turn, controls for causality problem in a way that it does not allow influence of the error term on these fluctuations. In such a way "correlation between changes in output and the induced changes in the endogenous inputs can be interpreted as the casual effect of input increase on output increase, disentangled from reverse causality problem" Bloom (2001).

For preventing reverse causality problem in this particular estimation, I tried "marriages" as instrumental variable (marital status and health are strongly correlated (Fuchs V.,1997,p.30) The idea is that married people usually are healthier than unmarried or separated ones and during the period of crises or economic instability the number of divorces usually increases, while the number of marriages decreases. Applying for the case of transition countries, at the beginning of transition process I would assume decrease in marriages and increase in divorces, which would indirectly influence on health factors in general. From the figure 1 we could see that starting from the years of transition number of marriages in most post socialist countries sharply declines, when number of divorces (could be seen on the figure 2) vice versa tends to grow. Taking in consideration all the above-mentioned facts, marriages as an IV variable should satisfy at least first restriction.

Figure 1

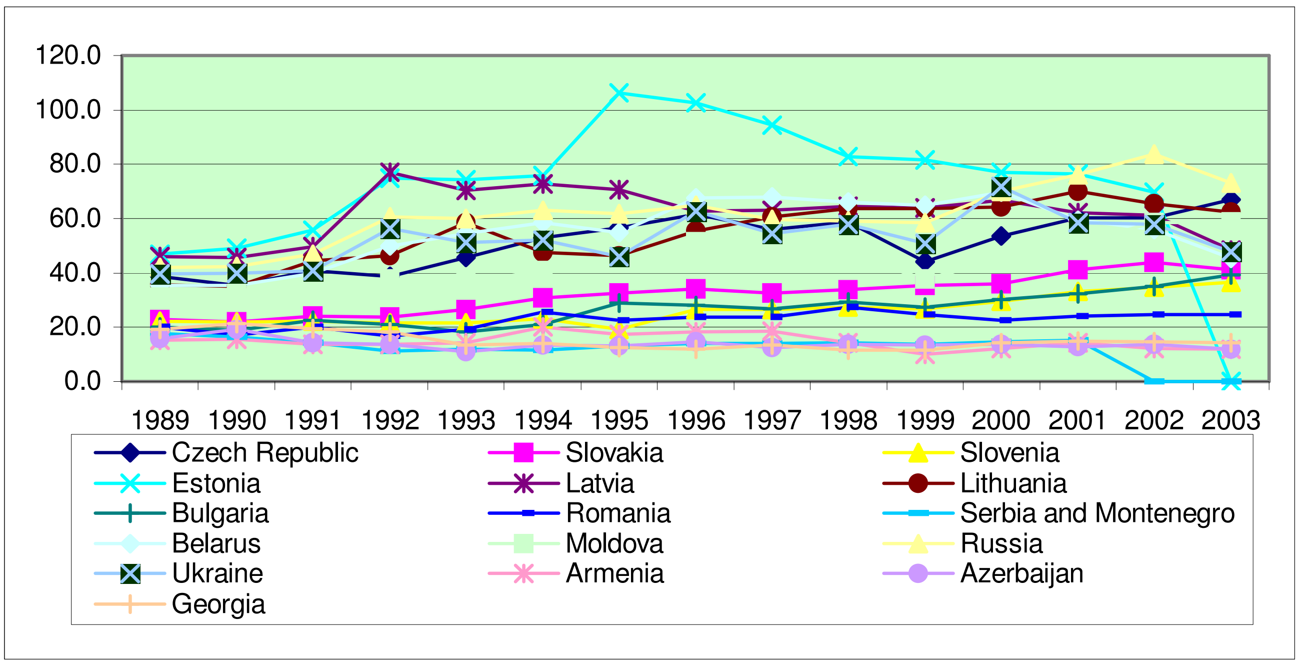
Marriages in (1000s), 1989-2003



Source: TransMonee 2005

Figure 2

General Divorce Rate per 100 Marriages



Source: TransMonee 2005

In reality the idea with marriages as an IV variable was found invalid in case of transition countries, similar to Bloom (2001) I use lagged levels of health as valid IVs.

The next approach is based on the Simar (2005) stochastic frontier model. Following his methodology I estimate inefficiencies in production frontier of each country and clarify how much of this inefficiency could be explained by health factors. This method allows checking the assumption about the importance of health factor in different groups of countries along with the transition ones.

To simplify the estimation I'll assume the same specification of the function as in the previous method.

For now in terms of method description, assume:

$$Yit = A(L)^{\alpha}(K)^{\beta}e^{S+Health\_index}$$

Simar et al. (2005) applied the stochastic frontier estimation for the cross sectional data. Following their method I am going to use panel data, but hopefully there will be no much problems as STATA facilities gives opportunities to estimate frontier for panel data either.

For the ease of estimation we'll turn the model in the log form:

$$\ln Y_{it} = \ln A + \alpha \ln L_{it} + \beta \ln K_{it} + S_{it} + Health\_index_{it} + \varepsilon_{it}, \qquad (2)$$

Based on Simar (2005) the error term is $\varepsilon_i = v_i - u_i$, i=1,…,n, where v –white noise and u –technical inefficiency :

The two-sided error term v is invariably assumed to be normally distributed, and u is assumed to be distributed half normal on the non-negative part of the real number line:

$$v_i \xrightarrow{iid} N(0, \sigma_v^2) \qquad (3)$$

$$u_i \xrightarrow{iid} |N(0, \sigma_u^2)| \qquad (4)$$

Mean and variance of general residual term are:

$$E(\varepsilon_i) = E(\varepsilon) = E(-u_i) - E(u) = -\frac{\sqrt{2}}{\sqrt{\pi}}\sigma_u \quad (5)$$

$$V(u_i) = V(v_i - u_i) = V(v) + V(u) = \sigma_v^2 + \left(\frac{\pi - 2}{\pi}\right)\sigma_u^2 \quad (6)$$

Distribution of the error term assuming between u and v is:

$$f_\varepsilon(\varepsilon) = \frac{2}{\sigma}\phi(\frac{\varepsilon}{\sigma})[1 - \Phi(\frac{\varepsilon\lambda}{\sigma})] \qquad -\infty \le \varepsilon \le +\infty . \quad (7)$$

These were general estimation steps, now we'll follow more applicable for this particular problem of investigation. Considering the distribution of an error term as in (10), we compose log-likelihood function, which will look like:

$$\ln L(\lambda, \sigma^2 \mid \varepsilon_1, ..., \varepsilon_n) = \frac{n}{2}\ln(\frac{2}{\pi}) - \frac{n}{2}\ln(\sigma^2) -$$

$$-\frac{1}{2\sigma^2}\sum_{i=1}^{n}(\varepsilon_i)^2 + \sum_{i=1}^{n}\ln(1 - \Phi(\frac{\varepsilon_i\lambda}{\sigma})) \quad (8)$$

Changing factor parameters into the function in a way that

$\varepsilon_i = y_i - g(x_i),$ $i=1,\ldots,n$ will turn the function into

$$\ln L(\beta, \lambda, \sigma^2 \mid x_1, ..., x_n; y_1, ..., y_n) = \frac{n}{2}\ln(\frac{2}{\pi}) - \frac{n}{2}\ln(\sigma^2) -$$

$$-\frac{1}{2\sigma^2}\sum_{i=1}^{n}(y_i - g(x_i))^2 + \sum_{i=1}^{n}\ln(1 - \Phi(\frac{y_i - g(x_i)\lambda}{\sigma})) \quad (9)$$

Then following the procedure we have to maximize (12) w.r.t. the function parameters σ^2, λ, β.

$$\frac{\partial}{\partial \sigma^2} \ln L(\beta, \lambda, \sigma^2 \mid ...) = -\frac{n}{2\sigma^2_{MLE}} + \frac{1}{2\sigma^4_{MLE}} \sum_{i=1}^{n} (y_i - g(x_i))^2 +$$

$$+\frac{\lambda}{2\sigma^3_{MLE}} \sum_{i=1}^{n} \frac{\phi((y_i - g(x_i))\lambda_{MLE}\sigma^{-1}_{MLE})}{(1-\Phi((y_i - g(x_i)\lambda_{MLE}\sigma^{-1}_{MLE}))} (y_i - g(x_i)) = 0 \quad (10)$$

$$\frac{\partial}{\partial \lambda} \ln L(\beta, \lambda, \sigma^2 \mid ...) = -$$

$$\frac{1}{\sigma_{MLE}} \sum_{i=1}^{n} \frac{\phi((y_i - g(x_i))\lambda_{MLE}\sigma^{-1}_{MLE})}{(1-\Phi((y_i - g(x_i)\lambda_{MLE}\sigma^{-1}_{MLE}))} (y_i - g(x_i)) = 0 \quad (11)$$

$$\nabla_\beta \ln L(\beta, \lambda, \sigma^2 \mid ...) = \frac{1}{\sigma^2_{MLE}} \sum_{i=1}^{n} (y_i - g(x_i)) \cdot \nabla_\beta g(x_i) +$$

$$+\frac{\lambda_{MLE}}{\sigma_{MLE}} \sum_{i=1}^{n} \frac{\phi((y_i - g(x_i))\lambda_{MLE}\sigma^{-1}_{MLE})}{(1-\Phi((y_i - g(x_i)\lambda_{MLE}\sigma^{-1}_{MLE}))} \nabla_\beta g(x_i) = 0 \quad (12)$$

After solving the system of K+2 equations (4 in the particular case) we'll get .the MLE estimates ($\beta_{MLE}, \lambda_{MLE}, \sigma^2_{MLE}$)

Then the expectation of expected individual inefficiency is

$$E(u_i \mid \varepsilon_i) \equiv \int_0^\infty f_{u|\varepsilon}(u \mid \varepsilon) du \quad (13)$$

Where the distribution $f_{u|\varepsilon}(u \mid \varepsilon) \equiv \frac{f_{u,\varepsilon}(u,\varepsilon)}{f_\varepsilon(\varepsilon)}$ (14)

is presented in a way:

$$f_{u|\varepsilon}(u \mid \varepsilon) \equiv \frac{1}{1-\Phi(-\mu_* / \sigma_*)} \phi\left(\frac{u-\mu_*}{\sigma_*}\right), \; \mu_* = \frac{-\sigma_u^2 \varepsilon}{\sigma^2}, \; \sigma_*^2 = \frac{\sigma_v^2 \sigma_u^2}{\sigma^2},$$

$$u \geq 0 \qquad (15)$$

The mean of the individual expected inefficiency is

$$E(u \mid \varepsilon) \equiv \sigma_* \left[-\frac{\varepsilon\lambda}{\sigma} + \frac{\phi(\varepsilon\lambda / \sigma)}{1-\Phi(\varepsilon\lambda / \sigma)} \right] \qquad (16)$$

To measure efficiency we have to obtain:

$$E[\exp(-u_i)] \qquad (17)$$

But because we obtain expectations of u, we can't directly receive the Afriat measure, that is the problem arises which can be reflected by Jensen's inequality that

$\exp(E(u_i)) \neq E[\exp(-u_i)]$, actually $\exp(E(u_i)) \leq E[\exp(-u_i)]$

But the problem is kind of solved by applying numerical methods – Taylor-expand the measure:

$$E[\exp(-u_i)] \cong 1-\hat{\mu}, \qquad (21)$$

In the next chapter will proceed with the empirical application of the method described above.

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Chapter 5

EMPIRICAL ESTIMATIONS AND RESULTS

Based on methodology provided previously, in this chapter I will try empirically analyze the influence of health factors along with usual factors on the productivity of different countries proxied by real GDP. The estimated results will be based on the panel data for 135 countries representing different country groups for the period from 1988 till 2003.

Before starting the empirical testing of both previously described methods, I would like to stop on the health index construction, which was created by applying of the principle component analysis.

The main idea behind using PCA is to reduce the number of variables comprising the dataset while retaining the variability in the data. Simplifying, this method allows computing a compact and optimal description of the dataset while efficiently reducing multicollinearity.

The peculiarity of the health factor is that health itself cannot be exactly determined, for now there is no one unique definition of health. This fact creates the situation when it is difficult to find appropriate proxy for health factor. Based on the data available, I take the variables such as birth rate (per 1000 people), CO_2 emissions, death rate (per 1000 people), fertility rate(births per woman), immunization DPT (% of children under 12 months), immunization of measles (% of children under 12 months), life expectancy at birth (total years),number of physicians (per 1000 people), which all can be a proxy for health on the country level. Combining these variables I construct 4 different health indexes, based on the number of observations for each variable. The logic is to construct an index which would capture both the appropriate proxy for health and a maximum possible number of observations. The health indices are constructed in a way that each following index includes fewer observations than the previous one, but a larger amount of proxies for health variable. Applying the PCA method in STATA I got the following linear combination of constructed health indexes.

$$Health_1 = 0.63920 i\_DPT + 0.62806\ i\_mzls + 0.44381 CO_2$$

$$Health_2 = 0.54001 i\_DPT + 0.50172\ i\_mzls + 0.35678 CO_2 - 0.49753 b\_rate - 0.28606\ d\_rate$$

$$Health_3 = 0.39667\ i\_DPT + 0.34660\ i\_mzls + 0.29689 CO_2 - 0.43314 b\_rate - 0.25598 d\_rate - 0.43562\ f\_rate + 0.43668\ lf\_exp$$

$$Health_4 = 0.38443\ i\_DPT + 0.30807 i\_mzls + 0.28300 CO_2 - 0.43885 b\_rate - 0.09433 d\_rate - 0.43768\ f\_rate + 0.40750\ lf\_exp + 0.34367 phys$$

From the results obtained, it can be seen that the sign of the components of four constructed health indexes coincides. Thus the number of immunizations of both DPT and measles has positive influence on health, the higher is the immunization the healthier should be people. CO2 emissions per 1000 people also have the positive sign, the possible explanation of such sign is that the more developed countries have more developed industries and higher CO2 emission per thousand people, this allows for safer technologies and improved healthcare systems, birth rate and fertility rate both have negative influence on health, this can be explained by the fact that in poor countries the birth rate and fertility rate are high, but GDP per capita is very small, so that many people are not able to receive appropriate health care, death rate was found to have negative influence on health index, by other words the more people die in the country the worse is the health care system and health factor overall, life expectancy positively influence on health, so that healthier people usually live longer, physicians per 1000 of people also has positive influence, as more physicians per 1000 people correlates with appropriate health care treatment, the idea is that the more doctors the healthier people should be.

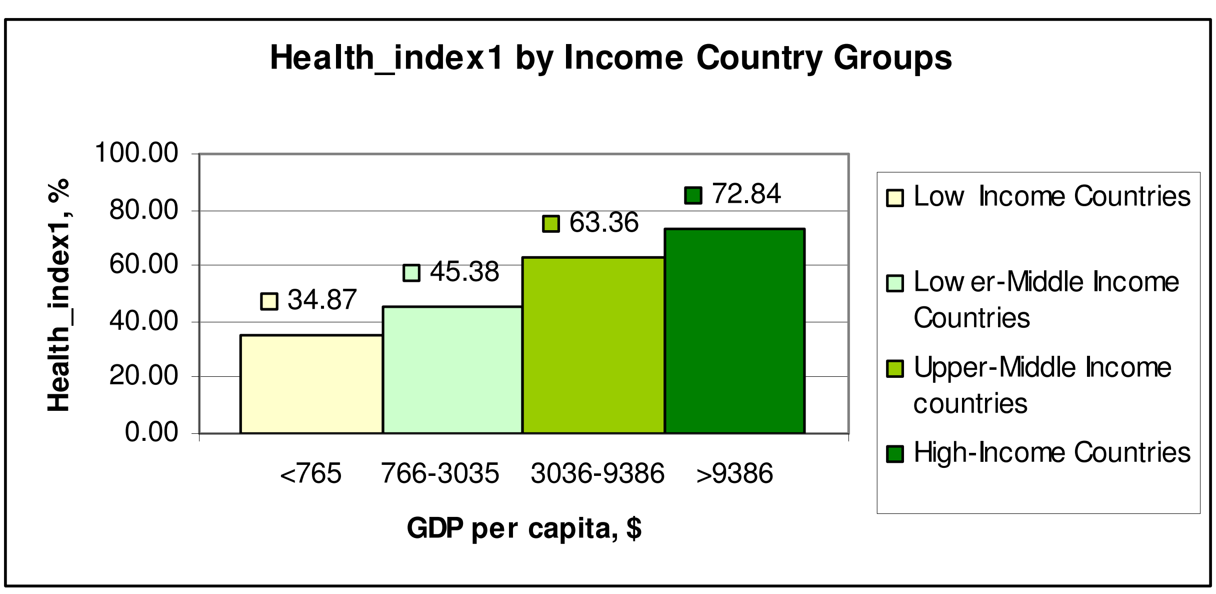
As health is quite an abstract notion, the obtained health indices are difficult to interpret from the economic point of view. In order to make it easier I turn the index into the percentage scale. First, I calculate the mean, minimum and maximum value for each health index, then using the ratio of difference between health index and its minimum value and difference between maximum and minimum value I calculate the health index for each country in percentage points.

$$Health\_index\_scaled(\%) = \frac{Health\_index_{it} - \min(Health\_index)}{\max(Health\_index) - \min(Health\_index)}$$

Now the country with the highest health index has 100% of health, and with minimum health index 0 %. Of course in reality it is impossible for a country to have absolute health or not to have health at all, but this scaling of health helps us to compare the relative health values in different countries.

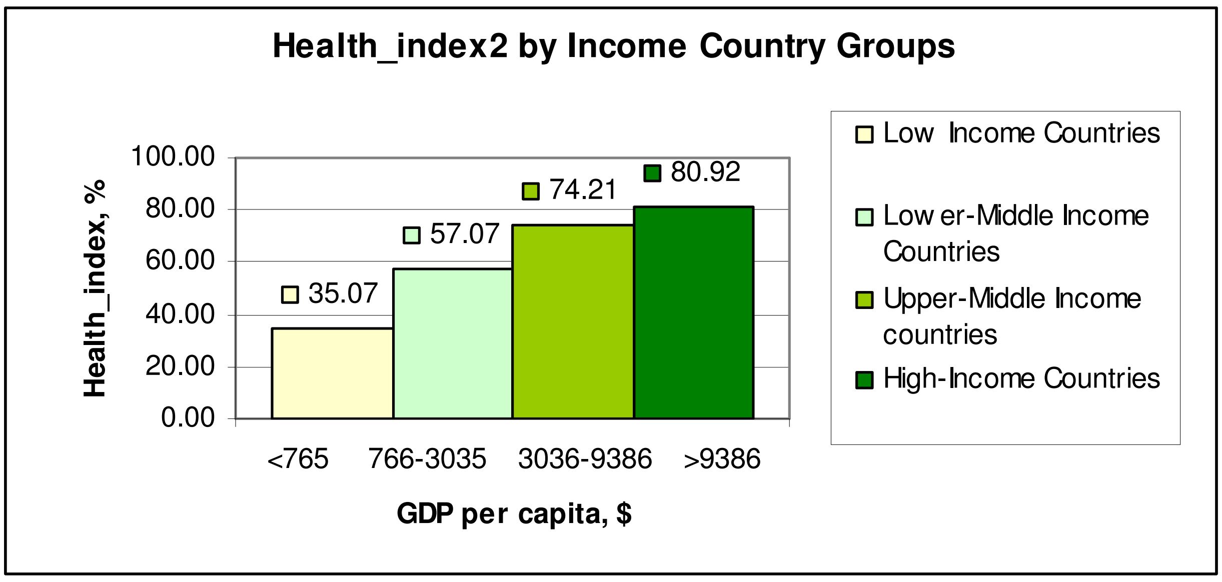
At the next step I sort the countries of the sample according to the income groups divided by World Bank Atlas method (low income, $765 or less GDP per capita; lower middle income, $766- $3,035 GDP per capita; upper middle income, $3,036-$9,385 GDP per capita; and high income, $9,386 or more GDP per capita). Then I find the mean value of each health index for the low-income countries, lower middle income countries, upper middle income countries and high income countries. In the diagrams below we can see the relationship between health indices and different income level countries.

Figure 3.



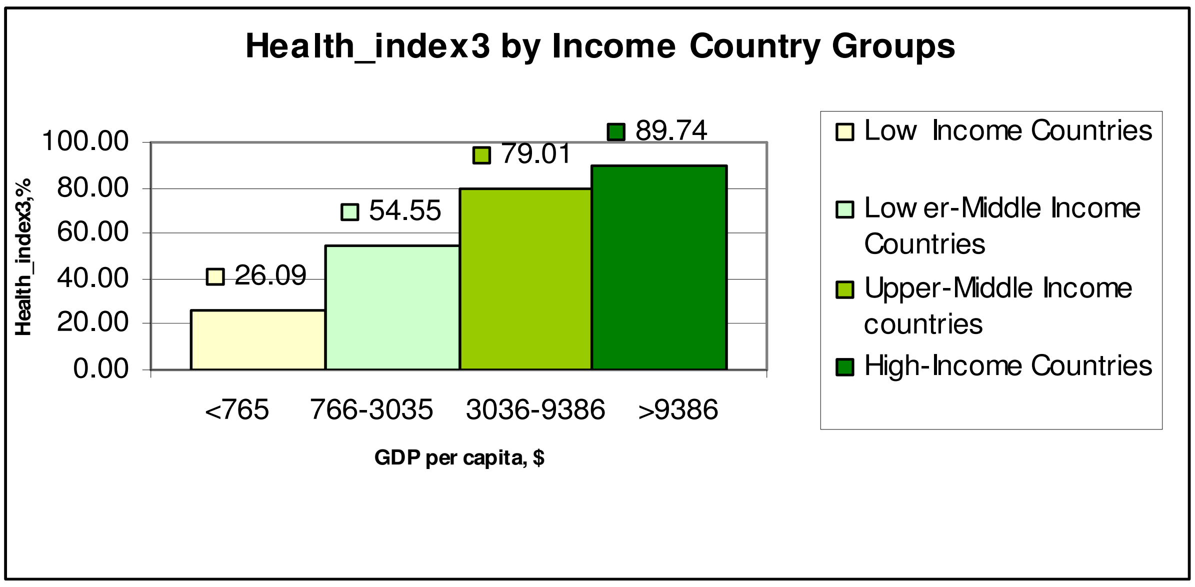
From the results presented in the chart1, we can see that the countries that have the lowest GDP per capita on average have lower health index, the countries with higher income have higher health index. Based on the results obtained I can conclude that high income countries have health index on 37.97% higher than the lower income countries.

Figure 4.



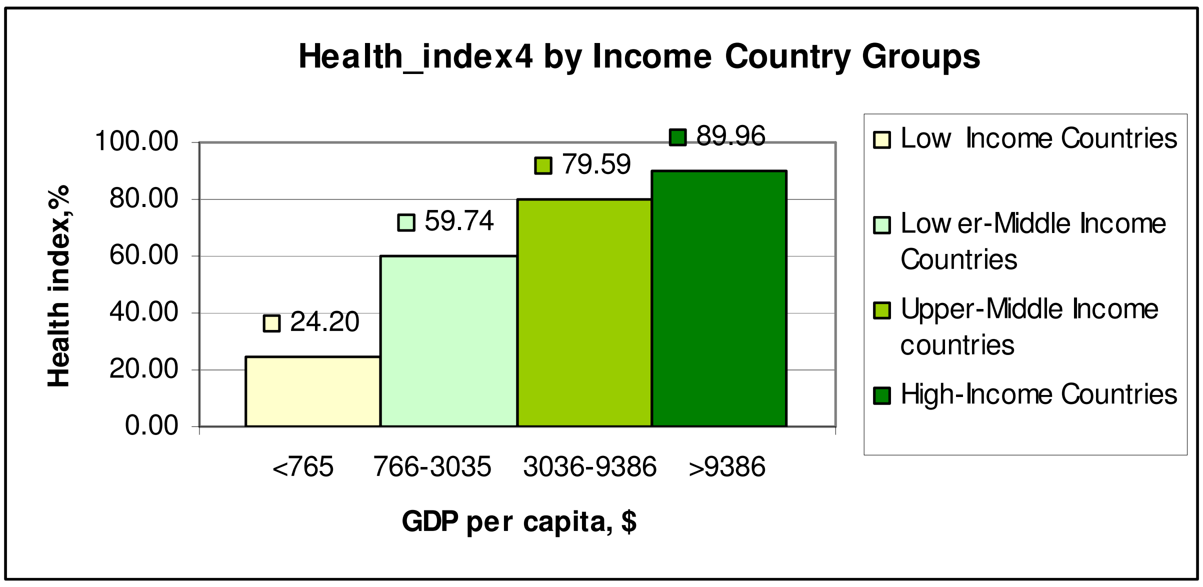
The health index2 presented in the chart2 shows the similar trend, so that it is higher in high income countries and lower in the lower income ones. The high income countries have health index2 45.85% higher than the low income ones. Comparing this gap with the previous result, we can see that the gap increases when more health factors are included in the index.

Figure5.



From the results obtained in chart 3, we can see that when we additionally consider for life expectancy and fertility rate the share of health between countries do not differ much. Health index3 follows the same trend as two previous health indices.

Figure6.



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Health index4 includes 8 different factors that can proxy for health. Again, we can see that the richest countries are much better off in terms of health than the poorest ones. Consideration for more factors increases the gap between the high-income countries and lower-income countries up to 65.76 percentage points.

Of course, this procedure does not allow us to make any conclusions concerning the model estimation. Still, we can see the intuition behind the idea of relationship between the health indices and output. Really, the overall tendency is evident, wealthier countries on average are better off in terms of health than the poor ones. Then the question arises whether the countries which have better health on average are more productive, or rich countries are able to improve their health factor because of higher income. This is the question that in later estimations will arise as endogeneity problem, which would be considered in his chapter below.

On the further steps following Bloom(2001) methodology I will estimate the model, including all the indexes constructed, and then check which of them and under which assumptions performs better.

First of all, before starting the model estimation I have to check pooled least squares vs panel data estimation. The usual way to test this is F-test for common intercepts. The null hypothesis of the test is that the efficient estimators are obtained by pooled least square estimation. If the p-value is zero and the hypothesis is rejected then unbiased estimators would be obtained with panel data estimation.

Fixed vs Random-Effects Estimation

The following step will be to test whether the model is appropriately specified and chose which of the estimation methods would be more precise. Basically, on this stage I test fixed effects model vs random effects model. The main difference between two estimation procedures is in group specific effects, we have to determine whether $\alpha's$ represent N fixed unknown parameters or they are drawn from the population of randomly distributed intercepts and in this case can be treated as the part of the error term. This procedure is usually tested by Hausman test. If the null hypothesis is rejected then the fixed effect estimation should be used. (Wooldridge, 2002)

In some cases when applying Hausman test the differences between random effects and fixed effect estimates can be particularly small and it is possible to get statistical rejection of the random effect. The opposite case is when the differences between the fixed effects and random effects are large due to large standard errors, in this case the Hausman statistic fails to reject. Following the Wooldridge we should consider for random effect estimates. Unfortunately these particular cases can suffer from Type II error. While estimating different specifications of my empirical model, I chose fixed versus random effect estimations based on the criteria described above. Most of the estimated specifications were found to be under fixed effect estimation assumption.

After estimating either fixed or random effects model, the results obtained cannot be very much trusted unless the model is tested for the autocorrelation and heteroskedasticity. Only after implementation of these both tests the results of the model can be interpreted.

Checking for the autocorrelation problems:

In case of autocorrelation problems the estimators remain unbiased and consistent despite no longer efficient. The inefficiency of estimators means that t statistics and F statistics tests cannot be trusted any more. To check for autocorrelation I used usual for panel data `xtregar` operator , which offers a within estimator for a fixed effect model and the Baltagi-Wu GLS estimator of the random effects model. The advantage of this operator is that it can accommodate unbalanced panel whose observations are unequally spaced over time. Both of the approaches offer Durbin-Watson estimator of ρ by default. Using this estimator I calculated d-statistics for each specification of the model using the formula $d = 2(1-\hat{\rho})$, then from the Durbin-Watson d-statistic table took the critical values of d_L and d_U. Then following the decision rule given in Table 12.5 (Gujarati, D. 1995, p. 423) checked for the autocorrelation problem. In majority of the estimation of the different model specifications the hypothesis of "no positive autocorrelation" was rejected, which means both that received coefficients, despite consistent and unbiased, cannot be considered efficient, and standard errors cannot be trusted.

Checking for the heteroskedasticity problems:

As the analysis is based on the panel data, which includes small, medium and large-sized countries sampled together the heteroskedasticity problem can be intuitively expected. Heteroscedasticity means that estimators are no longer of minimum variance or inefficient, however it does not destroy the unbiasedness and consistency properties. To test for the heteroskedasticity problem I use standard Breusch-Pagan test, where zero hypothesis is constant variance or homoscedastic residuals. In majority cases the H_0 was rejected, which means that most specifications suffer from the heteroskedasticity problem. As a remedy for the problem, robust operator estimation was applied. The finally obtained estimation output after the robust operator procedure can be interpreted as the most efficient, unbiased and consistent.

The results obtained are presented in four different tables each including four different estimations of Cobb-Douglas function specifications considering for human capital presented in methodology part in equation (1). Each regression is estimated with the help of statistical package STATA 8.2 . The estimation output is obtained based on the 3-step procedure described above by adding a new variable for each specification. I consider for different specifications in order to compare the difference in model estimation in both cases including and excluding health variable along with some other variables such as trade (% of GDP) and listed domestic companies which could capture for good governance and institutional quality. To compare the influence of education and health factors on productivity in transition countries versus other countries time dummies for literacy rate and health index for transition countries were included .

Table 1

Health index1 estimation results:

RHS variables	(1.1)	robust	(1.2)	robust	(1.3)	robust	(1.4)	robust	(1.5)	robus
Capital	.6797*** (0.000)	0.7516 (0.000)	.2683*** (0.000)	.2683 (0.000)	.2239*** (0.000)	.2239 (0.000)	.1723*** (0.000)	.1622 (0.000)	.1789*** (0.000)	.1680 (0.000
Labor	.4555*** (0.000)	0.2422 (0.091)	.7763*** (0.000)	.7763 (0.000)	.8091*** (0.000)	.8091 (0.000)	.7036*** (0.000)	0.8019 (0.000)	.6783*** (0.000)	.8100 (0.000
Schooling	-.0083** (0.035)	-0.0135 (0.001)	-.0036*** (0.036)	-.0036 (0.097)	-.0050*** (0.002)	-.0050 (0.012)	.0023* (0.159)	-.0011 (0.691)	.0034*** (0.034)	-.001 (0.589
Dummy_Schooling transition countries									-.0039*** (0.020)	.1489 (0.005
Health_index1			.0137*** (0.022)	.0137 (0.034)	.0119 (0.028)***	.0119 (0.052)	.0181*** (0.007)	.0157 (0.020)	.0174*** (0.012)	.0145 (0.033
Dummy_Health_index1 in transition countries									.0561 (0.237)	.0178 (0.674
Trade(% of GDP)					6.07e-13*** (0.000)	6.07e-13 (0.000)	5.32e-13*** (0.000)	5.37e-13 (0.000)	5.28e-13*** (0.000)	5.55e 13 (0.000
List of registered domestic companies							.0002*** (0.000)	0.0002 (0.001)	.0001*** (0.000)	0.000 (0.010
constant	.8291*** (0.000)	2.5762 (.144)	.01367*** (0.000)	5.5285 (0.000)	6.3932*** (0.000)	6.2162 (0.000)	8.9351*** (0.000)	6.8753 (0.000)	9.138*** (0.000)	-6.732 (0.217
N	1269	1368	1162	1162	1145	1145	647	647	647	647
R^2coefficient	0.8827	0.9813	0.8122	0.9973	0.7967	0.9978	0.8468	0.9985	0.8582	0.998
Test on CRS:										
Fixed vs Random:	f.e		f.e(r.e)		f.e		r.e		r.e	
Autocorrelation test:										
rho_dw	.6607		.81896318		.78651835		.81950116		.82033262	
d_calculated	.6785		0.362074		0.426963		0.360998		0.359335	
d_lower	1.643		1.633		1.623		1.613		1.592	
d_upper	1.704		1.715		1.725		1.735		1.757	
Decision:	**+autocorr**		**+autocorr**		**+autocorr**		**+autocorr**		**+autocorr**	
Heteroscedasticity test:	Yes	No	Yes	No	Yes	No	Yes	No	No	No

Model specification presented in column (1.1) of table (4.1) includes only capital, labor and literacy rate (a proxy for schooling) as inputs. The estimated coefficients are 0.68 for capital, 0.46 for labor and -0.008 for literacy rate. Despite the sum of labor and capital coefficients is close to one, which is appropriate under constant returns to scales technology assumption, the shares of capital and labor are not consistent with theory, as shares of capital and labor in national income according to (Mankiw,1994) should be one-third and two-thirds respectively. The estimate of literacy rate coefficient was found negative, which contradicts the results obtained in previous studies, as mostly it was found positive and significant, so that Barro and Lee found it 9.1 percent, Bloom et al. (2001) as 8.5 percent. This can be explained by not a very good proxy used for schooling.- in most papers which consider the influence of human capital on economic growth schooling is taken from Barro and Lee (2000). I didn't use their data for schooling because it was available only up to 1995, when I am interested in data up to 2003. In terms of goodness of fit I obtained R^2 0.8592, which means that the model fits the data well, moreover as the estimates obtained are based on fixed effect procedure R^2 within can be considered as an ordinary R^2.

The F statistic is a test that the coefficients near the regressors are all jointly zero, in all the models specification we rejected this hypothesis, so (1.1) model specification along with the rest ones is a significant model.

Adding health_index1 in column (1.2) improves results in terms of shares between capital and labor, so that under this specification capital is 0.27 and labor is 0.78. In sum they add approximately to one which is good, as it satisfies CRS assumption. The estimated schooling coefficient again is found to be negative and significant at 5% level. Health index1 was found to be positive and significant under 5% significance level, so that improvement in one unit of health index would increase the output by 1.4 percentage points. The R^2 obtained is equal to 0.8112, which is a bit less than in previous regression, but still is reasonably high.

In the next columns (1.3) and (1.4) the trade as a percentage of GDP and listed domestic companies variables are added. These variables were included in order to capture some other effects which could possibly influence the results of health_index estimation when omitted. Both variables included could be treated as a proxy for quality of political institutions. I would stop on the (1.4) specification model, as it included both added variables trade and listed domestic companies, when (1.3) considers only trade. Under this specification I received literacy rate positive and statistically insignificant, while all the rest of the estimated coefficients are positive and statistically significant. As it was already mentioned health_index1 has positive and significant influence on productivity, so that one unit improvement in health index would increase the output by 1.8%. This result is a bit larger than the result we got under previous specification. The influence of trade and listed domestic companies despite is statistically significant with p-value (0.000), is very negligible in terms of coefficients values, so are not worth interpreting from the economic standpoint. Under (1.4) model specification the number of observations decreased almost twice, this could bring negative results in terms of degrees of freedom decrease. Such sharp decrease in observations can be explained by the poor data availability on included new variables trade and listed domestic companies. The R^2 of the model is 0.8468, which is quite high.

In model specification (1.5) along with all the factors included in (1.4) dummy variable for literacy rate and dummy variable for health index in transition countries are estimated. I included dummy variables for transition countries in order to see whether the influence of health and schooling differs in transition countries vs the other countries groups. Both literacy rate and dummy for literacy rate are statistically significant. The coefficient near the literacy rate dummy is negative -0.004, when the coefficient near the literacy rate variable, which stands for the rest countries groups is positive and is estimated to be nearly 0.003. Overall the influence of literacy rate on transition countries can be interpreted as with 1 per cent increase in literacy rate decreases the productivity growth by 0.001 per cent. This result may seem a bit strange at the first glance, but after considering the peculiarities of transition countries where for many years education was free of charge and many people with higher education are unemployed now, the estimated result could be taken as quite reasonable. As for the health index1 it was found positive for transition and rest non-transition countries, but in case of transition it was found to be statistically insignificant. This result can be interpreted in a way that health factor influence on productivity growth in transition countries do not differ from the health influence on productivity of the other countries groups. Capital and labor under this model specification are 0.18 and 0.68 respectively, this result does not coincide with the stylized shares of these inputs, but again their sum tends to 1, which is good in terms of CRS assumption. The other variables included in regression, such as trade and listed domestic companies are also found to be positive and statistically significant. The R^2 coefficient of the model is 0.8582, which is good, in terms that model fits the data well.

Based on the LR test the most appropriate model specification is (1.4). In terms of output growth interpretation, if we increase the Health_index1 by one unit, the output will increase by 1.81 per cent, which in money equivalent is equal to 3746700.00 of current international $. This was calculated in terms of average GDP and Health index1 of the overall country sample.

In the next table 4.2 similar results with the Health_index2 are presented.

Table 2

Health Index2 Estimation Results:

RHS variables	**(2.1)**	**robust**	**(2.2)**	**robust**	**(2.3)**	**robust**	**(2.4)**	**robust**
Capital	.3311*** (0.000)	.3062 (0.000)	.2461*** (0.000)	.2461 (0.000)	.4607*** (0.000)	.1848 (0.000)	.5434 *** (0.000)	.1969 (0.000)
Labor	.6178*** (0.000)	.8652 (0.000)	.8952*** (0.000)	.8952 (0.000)	.4207*** (0.000)	1.0843 (0.000)	.3812*** (0.000)	1.1272 (0.000)
Schooling	.0046*** (0.026)	-.0042 (0.352)	-.0064** (0.057)	-.0064 (0.128)	-.0001 (0.986)	-.0058 (0.225)	.0048** (0.060)	-0.0073 (0.121)
Dummy_for_Schooling in transition countries							- .01123*** (0.000)	0.1881 (0.002)
Health_index2	.0279*** (0.004)	.0176 (0.060)	.0142 (0.120)	.0142 (0.093)	.0779*** (0.048)	0.0084 (0.458)	.1059*** (0.002)	0.0021 (0.858)
Dummy_for_Health_index2 in transition countries							.3872** (0.055)	0.0478 (0.301)
Trade(% of GDP)			5.72e-13 *** (0.000)	5.72e- 13 (0.000)	4.69e-13*** (0.046)	4.78e- 13 (0.000)	2.62e- 13*** (0.193)	5.07e- 13 (0.000)
List of registered domestic companies					.0006773*** (0.000)	.0001 (0.158)	.0002*** (0.201)	.00001 (0.798)
constant	6.0235*** (0.000)	3.3911 (0.020)	4.551*** (0.000)	4.5581 (0.001)	6.287062*** (0.000)	5.224 (0.000)	4.6185*** (0.000)	4.5571 (0.002)
N	589	589	572	572	377	377	377	377
R2coefficient	0.8592	0.9972	0.9978	.9978	0.8793	.9985	0.9162	0.9985
Test on CRS								
Fixed vs Random:	r.e		f.e		f.e		r.e	
Autocorrelation test:								
rho_dw	.8736		0.8568		.86328357		.86303329	
d_calculated	0.2527		0.2862		0.273433		0.273933	
d_lower	1.633		1.623		1.613		1.592	
d_upper	1.715		1.725		1.735		1.757	
Decision:	**+autocorr**		**+autocorr**		**+autocorr**		**+autocorr**	
Heteroscedasticity test:	Yes		Yes		Yes		Yes	

As it was previously mentioned Health_index2 was constructed via application of principal component analysis. The main difference between Health index1 and Health index2 is that the last one considers along with Health index1 variables also for the birth rate crude (per 1000 people) and death rate crude (per 1000 people). I didn't include all the possible proxies for health at once in one index, as the data was sorted in a way that each following variable that I include in the index contains fewer observations than the previous one, so that the Health index1 contains the least number of proxies, but the largest number in terms of observations, the health index4 vice versa includes the largest amount of proxies, but the number of observation for it drops significantly. This could be easily seen from the results presented in the following tables.

In all four columns of table 4.2 the coefficients near Health_index2 are positive, and in all but (2.2) specification model are statistically significant. In (2.2) specification model, when trade variable is additionally considered Health_index2 is statistically significant only at 12% level.

Overall the estimation output we got in table 4.2 doesn't differ much from the results we obtained in previous table. In model specification (2.1) the capital is0.33 labor is 0.62, which is good result from the both sides as stylized facts of capital and labor shares as of one third to two thirds, and from the other side that the coefficients sum very close to 1 which is good according to the CRS assumption. Both literacy rate and Health_index2 are statistically significant, however their influence on productivity is opposite. If literacy rate would increase by 1 percentage point the output will decrease by 0.6 percentage points, which means that influence of literacy rate on output growth is not very much economically significant. In case of health_index2, if it increases by one unit, the output will increase by 2,8 percentage points. The estimated result is quite reasonable comparably to other papers which estimated health just by life expectancy; they got the coefficient 0.04 or 4 percentage points. The R^2 coefficient is 0.8592, which is reasonably high.

In (2.2) (2.3) columns we by turns estimate at first model including trade and then including both trade and listed domestic companies variables. I would stop on the model specification (2.3) as it considers for both added variables. So the results in column (2.3) along with capital, labor, literacy rate and Health_index2 include trade and listed domestic companies. The coefficients close to 0.5 were found for both capital and labor, theoretically under condition that the technology exhibits CRS and perfectly competitive input markets, such case is possible. The coefficient of literacy rate is negative and strongly insignificant, when Health index2 is positive at 5 % significance level, and its value is quite big 0.079. In terms of interpretation it means that if the health_index2 would increase by one unit, the output would increase by 7.9 percentage point. This result is quite different in comparance to the 4% found in Bloom, Canning, Graham and Sevilla (2000), but this I quite logical as in my model health is different from the one they used as a proxy. Trade and listed domestic companies which are proxies for the quality of political institutions are both statistically significant. The R^2 of the model is rather high 0.8793.

Adding the dummy variables for literacy rate and Health _index3 for transition countries changes the results. Two variables standing for the quality of political institutions are statistically insignificant. As for the literacy rate the estimated results show that it has negative influence in transition countries as for the other countries it is positive. It means that overall the influence of literacy on output in transition countries would be less than in the rest country groups. Health_index2 vise versa is positive and significant both for index itself and for its dummy, so that for transition countries the coefficient would be equal to the sum of 0.11 and 0.39, which is 0.5. This result looks unrealistically large for the transition countries and cannot be unambiguously interpreted. Despite the high R^2 (0.9258) the (2.4) model specification to my mind cannot be considered a good one, as most of its estimates despite statistical significance do not contain much economic reasoning.

Based on the LR test model specification (2.1) should be chosen. Health_index2 under such model specification is equal 0.0279, which can be interpreted as if we change health_index1 by one unit the output will increase by 2.8 percentage points, in money equivalent it means that the output will grow by 5775300 current international $.

In the next table similar model specifications are considered, the only difference is in the health index, which for that particular case would consider for two more proxies that could influence health index such as fertility rate and life expectancy.

Table 3

Health Index3 Estimation Results:

RHS variables	**(3.1)**	**robust**	**(3.2)**	**robust**	**(3.3)**	**robust**	**(3.4)**	**robust**
Capital	.2831*** (0.000)	.2611 (0.000)	.2425*** (0.000)	.2164 (0.000)	.3075*** (0.000)	.1284 (0.000)	.4107*** (0.000)	.143185 (0.000)
Labor	.6967*** (0.000)	.8537 (0.000)	.6401*** (0.000)	.8275 (0.000)	.5654*** (0.000)	.9001 (0.000)	.5204*** (0.000)	.938087 (0.000)
Schooling	-.0057** (0.035)	-.0065 (0.244)	-.0052*** (0.050)	-.006 (0.267)	-.0036 (0.327)	.0009 (0.894)	.0038 (0.223)	.0004935 (0.946)
Dummy_for_Schooling in transition countries							-.0167*** (0.000)	.0004935 (0.120)
Health_index3	.2578*** (0.000)	.0268 (0.073)	.2217*** (0.000)	.0227 (0.113)	.1556*** (0.000)	.0252084 (0.174)	.1511*** (0.000)	.0086232 (0.624)
Dummy_for_Health_index3 in transition countries							.8631*** (0.000)	.1467713 (0.121)
Trade(% of GDP)			1.88e-12 *** (0.000)	6.21e-13 (0.000)	1.30e-12*** (0.000)	5.73e-13 (0.000)	7.79e-13 *** (0.008)	6.14e-13 (0.000)
List of registered domestic companies					.0006*** (0.005)	.0000392 (0.461)	.0001 (0.492)	-5.08e-06 (0.928)
constant	7.066*** (0.000)	4.8257 (0.021)	8.744*** (0.000)	6.211 (0.002)	8.192*** (0.000)	5.720745 (0.178)	5.929*** (0.000)	-6.598416 (0.450)
N	425	425	414	414	250		250	
R2coefficient	0.8813	0.9972	0.8962	0.9977	0.8852		0.9258	
Test on CRS								
Fixed vs Random:	f.e		r.e		r.e		f.e	
Autocorrelation test:								
rho_dw	.67916066		.62485496		0.740045		.78361656	
d_calculated	0.641679		0.75029		0.519909		0.432767	
d_lower	1.633		1.623		1.613		1.592	
d_upper	1.715		1.725		1.735		1.757	
Decision:	**+autocorr**		**+autocorr**		**+autocorr**		**+autocorr**	
Heteroscedasticity test:	Yes		Yes		Yes		Yes	

The results in column (3.1) of table 4.3 include capital, labor, literacy rate and Health_index3 as inputs. All the coefficients obtained under this model specification are statistically significant. The coefficient on capital is 0.28 and on labor 0.7, their shares sum to 1. Moreover they take the values that are close to their stylized factor shares of one third for capital and two thirds for labor. The schooling coefficient is significant only at 5 per cent significance level and its value is negative, Health_index3 vice versa is positive and significant. It's influence on output under this model specification can be interpreted as very high, so that one unit increase in Health_index3 will increase output by 25.8 percentage points. The R^2 of the model is 0.8813, which is good result in terms of fitting the model.

Adding the trade for the column (3.2) and both trade and listed domestic companies in column (3.3) changes the results. Under model specification (3.3) the capital has larger influence than under (3.2) and labor reciprocally has less, both this variable in sum are very close to one which is good in terms of CRS assumption. The capital is 0.31 and labor 0.57. The literacy rate coefficient is negative and statistically insignificant, such results contradicts to the results obtained in other empirical papers. This again evidence the fact that literacy rate as a proxy for schooling is not very much good. Health index3 is statistically significant with the value of 0.1556, which means that one unit increase in health index would lead to an output increase of 15.56 per cent. The trade and listed domestic companies, which stand for the quality of political institutions are both positive and statistically significant but their influence on the output growth is comparatively small.

Adding the dummy variables for literacy rate and Health _index3 for transition countries influences the results. The literacy rate coefficient changes the sign from negative to positive, but as under (3.4) specification model it is still statistically insignificant, we should consider for the coefficient near dummy, which negative, so overall literacy would be negative and insignificant just as under the previous (3.3) specification model. The shares of the capital and labor are 0.41 and 0.52 correspondingly, they do not respond to the stylized shares but still their sum is approximately equal to 1. Health_index3 vise versa is positive and significant both for index itself and for its dummy, so that for transition countries the coefficient would be equal to the sum of 0.86and 0.15, which is 1.01. This result is unrealistically large and economically doesn't have much sense. The list of domestic companies is also statistically insignificant under this model specification. The R^2 is very high 0.9258, which is good in terms fitting the data by the model.

Applying LR test we should choose (3.1) model specification. Under (3.1) specification model if we increase health_index3 by one unit, the productivity will grow by 15.56 percentage points, which in money equivalent means 32209200.00 current international $.

The next table considers for the Health_index4, which includes all previous proxies plus the variable physicians (per 1000 people). The estimation output with Health_index4 is presented in the next table 4.4.

Table 4.

Health Index4 Estimation Results:

RHS variables	**(4.1)**	**robust**	**(4.2)**	**robust**	**(4.3)**	**robust**	**(4.4)**	**robust**
Capital	.1963*** (0.001)	.3790 (0.000)	.1854*** (0.001)	.2991 (0.000)	.1615** (0.053)	.0777 (0.136)	.2171*** (0.001)	.1047 (0.038)
Labor	.7996*** (0.000)	.5529 (0.026)	.7114*** (0.000)	.6128 (0.006)	.7197*** (0.000)	.7329 (0.018)	.7133*** (0.000)	.8890516 (0.003)
Schooling	-.0063** (0.129)	.0083 (0.368)	-.0026 (0.529)	.0046 (0.593)	.0025 (0.635)	.0235 (0.059)	.0083 (0.047)	.0211319 (0.079)
Dummy_for_Schooling in transition countries							-.01216*** (0.000)	.0964052 (0.238)
Health_index4	.2394*** (0.000)	.0229 (0.329)	.1849*** (0.000)	.0224 (0.322)	.1143** (0.018)	.0081 (0.685)	.1935*** (0.000)	-.0200019 (0.249)
Dummy_for_Health_index4 in transition countries							.2665 (0.147)	.1465359 (0.110)
Trade(% of GDP)			1.64e-12 *** (0.000)	4.74e-13 (0.000)	1.13e-12*** (0.006)	5.22e-13 (0.000)	4.04e-13 (0.213)	5.59e-13 (0.000)
List of registered domestic companies					.0008*** (0.003)	-7.81e-06 (0.875)	.0002 (0.343)	-.0000528 (0.322)
constant	7.791*** (0.000)	5.166 (0.057)	8.942*** (0.000)	6.4888 (0.013)	9.041*** (0.000)	9.1962 (0.018)	7.691*** (0.000)	6.530816 (0.077)
N	301	301	293	293	185	185	185	185
R2coefficient	0.8539	0.9974	0.8691	0.9979	0.8668	0.9989	0.9212	
Test on CRS								
Fixed vs Random:	f.e		f.e		r.e		r.e	
Autocorrelation test:								
rho_dw	.81735215		.79357178		.85315724		.90421987	
d_calculated	0.365296		0.412856		0.293686		0.19156	
d_lower	1.633		1.623		1.613		1.592	
d_upper	1.715		1.725		1.735		1.757	
Decision:								
Heteroscedasticity test:	Yes		Yes		Yes		Yes	

The results of column (4.1) include capital, labor, literacy rate and Health_index4 as inputs. As in previous regressions all the obtained coefficients except for literacy rate are statistically significant. The coefficients of capital and labor are 0.2 and 0.8 correspondingly. The sum of the coefficients is 1, exactly what we expect under CRS technology. The shares of capital and labor do not take values that are close to their stylized factor shares. Helth_index4 has positive and significant value, if the health index3 changes by one unit the output would increase by 23.9 percentage points. The results obtained under this specification can be judged as good in terms of R^2-coefficient, despite the number of observation in comparison with the similar model in previous table significantly decreased.

The model specifications (4.2) and (4.3) consider for quality of political institutions factors, which accordingly with the previous tables are proxied by trade and listed domestic companies. As (4.3) specification considers for both factors I would stop on the interpretation of this particular model. The coefficient of literacy rate is positive and statistically insignificant, the health index4 can be considered significant only at 5 per cent significance level. The value of health_index4 is quite big, so that one unit increase in health index4 would increase the output by 11.4 percentage points. The coefficient of capital is significant at 10 per cent significance level. The capital and labour coefficients under (4.3) specification of the model also approximately sum to one, but as under the majority specifications their shares do not coincide with the stylized factor shares. Trade and listed domestic companies are both statistically significant and positively influence on productivity. The R^2 square of the model is rather high0.8668.

Adding dummy for literacy rate in transition countries changes its sign from the positive to negative one, but overall effect of literacy rate on other country groups would be negative after summation, as the coefficient near dummy is much higher than the coefficient near literacy rate itself. Overall our proxy for schooling in terms of literacy rates would have negative influence on productivity growth. Dummy for Health_index4 for transition countries is both positive and significant, which after summation will give the result that health is more important in terms of economic growth for the transition countries vs rest country groups. Thus I obtained that one unit of health_index4 improvement would benefit in output increase by 46 percentage points. As for the quality of political institutions both the trade variable and listed domestic companies were found to be insignificant under this model specification. The R^2 coefficient of the model is extremely high 0.9212, which means that given specification of the model fits the data well.

Overall the picture that emerges from the all above analysed tables is that in the majority of specifications health variables were found to be positive and significant. The coefficients of capital and labour summed to one, though their shares where not very much close to the stylized fact. The institutional variables that were taken as a proxy for the quality of institutional environment were found statistically significant, though in majority their value is extremely small. Possibly,this problem can be explained in terms of scale, so that the difference in listed domestic companies in big countries versus small can be rather large. All the specifications proved to have autocorrelation and heteroskedasticity problems, which make the estimated results inefficient and standard errors not reliable. To control for the heteroskedasticity problem the robust regressions were run. The results obtained in robustness check in some specifications were significantly different from those obtained in fixed/random effect estimations. This fact can be partially explained with the endogeneity problem.

Statistically speaking, endogeneity creates a correlation between the independent variables and the error term that makes the coefficients in equation inconsistent. To control for this problem I assume lagged variables of health indices and literacy rate as valid IVs. I decided not to include the results on the IV estimation for all the specifications, only those that consider all the variables of interest. The estimated results are presented in the table 4.5

Table 5. **Instrumental Variables Estimations Output**

RHS variables	**(1.5)**	**(IV_1.5)**	**(2.4)**	**(IV_2.4)**	**(3.4)**	**(IV_3.4)**	**(4.4)**	**(IV_4.4)**
Capital	.1789***	**.1591**	.4107***	**.2267**	.4107***	**.0806**	.2171***	**.0778**
	(0.000)	**(0.000)**	(0.000)	**(0.000)**	(0.000)	**(0.348)**	(0.001)	**(0.488)**
Labor	.6783***	**.8412**	.5204***	**1.3361**	.5204***	**1.491**	.7133***	**1.6257**
	(0.000)	**(0.000)**	(0.000)	**(0.000)**	(0.000)	**(0.000)**	(0.000)	**(0.657)**
Schooling	.0034***	**-.0029**	.0038	**-.0022**	.0038	**.0125**	.0083	**.0125**

	(0.034)	**(0.238)**	(0.223)	**(0.727)**	(0.223)	**(0.415)**	(0.047)	**(0.598)**
Dummy_for_Schooling in transition countries	-.0039*** (0.020)	**.1598 (0.005)**	-.0167*** (0.000)	**.2067 (0.004)**	-.0167*** (0.000)	**.0288 (0.810)**	-.01216*** (0.000)	**.0273 (0.845)**
Health_index4	.0174*** (0.012)	**.0288 (0.049)**	.1511*** (0.000)	**-.0405 (0.463)**	.1511*** (0.000)	**-.1139 (0.468)**	.1935*** (0.000)	**-.2202 (0.804)**
Dummy_for_Health_index4 in transition countries	.0561 (0.237)	**.2220 (0.093)**	.8631*** (0.000)	**.4301 (0.002)**	.8631*** (0.000)	**.6263 (0.001)**	.2665 (0.147)	**.6009 (0.522)**
Trade(% of GDP)	5.28e-13*** (0.000)	**5.01e-13 (0.000)**	7.79e-13 *** (0.008)	**3.76e-13 (0.001)**	7.79e-13 *** (0.008)	**7.90e-13 (0.043)**	4.04e-13 (0.213)	**1.12e-12 (0.459)**
List of registered domestic companies	.0001*** (0.000)	**.0001 (0.021)**	.0001 (0.492)	**-.0001 (0.126)**	.0001 (0.492)	**.0001 (0.086)**	.0002 (0.343)	**-.0001 (0.188)**
constant	9.138*** (0.000)	**5.4379 (0.000)**	5.929*** (0.000)	**-7.463 (0.056)**	5.929*** (0.000)	**-2.8559 (0.690)**	7.691*** (0.000)	**-5.2034 (0.924)**
N	647	**613**	250	**275**	250	**133**	185	**108**
R2coefficient	0.8582	**0.0254**	0.9258	**0.0007**	0.9258	**0.3327**	0.9212	**0.3675**

From the results presented in the table above I can conclude that taking lagged variables of health indices as instrumental variables change the coefficients. Under the (IV_2.4), (IV_3.4) and (IV_4.4) the coefficients near health variable turned to negative, just opposite to the expected. In IV specifications the R^2 is very low, which means that the model fits the data not appropriately and the obtained results cannot be very much trusted. On this step, the evident thing is that model needs further check for the robustness.

In the second part of my empirical investigation I will estimate the stochastic frontier, considering for health as a explanatory variable for the efficiency terms.

The second approach is based on estimation of the stochastic frontier, considering for health as an explanatory variable of the inefficiency terms. As it was previously mentioned in methodology part the disturbance term in a stochastic frontier model is assumed to have two components. One component is assumed to have a symmetric distribution, the other is assumed to have strictly non-negative distribution. Non-negative component is known also as inefficiency term. A fundamental assumption of our country analysis is that potentially each country produces less than it might due to a degree of inefficiency.

Assume the country has the production function as in (6):

$$y_{it} = K^{\alpha} L^{\beta} HS\varepsilon_{it},$$

where ε_{it} is the level of efficiency for country *i* at time *t*. ε_{it} can be in the range (0.1]. If $\varepsilon_{it}=1$, the country produces its optimal output appropriately using all its factors, $\varepsilon_{it}<0$ means that the country is not appropriately using most of its inputs. As we assume that output is strictly positive, the term ε_{it} of technical efficiency has also to be strictly positive. Generally, technical efficiency term shows the difference between actual and potential output values.

At first I estimate the model given in without health and schooling indicators

$$\ln Y_{it} = \ln A + \alpha \ln L_{it} + \beta \ln K_{it} + \varepsilon_{it}, \alpha + \beta = 1$$

(basically production frontier, excluding human capital):

where $\alpha + \beta = 1$, restriction implied for having constant returns to scales.

At the next step I estimate the same model including previously constructed health indices. This will be "stochastic frontier function" considering for health variable;

$$\ln Y_{it} = \ln A + \alpha \ln L_{it} + \beta \ln K_{it} + H_{it} + S_{it} + \varepsilon_{it}, \alpha + \beta = 1$$

Then, based on the output of these two specifications I estimate technical efficiency for each health index separately. Such approach will help to determine the influence of health factor on output in terms of efficiency.

Table 6. **Technical Efficiency Estimation Output**

RHS variables	(0)	(1)	(2)	(3)	(4)
Capital	.7526 (0.000)	.2796 (0.000)	.4486 (0.000)	.2854 (0.000)	.4238 (0.000)
Labor	.1607 (0.000)	.6801 (0.000)	.6443 (0.000)	.6682 (0.000)	.5409 (0.000)
Literacy Rate	-.0011 (0.424)	.0007 (0.671)	-.0238 (0.000)	.0049 (0.032)	.0033 (0.308)
Health_index1		.0176 (0.003)			
Health_index2			-.0682 (0.000)		
Health_index3				.0568 (0.000)	
Health_index4					.0567 (0.012)
constant	3.6017 (0.000)	8.0429 (0.000)	5.4879 (0.000)	7.6353 (0.000)	6.0194 (0.000)
N	1368	1162	589	425	301
Technical efficiency	**.6131**	**.2952**	**.4888**	**.3664**	**.4391**

From the results presented in the table 4.6 follows that in the model specifications (1-4), when we consider for four different health indices the technical efficiency is lower than in the (0) specification model which excludes health variable, moreover, in each model technical efficiency varies. Based on such results we cannot predict the influence of health on output in terms of efficiency, the only possible conclusion we can make is that health factor influences the efficiency. In case the estimated technical efficiencies were all approximately equal when including other variables would witness the fact that these variables do not influence the efficiency or by other words are not an omitted variables.

The estimated variety in technical efficiencies could be partially explained by a significant gap between minimum and maximum values of health indices, and also possible correlation between output and health actor.

In terms of coefficients this method also proved that in 3 out of 4 model specifications health has positive and significant influence on output growth. As a result of estimation I got that the change of the health index by one unit will increase the output by 1.57 percentage points (0.0176-0.0682+0.0568+0.0567)*0.25. Such result does not differ much from the results got in the previous methods. The capital and labor coefficients in (1) and (3) specifications have the shares close to their stylized facts, and under all the considered specifications their sum is approximately equal to 1, which is good under assumption of constant returns to scales. Overall, based on the results got from the stochastic frontier estimation it is inappropriate to judge about the influence of health on the technical efficiencies, from the other side the results in terms of coefficients can be interpreted so that health indexes proved to have positive and significant value on output growth.

C h a p t e r   6

CONCLUSIONS

The main purpose of this study has been to investigate the empirical evidence of health factor influence on economic growth. A specific question guiding the research was to find the peculiarities of health impact on transition economies countries.

Based on the Principle Component Analisis I constructed four different health indices including different health factors that could proxy for health. To make the estimated result more comprehensive the estimated output was scaled to the percentage equivalent, so that it would be possible to receive relative estimates of health. Sorting the countries by income, showed the result that wealthier countries along with high income present high values of health indices, when the countries whose income is low also do not perform very well in terms of health. Such result indicates correlation and gives the intuition on understanding health-wealth nexus between differen countries groups.

Following Bloom et al (2001) I examined the influence of constructed health indices on the real output. The main finding is that under majority of specifications health indices were found to be positive and significant, so that on average one unit improvement in health index would increase the output by 1.8%. In case of transition countries versus the rest countries groups the coefficient near literacy rate was found negative ,when the coefficient near the literacy rate variable, which stands for the rest countries groups was found positive. As for the health index its influence on productivity growth in transition countries do not differ from the health influence on productivity of the other countries groups. The negative influence of education of the literacy rate on productivity in case of transition countries can be explained by the fact that in post-Soviet countries secondary education was compulsory and free of charge, so that in these group of countries unlike in the rest countries group education doesn't necessarily mean better job or higher standard of living. The institutional variables that were taken as a proxy for the quality of institutional environment were found statistically signifcant, though they are not easy to interprete economically as for both variables the proxies were taken in the absolute values, so that listed domestic companies are the number of listed domestic companiese in the country, and trade was taken just as absolute trade.

To control for the endogeneity problem I use lagged variables of health indices and literacy rate as valid IVs. The results obtained via IV estimation approach, except for the health_index1, were found opposite to the expected. At this point the conclusion is that the only results we can trust in terms of robustness are obtained with the health_index1 model specifications.

Under stochastic frontier estimation approach, in terms of coefficients the health influence on output (except for the health_index2) was also found to be positive and significant. In terms of efficiency the change in technical efficiency varied in all specifications when health_index was considered. It means that though we cannot make definite conclusion whether considering for health decrease or increase the efficiency, the overall conclusion is that it influences the efficiency and health indexes cannot be considered as omitted variables of the model.

In my model under different specifications I considered the health influence on output only through labor productivity, but improvements of health may increase output also through capital accumulation. In further research it would be appropriate to consider this approach also. The other interesting question for further research can be not only how health influences output, but also how health itself can be determined. In my research I assumed that for different country groups it is influenced by the same set of channels, the peculiarities of different countries health factor formation would be interesting to consider.

Based on results obtained I think that the following policy implications would be appropriate. At first, it is necessary for the governments to consider for the nexus between the health factor and output growth, so that the policies geared to increasing expenditures for health care will be in the long-run effective in terms of increasing productivity, income and wealth. It follows that government policies aimed directly at improving health should be emphasized and funded. The other important issue is that just an increase in health expenditures will not necessarily result in higher levels of population health. As it was previously mentioned health has a multifaceted nature and itself can be influenced by different factors. This suggest the demand for a complex approach from different policies traditionally concidered outside the borders of health policy that indirectly can influence the population health. For example, labour market policy, education policy, parentel and child-care policy. In case of transition countries labor market policy can have a remarkable effect on the productivity growth, which based on Becker (2004) can be explained by the fact that in the transition countries work-related injuries and illnesses are a major source of productivity losses.

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APPENDIX A

Variables List

Variable Name	Short Description	STATA coding
Country Name	country name	c_name
Year	year	year
GDP	Gross Domestic Product, PPP (current international $)	Y
Real Capital	capital calculated by perpetual method	K
Labour Force	comprises people who supply labor for the production of goods and services during a specified period, includes both the employed and the unemployed	L
Birth Rate	birth rate, crude(per 1000 people)	b_rate
CO_2 emissions	CO_2 emissions (kt) per 1000 people	CO_2
Death Rate	death rate, crude (per 1000 people)	d_rate
Fertility Rate	fertility rate, total (births per woman)	f_rate
Health Expenditure	health expenditure, total (% of GDP)	h_exp
Hospital Beds per 1000 People	hospital beds per 1000 people	h_bed
Immunizations DPT	Immunizations from diphtheria, pertussis, tetanus (% of children under 12 months)	i_DPT
Immunizations measles	Immunizations from measles (% of children under 1 months)	i_mzls
Life Expectancy	theoretical number of years a newborn will live if the age specific mortality rates in the year of birthare taken as constant	lf_exp
Physicians per 1000 of people	physicians per 1000 of people	phys
Population Total	Population total	pop
Literacy Rate	literacy rate, adult total (% of people aged 15 and above)	lit_rate
Marriages (in 1000's)	marriages in 1000s of peopple	marr
Dummy for Transition Countries		dummy_t
Exports of Goods and Services	exports of goods and services (% of GDP)	exp_good
Listed Domestic Companies	listed domestic companies, total	listed_dom_comp
Trade	trade (% of GDP)	trade_n
Real GDP	GDP devided by deflator	Y_real
Real Capital	capital devided by deflator	K_real
Real Trade	trade considered for deflator	trade_n_real
Specifications of variables are not enlisted to the table		

APPENDIX B

Estimation Output

1. SUMMARY STATISTICS

Variable	Obs	Mean	Std. Dev.	Min	Max
c_name	0				
year	2161	1995.497	4.612595	1988	2003
Y	2121	2.64e+11	8.47e+11	2.14e+08	1.09e+13
K	2160	6.09e+11	1.73e+12	7.46e+08	1.77e+13
L	2112	1.96e+07	7.28e+07	55853.07	7.73e+08
b_rate	1370	20.20587	10.62477	7.07	55.5
CO_2	1651	154892.7	547106.5	14.66	5601509
d_rate	1370	9.532438	4.018515	2.9	29.8
f_rate	1279	2.70147	1.540523	.93	7.64
h_exp	670	6.009403	2.066955	1.9	14.6
i_DPT	2046	80.40176	19.59791	9	99
i_mzls	2045	79.33301	18.43211	10	100
lf_exp	1155	68.46969	10.43534	34.22	81.68
phys	1094	2.069397	1.385743	.01	6.06
pop	2161	3.97e+07	1.34e+08	40130	1.29e+09
lit_rate	1391	75.80007	22.45945	10.67	99.8
logY	2121	24.35582	2.016771	19.17946	30.02193
logK	2160	25.12613	2.127348	20.43087	30.5041
logL	2112	15.30101	1.583468	10.93048	20.46571
health1	1620	-1.56e-09	1.38382	-4.781328	2.784246
health2	939	4.17e-10	1.587433	-7.751433	1.701697
health3	815	-3.20e-09	1.820504	-1.852499	7.842896
health4	723	-7.11e-10	2.046553	-8.012486	2.192096
health5	536	-2.63e-09	2.067121	-9.639101	2.317766
marr	359	110.9389	218.8816	5.43	1384.31
dummy_t	2395	.1803758	.3845804	0	1
logmarr	359	3.795182	1.215978	1.691939	7.232957
exp_good	2078	35.50513	22.2595	3.95	170
listed_dom~p	1112	200.6214	213.8431	1	998
export	2078	35.50513	22.2595	3.95	170
trade_n	2063	1.23e+11	2.88e+11	1.67e+08	4.26e+12

2. HEALTH INDEX CONSTRUCTION, PCA METHOD

```
. pca i_mzls i_DPT CO2_per_1000, factors(1)
(obs=1623)
```

(principal components; 1 component retained)

Component	Eigenvalue	Difference	Proportion	Cumulative
1	2.17738	1.46410	0.7258	0.7258
2	0.71328	0.60393	0.2378	0.9636
3	0.10934	.	0.0364	1.0000

Eigenvectors

Variable	1
i_mzls	0.62806
i_DPT	0.63920

```
CO2_per_1000 |   0.44381

. score Health1
            (based on unrotated principal components)
               Scoring Coefficients
    Variable |      1
-------------+----------
      i_mzls |   0.62806
       i_DPT |   0.63920
CO2_per_1000 |   0.44381

. gen logHealth1=log(Health1)
(1184 missing values generated)

. pca i_mzls i_DPT CO2_per_1000 d_rate b_rate, factors(1)
(obs=941)

            (principal components; 1 component retained)
Component    Eigenvalue     Difference    Proportion    Cumulative
------------------------------------------------------------------
     1        2.77082        1.81543      0.5542         0.5542
     2        0.95538        0.25001      0.1911         0.7452
     3        0.70537        0.32327      0.1411         0.8863
     4        0.38210        0.19577      0.0764         0.9627
     5        0.18633              .      0.0373         1.0000

               Eigenvectors
    Variable |      1
-------------+----------
      i_mzls |   0.50172
       i_DPT |   0.54001
CO2_per_1000 |   0.35678
      d_rate |  -0.28606
      b_rate |  -0.49753

. score Health2
            (based on unrotated principal components)
               Scoring Coefficients
    Variable |      1
-------------+----------
      i_mzls |   0.50172
       i_DPT |   0.54001
CO2_per_1000 |   0.35678
      d_rate |  -0.28606
      b_rate |  -0.49753

. gen logHealth2=log(Health2)
(1525 missing values generated)

. pca i_mzls i_DPT CO2_per_1000 d_rate b_rate f_rate, factors(1)
(obs=811)

            (principal components; 1 component retained)
Component    Eigenvalue     Difference    Proportion    Cumulative
------------------------------------------------------------------
     1        3.60776        2.67489      0.6013         0.6013
     2        0.93287        0.22185      0.1555         0.7568
     3        0.71102        0.16879      0.1185         0.8753
     4        0.54224        0.34790      0.0904         0.9656
     5        0.19433        0.18255      0.0324         0.9980
     6        0.01178              .      0.0020         1.0000

               Eigenvectors
```

```
    Variable |      1
-------------+----------
      i_mzls |  -0.40740
       i_DPT |  -0.45453
CO2_per_1000 |  -0.32203
      d_rate |   0.25264
      b_rate |   0.47779
      f_rate |   0.48126
```

. score Health3

```
            (based on unrotated principal components)
               Scoring Coefficients
    Variable |      1
-------------+----------
      i_mzls |  -0.40740
       i_DPT |  -0.45453
CO2_per_1000 |  -0.32203
      d_rate |   0.25264
      b_rate |   0.47779
      f_rate |   0.48126

. gen logHealth3=log(Health3)
(1929 missing values generated)

. pca i_mzls i_DPT CO2_per_1000 d_rate b_rate f_rate lf_exp, factors(1)
(obs=720)

            (principal components; 1 component retained)
Component    Eigenvalue     Difference    Proportion    Cumulative
------------------------------------------------------------------
     1        4.51541        3.59088      0.6451         0.6451
     2        0.92453        0.12855      0.1321         0.7771
     3        0.79598        0.29633      0.1137         0.8908
     4        0.49965        0.31407      0.0714         0.9622
     5        0.18558        0.11709      0.0265         0.9887
     6        0.06849        0.05813      0.0098         0.9985
     7        0.01036              .      0.0015         1.0000

               Eigenvectors
    Variable |      1
-------------+----------
      i_mzls |   0.34660
       i_DPT |   0.39667
CO2_per_1000 |   0.29689
      d_rate |  -0.25598
      b_rate |  -0.43314
      f_rate |  -0.43652
      lf_exp |   0.43668
```

. score Health4

```
            (based on unrotated principal components)
               Scoring Coefficients
    Variable |      1
-------------+----------
      i_mzls |   0.34660
       i_DPT |   0.39667
CO2_per_1000 |   0.29689
      d_rate |  -0.25598
      b_rate |  -0.43314
      f_rate |  -0.43652
      lf_exp |   0.43668

. gen logHealth4=log(Health4)
```

```
(1670 missing values generated)

. pca i_mzls i_DPT CO2_per_1000 d_rate b_rate f_rate lf_exp phys, factors(1)
(obs=536)

            (principal components; 1 component retained)
Component    Eigenvalue     Difference    Proportion    Cumulative
------------------------------------------------------------------
     1        4.58063         3.25979      0.5726         0.5726
     2        1.32084         0.46435      0.1651         0.7377
     3        0.85650         0.22482      0.1071         0.8447
     4        0.63168         0.34697      0.0790         0.9237
     5        0.28471         0.06738      0.0356         0.9593
     6        0.21732         0.11903      0.0272         0.9865
     7        0.09829         0.08825      0.0123         0.9987
     8        0.01004               .      0.0013         1.0000

               Eigenvectors
    Variable |      1
-------------+----------
      i_mzls |   0.30807
       i_DPT |   0.38443
CO2_per_1000 |   0.28300
      d_rate |  -0.09433
      b_rate |  -0.43885
      f_rate |  -0.43768
      lf_exp |   0.40750
        phys |   0.34367
```

. score Health5

```
            (based on unrotated principal components)
               Scoring Coefficients
    Variable |      1
-------------+----------
      i_mzls |   0.30807
       i_DPT |   0.38443
CO2_per_1000 |   0.28300
      d_rate |  -0.09433
      b_rate |  -0.43885
      f_rate |  -0.43768
      lf_exp |   0.40750
        phys |   0.34367

. gen logHealth5=log(Health5)
(1814 missing values generated)
```

HEALTH 1

FIXED vs RANDOM effects:

xtreg logY_real logK_real logL,fe

```
Fixed-effects (within) regression               Number of obs      =      2072
Group variable (i): country                     Number of groups   =       132

R-sq:  within  = 0.7126                         Obs per group: min =        11
       between = 0.8511                                        avg =      15.7
       overall = 0.8465                                        max =        16

                                                F(2,1938)          =   2402.42
```

```
corr(u_i, Xb)  = 0.3260                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7358576   .0110376    66.67   0.000     .7142107    .7575044
        logL |   .0069996   .0533055     0.13   0.896    -.0975426    .1115418
       _cons |   5.738467   .7869369     7.29   0.000     4.195136    7.281799
-------------+----------------------------------------------------------------
     sigma_u |  .76204941
     sigma_e |  .24326983
         rho |   .9075164   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(131, 1938) =   106.78          Prob > F = 0.0000
```

. est store fixed

. xtreg logY_real logK_real logL,re

```
Random-effects GLS regression                   Number of obs      =      2072
Group variable (i): country                     Number of groups   =       132

R-sq:  within  = 0.7109                         Obs per group: min =        11
       between = 0.8778                                        avg =      15.7
       overall = 0.8719                                        max =        16

Random effects u_i ~ Gaussian                   Wald chi2(2)       =   5718.05
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7286296   .0107156    68.00   0.000     .7076274    .7496319
        logL |   .1889628   .0313834     6.02   0.000     .1274524    .2504731
       _cons |   3.125488   .4601273     6.79   0.000     2.223655    4.027321
-------------+----------------------------------------------------------------
     sigma_u |  .63874341
     sigma_e |  .24326983
         rho |  .87332281   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

. est store random

. hausman fixed random

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .7358576     .7286296        .0072279        .0026465
        logL |    .0069996     .1889628       -.1819632        .0430878
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       19.86
                Prob>chi2 =      0.0000
```

Checking for autocorrelation:

. xtregar logY_real logK_real logL,fe

```
FE (within) regression with AR(1) disturbances  Number of obs      =      1940
Group variable (i): country                     Number of groups   =       132

R-sq:  within  = 0.8918                         Obs per group: min =        10
       between = 0.8815                                        avg =      14.7
       overall = 0.8779                                        max =        15

                                                F(2,1806)          =   7445.71
corr(u_i, Xb)  = -0.1784                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .6604048   .0104293    63.32   0.000       .63995    .6808596
        logL |   .4309295   .0238498    18.07   0.000     .3841535    .4777056
       _cons |   1.128342   .0799618    14.11   0.000     .9715148     1.28517
-------------+----------------------------------------------------------------
      rho_ar |  .66126595
     sigma_u |  .67610203
     sigma_e |  .15226695
     rho_fov |  .95172754   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(131,1806) =    35.62           Prob > F = 0.0000
```

Checking for heteroskedasticity:

. xi: reg logY_real logK_real logL i(country)
i: operator invalid
r(198);

```
. xi: reg logY_real logK_real logL i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =    2072
-------------+------------------------------           F(133,  1938) =  957.56
       Model |  7536.92228   133  56.6685886           Prob > F      =  0.0000
    Residual |  114.691246  1938  .059180209           R-squared     =  0.9850
-------------+------------------------------           Adj R-squared =  0.9840
       Total |  7651.61353  2071   3.6946468           Root MSE      =  .24327

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7358576   .0110376    66.67   0.000     .7142107    .7575044
        logL |   .0069996   .0533055     0.13   0.896    -.0975426    .1115418
..............................................................................
       _cons |   5.234003   .7358705     7.11   0.000     3.790822    6.677184
------------------------------------------------------------------------------
```

. hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =    13.02
         Prob > chi2  =   0.0003
```

Specification (2)

. xtreg logY_real logK_real logL lit_rate ,fe

```
Fixed-effects (within) regression               Number of obs      =      1368
Group variable (i): country                     Number of groups   =        99

R-sq:  within  = 0.7424                         Obs per group: min =         1
       between = 0.8819                                        avg =      13.8
       overall = 0.8744                                        max =        15

                                                F(3,1266)          =   1216.36
corr(u_i, Xb)  = -0.0744                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7515716   .0128937    58.29   0.000     .7262763    .7768669
        logL |   .2422081   .1122245     2.16   0.031     .0220416    .4623747
    lit_rate |  -.0135044   .0036083    -3.74   0.000    -.0205833   -.0064255
       _cons |    2.71966   1.486045     1.83   0.067     -.195722    5.635042
-------------+----------------------------------------------------------------
     sigma_u |  .58246822
     sigma_e |  .24991197
         rho |  .84453057   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(98, 1266) =    63.05            Prob > F = 0.0000

. est store fixed

. xtreg logY_real logK_real logL lit_rate ,re

Random-effects GLS regression                   Number of obs      =      1368
Group variable (i): country                     Number of groups   =        99

R-sq:  within  = 0.7420                         Obs per group: min =         1
       between = 0.8904                                        avg =      13.8
       overall = 0.8832                                        max =        15

Random effects u_i ~ Gaussian                   Wald chi2(3)       =   4469.78
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7487218   .0126701    59.09   0.000     .7238888    .7735547
        logL |   .2036281   .0332821     6.12   0.000     .1383963    .2688598
    lit_rate |  -.0094102    .001675    -5.62   0.000     -.012693   -.0061274
       _cons |   3.054944   .4824019     6.33   0.000     2.109453    4.000434
-------------+----------------------------------------------------------------
     sigma_u |  .53645245
     sigma_e |  .24991197
         rho |  .82167517   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .7515716     .7487218        .0028498        .0023907
        logL |    .2422081     .2036281          .03858        .1071758
    lit_rate |   -.0135044    -.0094102       -.0040942         .003196
```

```
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       13.73
                Prob>chi2 =      0.0033
```

Checking for autocorrelation:

```
. xtregar logY_real logK_real logL lit_rate ,fe

FE (within) regression with AR(1) disturbances  Number of obs      =      1269
Group variable (i): country                     Number of groups   =        97

R-sq:  within  = 0.9048                         Obs per group: min =         8
       between = 0.8864                                        avg =      13.1
       overall = 0.8827                                        max =        14

                                                F(3,1169)          =   3702.99
corr(u_i, Xb)  = -0.3659                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .6797197   .0120479    56.42   0.000     .6560817    .7033577
        logL |   .4555281   .0367391    12.40   0.000     .3834461    .5276101
    lit_rate |  -.0082887   .0039238    -2.11   0.035    -.0159871   -.0005903
       _cons |   .8291125   .0996757     8.32   0.000     .6335491    1.024676
-------------+----------------------------------------------------------------
      rho_ar |  .66073021
     sigma_u |  .64050327
     sigma_e |  .15819567
     rho_fov |  .94250499   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(96,1169) =    21.64            Prob > F = 0.0000
```

Heteroscedasticity test:

```
. xi: reg logY_real logK_real logL lit_rate i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =    1368
-------------+------------------------------           F(101,  1266) =  657.68
       Model |  4148.70632   101  41.0763002           Prob > F      =  0.0000
    Residual |  79.0692863  1266  .062455992           R-squared     =  0.9813
-------------+------------------------------           Adj R-squared =  0.9798
       Total |  4227.77561  1367  3.09274002           Root MSE      =  .24991

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7515716   .0128937    58.29   0.000     .7262763    .7768669
        logL |   .2422081   .1122245     2.16   0.031     .0220416    .4623747
    lit_rate |  -.0135044   .0036083    -3.74   0.000    -.0205833   -.0064255
..............................................................................
      _cons |   2.576215   1.357816     1.90   0.058    -.0876014    5.240032
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
```

```
        Variables: fitted values of logY_real

        chi2(1)      =    48.64
        Prob > chi2  =   0.0000
```

SPECIFICATION (1.3)

```
. xtreg logY_real logK_real logL lit_rate Health1,fe

Fixed-effects (within) regression               Number of obs      =      1162
Group variable (i): country                     Number of groups   =        98

R-sq:  within  = 0.6369                         Obs per group: min =         1
       between = 0.8105                                        avg =      11.9
       overall = 0.8122                                        max =        13

                                                F(4,1060)          =    464.73
corr(u_i, Xb)  = -0.1197                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2683264   .0144336    18.59   0.000     .2400048    .2966481
        logL |   .7763202   .0556094    13.96   0.000     .6672032    .8854372
    lit_rate |  -.0036434   .0017311    -2.10   0.036    -.0070402   -.0002466
     Health1 |   .0136713   .0059813     2.29   0.022     .0019348    .0254078
       _cons |   5.743598   .7350961     7.81   0.000     4.301189    7.186007
-------------+----------------------------------------------------------------
     sigma_u |  .75745549
     sigma_e |  .09576529
         rho |  .98426688   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(97, 1060) =   375.04           Prob > F = 0.0000

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health1,re

Random-effects GLS regression                   Number of obs      =      1162
Group variable (i): country                     Number of groups   =        98

R-sq:  within  = 0.6341                         Obs per group: min =         1
       between = 0.8515                                        avg =      11.9
       overall = 0.8561                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(4)       =   2479.86
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2843884   .0143865    19.77   0.000     .2561914    .3125855
        logL |   .6439886   .0320894    20.07   0.000     .5810945    .7068828
    lit_rate |   .0006423    .001223     0.53   0.599    -.0017548    .0030393
     Health1 |    .018646    .005837     3.19   0.001     .0072058    .0300863
       _cons |   7.036821   .4314304    16.31   0.000     6.191233    7.882409
-------------+----------------------------------------------------------------
     sigma_u |  .58206861
     sigma_e |  .09576529
         rho |  .97364468   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random
```

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .2683264     .2843884        -.016062        .0011648
        logL |    .7763202     .6439886        .1323316        .0454167
    lit_rate |   -.0036434     .0006423       -.0042857        .0012251
     Health1 |    .0136713      .018646       -.0049748         .001306
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -81.01    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

. xtregar logY_real logK_real logL lit_rate Health1,fe

FE (within) regression with AR(1) disturbances  Number of obs      =      1064
Group variable (i): country                     Number of groups   =        96

R-sq:  within  = 0.0993                         Obs per group: min =         7
       between = 0.7585                                        avg =      11.1
       overall = 0.7572                                        max =        12

                                                F(4,964)           =     26.57
corr(u_i, Xb)  = 0.3371                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .0295936   .0122531     2.42   0.016     .0055477    .0536394
        logL |   .7322884   .0883338     8.29   0.000     .5589397     .905637
    lit_rate |   .0039703    .002239     1.77   0.077    -.0004236    .0083642
     Health1 |  -.0068943   .0041013    -1.68   0.093    -.0149428    .0011541
       _cons |   11.78203   .2384719    49.41   0.000     11.31404    12.25001
-------------+----------------------------------------------------------------
      rho_ar |  .81896318
     sigma_u |  .90831395
     sigma_e |  .05471386
     rho_fov |  .99638465   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(95,964) =    51.38              Prob > F = 0.0000

. xi: reg logY_real logK_real logL lit_rate Health1 i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =    1162
-------------+------------------------------           F(101,  1060) = 3826.17
       Model |  3544.06466   101  35.0897491           Prob > F      =  0.0000
    Residual |  9.72124957  1060   .00917099           R-squared     =  0.9973
-------------+------------------------------           Adj R-squared =  0.9970
       Total |  3553.78591  1161  3.06096978           Root MSE      =  .09577

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
   logK_real |   .2683264   .0144336    18.59   0.000     .2400048    .2966481
        logL |   .7763202   .0556094    13.96   0.000     .6672032    .8854372
    lit_rate |  -.0036434   .0017311    -2.10   0.036    -.0070402   -.0002466
     Health1 |   .0136713   .0059813     2.29   0.022     .0019348    .0254078
..............................................................................
       _cons |   5.528464   .6702978     8.25   0.000     4.213202    6.843725
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     6.10
         Prob > chi2  =   0.0135
```

SPECIFICATION - (1.4)

```
. xtreg logY_real logK_real logL lit_rate Health1 trade_n_real ,fe

Fixed-effects (within) regression               Number of obs      =      1145
Group variable (i): country                     Number of groups   =        97

R-sq:  within  = 0.6889                         Obs per group: min =         1
       between = 0.7936                                        avg =      11.8
       overall = 0.7967                                        max =        13

                                                F(5,1043)          =    461.88
corr(u_i, Xb)  = -0.1710                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2239215   .0135064    16.58   0.000     .1974186    .2504243
        logL |   .8091172   .0511833    15.81   0.000     .7086831    .9095512
    lit_rate |  -.0050015   .0015843    -3.16   0.002    -.0081102   -.0018928
     Health1 |   .0119521    .005448     2.19   0.028     .0012618    .0226423
trade_n_real |   6.07e-13   5.01e-14    12.12   0.000     5.09e-13    7.05e-13
       _cons |   6.393211   .6770924     9.44   0.000     5.064593     7.72183
-------------+----------------------------------------------------------------
     sigma_u |  .80119465
     sigma_e |  .08703122
         rho |  .98833783   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(96, 1043) =   426.96            Prob > F = 0.0000

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health1 trade_n_real ,re

Random-effects GLS regression                   Number of obs      =      1145
Group variable (i): country                     Number of groups   =        97

R-sq:  within  = 0.6855                         Obs per group: min =         1
       between = 0.8400                                        avg =      11.8
       overall = 0.8463                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(5)       =   2235.67
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
```

```
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2404443   .0135704    17.72   0.000     .2138468    .2670418
        logL |   .6643917   .0312736    21.24   0.000     .6030966    .7256867
    lit_rate |  -.0004223   .0011575    -0.36   0.715    -.0026909    .0018464
     Health1 |   .0171989    .005361     3.21   0.001     .0066916    .0277061
trade_n_real |   5.86e-13   5.10e-14    11.48   0.000     4.86e-13    6.86e-13
       _cons |   7.846615   .4246708    18.48   0.000     7.014275    8.678954
-------------+----------------------------------------------------------------
     sigma_u |  .58266034
     sigma_e |  .08703122
         rho |  .97817591   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (4) does not equal the number
of
        coefficients being tested (5); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .2239215     .2404443       -.0165228               .
        logL |    .8091172     .6643917        .1447255        .0405179
    lit_rate |   -.0050015    -.0004223       -.0045792        .0010817
     Health1 |    .0119521     .0171989       -.0052468        .0009699
trade_n_real |    6.07e-13     5.86e-13        2.09e-14               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                         =       67.38
               Prob>chi2 =      0.0000
               (V_b-V_B is not positive definite)

. xtregar logY_real logK_real logL lit_rate Health1 trade_n_real ,fe

FE (within) regression with AR(1) disturbances  Number of obs      =      1048
Group variable (i): country                     Number of groups   =        95

R-sq:  within  = 0.1499                         Obs per group: min =         3
       between = 0.7621                                        avg =      11.0
       overall = 0.7611                                        max =        12

                                                F(5,948)           =     33.44
corr(u_i, Xb)  = 0.2461                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .0328243   .0123134     2.67   0.008     .0086596    .0569889
```

```
        logL |   .7741337   .0826125     9.37   0.000     .6120092    .9362583
    lit_rate |   .0031016   .0021849     1.42   0.156    -.0011861    .0073894
     Health1 |  -.0069951   .0041424    -1.69   0.092    -.0151245    .0011343
trade_n_real |   2.74e-13   7.22e-14     3.80   0.000     1.33e-13    4.16e-13
       _cons |    11.0888   .2591606    42.79   0.000     10.58021     11.5974
-------------+----------------------------------------------------------------
      rho_ar |  .78651835
     sigma_u |  .88393311
     sigma_e |  .05432152
     rho_fov |  .99623757   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(94,948) =    60.79              Prob > F = 0.0000

. xi: reg logY_real logK_real logL lit_rate Health1 trade_n_real i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =    1145
-------------+------------------------------           F(101,  1043) = 4612.29
       Model |  3528.48681   101   34.935513           Prob > F      =  0.0000
    Residual |  7.90013417  1043  .007574434           R-squared     =  0.9978
-------------+------------------------------           Adj R-squared =  0.9975
       Total |  3536.38695  1144  3.09124733           Root MSE      =  .08703

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2239215   .0135064    16.58   0.000     .1974186    .2504243
        logL |   .8091172   .0511833    15.81   0.000     .7086831    .9095512
    lit_rate |  -.0050015   .0015843    -3.16   0.002    -.0081102   -.0018928
     Health1 |   .0119521    .005448     2.19   0.028     .0012618    .0226423
trade_n_real |   6.07e-13   5.01e-14    12.12   0.000     5.09e-13    7.05e-13
 .............................................................................
       _cons |   6.216219   .6169232    10.08   0.000     5.005667    7.426771
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =    52.04
         Prob > chi2  =   0.0000
```

SPEIFICATION (1.5)

```
xtreg  logY_real  logK_real  logL  lit_rate  Health1  trade_n_real  listed_dom_comp
,fe

Fixed-effects (within) regression               Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7689                         Obs per group: min =         1
       between = 0.8009                                        avg =       9.4
       overall = 0.8246                                        max =        13

                                                F(6,572)           =    317.26
corr(u_i, Xb)  = -0.1998                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1622399   .0154071    10.53   0.000     .1319786    .1925012
        logL |   .8018812   .0611808    13.11   0.000     .6817148    .9220476
```

```
    lit_rate |  -.0011158    .002387    -0.47   0.640    -.0058042    .0035727
     Health1 |   .0156904   .0067908     2.31   0.021     .0023525    .0290283
trade_n_real |   5.37e-13   6.10e-14     8.80   0.000     4.17e-13    6.57e-13
listed_dom~p |   .0001602   .0000359     4.46   0.000     .0000896    .0002308
       _cons |   8.040665    .808252     9.95   0.000     6.453161    9.628168
-------------+----------------------------------------------------------------
     sigma_u |   .7103779
     sigma_e |  .06479186
         rho |  .99174981   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(68, 572) =   511.58           Prob > F = 0.0000

. est store fixed
```

. xtreg logY_real logK_real logL lit_rate Health1 trade_n_real listed_dom_comp ,re

```
Random-effects GLS regression                   Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7677                         Obs per group: min =         1
       between = 0.8195                                        avg =       9.4
       overall = 0.8468                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   1539.38
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1722696   .0154109    11.18   0.000     .1420649    .2024743
        logL |   .7036196   .0369412    19.05   0.000     .6312161    .7760231
    lit_rate |   .0023344   .0016591     1.41   0.159    -.0009173    .0055861
     Health1 |    .018124   .0067267     2.69   0.007     .0049399     .031308
trade_n_real |   5.32e-13   6.16e-14     8.64   0.000     4.11e-13    6.53e-13
listed_dom~p |   .0001575   .0000362     4.35   0.000     .0000865    .0002285
       _cons |   8.935066   .5067289    17.63   0.000     7.941896    9.928236
-------------+----------------------------------------------------------------
     sigma_u |  .60189262
     sigma_e |  .06479186
         rho |  .98854489   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (5) does not equal the number
of
        coefficients being tested (6); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .1622399     .1722696       -.0100297               .
        logL |    .8018812     .7036196        .0982616        .0487692
    lit_rate |   -.0011158     .0023344       -.0034502        .0017162
```

```
     Health1 |    .0156904      .018124       -.0024335        .0009309
trade_n_real |    5.37e-13     5.32e-13        5.01e-15               .
listed_dom~p |    .0001602     .0001575        2.71e-06               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -59.52    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

.  xtregar  logY_real  logK_real  logL  lit_rate  Health1  trade_n_real
listed_dom_comp ,f
> e

FE (within) regression with AR(1) disturbances  Number of obs      =       578
Group variable (i): country                     Number of groups   =        67

R-sq:  within  = 0.9366                         Obs per group: min =         1
       between = 0.7163                                        avg =       8.6
       overall = 0.7152                                        max =        12

                                                F(6,505)           =   1243.25
corr(u_i, Xb)  = -0.8390                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .0038857   .0115398     0.34   0.736    -.0187861    .0265576
        logL |   1.614434   .0346747    46.56   0.000      1.54631    1.682559
    lit_rate |   -.012675   .0041957    -3.02   0.003    -.0209183   -.0044318
     Health1 |   .0054984   .0049927     1.10   0.271    -.0043105    .0153074
trade_n_real |   8.33e-14   6.21e-14     1.34   0.180    -3.86e-14    2.05e-13
listed_dom~p |  -9.82e-07   .0000287    -0.03   0.973    -.0000574    .0000554
       _cons |   .3989831   .0517626     7.71   0.000     .2972866    .5006797
-------------+----------------------------------------------------------------
      rho_ar |  .81950116
     sigma_u |  1.5103919
     sigma_e |  .03626104
     rho_fov |  .99942396   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(66,505) =    65.95             Prob > F = 0.0000

.  xi:  reg  logY_real  logK_real  logL  lit_rate  Health1  trade_n_real
listed_dom_comp i.
> country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     647
-------------+------------------------------           F( 74,   572) = 5044.88
       Model |  1567.19781    74  21.1783488           Prob > F      =  0.0000
    Residual |  2.40124767   572  .004197985           R-squared     =  0.9985
-------------+------------------------------           Adj R-squared =  0.9983
       Total |  1569.59906   646  2.42971991           Root MSE      =  .06479

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1622399   .0154071    10.53   0.000     .1319786    .1925012
```

```
        logL |   .8018812   .0611808    13.11   0.000     .6817148    .9220476
    lit_rate |  -.0011158    .002387    -0.47   0.640    -.0058042    .0035727
     Health1 |   .0156904   .0067908     2.31   0.021     .0023525    .0290283
trade_n_real |   5.37e-13   6.10e-14     8.80   0.000     4.17e-13    6.57e-13
listed_dom~p |   .0001602   .0000359     4.46   0.000     .0000896    .0002308
.............................................................................
       _cons |   6.875375   1.084197     6.34   0.000     4.745882    9.004867
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     3.72
         Prob > chi2  =   0.0537
```

SPECIFICATION (1.6)

```
. xtreg  logY_real  logK_real  logL  lit_rate  Health1  Health1_t  trade_n_real
listed_dom
> _comp ,fe

Fixed-effects (within) regression               Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7694                         Obs per group: min =         1
       between = 0.7998                                        avg =       9.4
       overall = 0.8239                                        max =        13

                                                F(7,571)           =    272.11
corr(u_i, Xb)  = -0.2039                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1630863   .0154287    10.57   0.000     .1327824    .1933902
        logL |   .8029305    .061187    13.12   0.000     .6827514    .9231097
    lit_rate |   -.001124    .002387    -0.47   0.638    -.0058123    .0035643
     Health1 |   .0146725   .0068632     2.14   0.033     .0011923    .0281526
   Health1_t |   .0469597   .0459503     1.02   0.307    -.0432926     .137212
trade_n_real |   5.37e-13   6.10e-14     8.81   0.000     4.18e-13    6.57e-13
listed_dom~p |   .0001583    .000036     4.40   0.000     .0000877     .000229
       _cons |   7.996807   .8093592     9.88   0.000     6.407123    9.586492
-------------+----------------------------------------------------------------
     sigma_u |  .71300856
     sigma_e |  .06478935
         rho |  .99181071   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(68, 571) =   413.05             Prob > F = 0.0000

. est store fixed

. xtreg  logY_real  logK_real  logL  lit_rate  Health1  Health1_t  trade_n_real
listed_dom
> _comp ,re

Random-effects GLS regression                   Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7678                         Obs per group: min =         1
       between = 0.8199                                        avg =       9.4
```

```
       overall = 0.8478                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(7)       =   1557.98
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1745446   .0155823    11.20   0.000     .1440039    .2050852
        logL |   .6980776   .0354743    19.68   0.000     .6285493     .767606
    lit_rate |    .002521   .0016249     1.55   0.121    -.0006637    .0057058
     Health1 |   .0177655    .006873     2.58   0.010     .0042947    .0312363
   Health1_t |   .0226519   .0446691     0.51   0.612     -.064898    .1102017
trade_n_real |   5.32e-13   6.24e-14     8.52   0.000     4.09e-13    6.54e-13
listed_dom~p |   .0001563   .0000367     4.26   0.000     .0000843    .0002282
       _cons |   8.942408   .4906085    18.23   0.000     7.980833    9.903983
-------------+----------------------------------------------------------------
     sigma_u |  .54812598
     sigma_e |  .06478935
         rho |  .98622091   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (6) does not equal the number
of
        coefficients  being  tested  (7);  be  sure  this  is  what  you  expect,  or
there
        may  be  problems  computing  the  test.   Examine  the  output  of  your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .1630863     .1745446       -.0114583               .
        logL |    .8029305     .6980776        .1048529        .0498541
    lit_rate |    -.001124      .002521       -.0036451        .0017485
     Health1 |    .0146725     .0177655        -.003093               .
   Health1_t |    .0469597     .0226519        .0243078         .010775
trade_n_real |    5.37e-13     5.32e-13        5.82e-15               .
listed_dom~p |    .0001583     .0001563        2.07e-06               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -89.82    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

.  xtregar  logY_real  logK_real  logL  lit_rate  Health1  Health1_t  trade_n_real
listed_d
> om_comp ,re

RE GLS regression with AR(1) disturbances       Number of obs      =       647
```

```
Group variable (i): country                    Number of groups   =        69

R-sq:  within  = 0.7343                        Obs per group: min =         1
       between = 0.8062                                       avg =       9.4
       overall = 0.8369                                       max =        13

                                               Wald chi2(8)       =   1206.49
corr(u_i, Xb)      = 0 (assumed)               Prob > chi2        =    0.0000

------------------- theta --------------------
  min      5%       median        95%      max
0.7409   0.7785     0.8174     0.8214   0.8214

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .073677   .0149347     4.93   0.000     .0444056    .1029484
        logL |   .7877432   .0296043    26.61   0.000     .7297199    .8457666
    lit_rate |   .0119351   .0018765     6.36   0.000     .0082571     .015613
     Health1 |    .006146   .0066258     0.93   0.354    -.0068404    .0191324
   Health1_t |  -.0039964   .0361957    -0.11   0.912    -.0749385    .0669458
trade_n_real |   4.06e-13   7.03e-14     5.77   0.000     2.68e-13    5.44e-13
listed_dom~p |   .0001035   .0000387     2.68   0.007     .0000278    .0001793
       _cons |    9.34938   .4528406    20.65   0.000     8.461828    10.23693
-------------+----------------------------------------------------------------
      rho_ar |  .82044763   (estimated autocorrelation coefficient)
     sigma_u |  .49508982
     sigma_e |  .07591785
     rho_fov |  .97702656   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xi: reg logY_real logK_real logL lit_rate Health1 Health1_t trade_n_real
listed_d
> om_comp i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     647
-------------+------------------------------           F( 75,   571) = 4978.02
       Model |  1567.2022     75  20.8960293           Prob > F      =  0.0000
    Residual |  2.39686357   571  .004197659           R-squared     =  0.9985
-------------+------------------------------           Adj R-squared =  0.9983
       Total |  1569.59906   646  2.42971991           Root MSE      =  .06479

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1630863   .0154287    10.57   0.000     .1327824    .1933902
        logL |   .8029305    .061187    13.12   0.000     .6827514    .9231097
    lit_rate |  -.001124     .002387    -0.47   0.638    -.0058123    .0035643
     Health1 |   .0146725   .0068632     2.14   0.033     .0011923    .0281526
   Health1_t |   .0469597   .0459503     1.02   0.307    -.0432926     .137212
trade_n_real |   5.37e-13   6.10e-14     8.81   0.000     4.18e-13    6.57e-13
listed_dom~p |   .0001583    .000036     4.40   0.000     .0000877     .000229
..............................................................................
       _cons |   6.830875   1.085029     6.30   0.000      4.69974    8.962009
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real
```

```
        chi2(1)      =     3.19
        Prob > chi2  =   0.0743
```

SPECIFICATION (1.7)

```
.  xtreg  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health1  Health1_t
trade_n_real
>  listed_dom_comp ,fe

Fixed-effects (within) regression               Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7730                         Obs per group: min =         1
       between = 0.0165                                        avg =       9.4
       overall = 0.0339                                        max =        13

                                                F(8,570)           =    242.61
corr(u_i, Xb)  = -0.9544                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1680286   .0154077    10.91   0.000     .1377659    .1982914
        logL |   .8100157   .0608027    13.32   0.000      .690591    .9294405
    lit_rate |  -.0015189   .0023738    -0.64   0.523    -.0061814    .0031436
  lit_rate_t |   .1488788   .0493403     3.02   0.003     .0519679    .2457898
     Health1 |   .0144996   .0068152     2.13   0.034     .0011136    .0278856
   Health1_t |   .0177999   .0466398     0.38   0.703    -.073807    .1094068
trade_n_real |   5.55e-13   6.09e-14     9.12   0.000     4.35e-13    6.74e-13
listed_dom~p |   .0001293    .000037     3.49   0.001     .0000566     .000202
       _cons |    5.81968   1.080044     5.39   0.000     3.698327    7.941033
-------------+----------------------------------------------------------------
     sigma_u |   6.254724
     sigma_e |  .06433438
         rho |  .99989422   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(68, 570) =   368.38             Prob > F = 0.0000

. est store fixed

.  xtreg  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health1  Health1_t
trade_n_real
>  listed_dom_comp ,re

Random-effects GLS regression                   Number of obs      =       647
Group variable (i): country                     Number of groups   =        69

R-sq:  within  = 0.7669                         Obs per group: min =         1
       between = 0.8340                                        avg =       9.4
       overall = 0.8582                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(8)       =   1590.78
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1789263   .0157012    11.40   0.000     .1481526       .2097
        logL |   .6783337    .034886    19.44   0.000     .6099583    .7467091
    lit_rate |   .0034472    .001629     2.12   0.034     .0002544    .0066401
  lit_rate_t |  -.0039863    .001712    -2.33   0.020    -.0073418   -.0006308
     Health1 |   .0174644   .0069154     2.53   0.012     .0039106    .0310183
   Health1_t |    .056111   .0474014     1.18   0.237    -.036794     .149016
trade_n_real |   5.28e-13   6.28e-14     8.40   0.000     4.05e-13    6.51e-13
```

```
listed_dom~p |   .0001524    .000037     4.12   0.000     .0000799    .0002249
       _cons |   9.138083   .4821851    18.95   0.000     8.193018    10.08315
-------------+----------------------------------------------------------------
     sigma_u |  .50813053
     sigma_e |  .06433438
         rho |  .98422283   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (7) does not equal the number
of
        coefficients being tested (8); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .1680286     .1789263       -.0108977               .
        logL |    .8100157     .6783337         .131682        .0497989
    lit_rate |   -.0015189     .0034472       -.0049662        .0017266
  lit_rate_t |    .1488788    -.0039863        .1528652        .0493106
     Health1 |    .0144996     .0174644       -.0029648               .
   Health1_t |    .0177999      .056111       -.0383112               .
trade_n_real |    5.55e-13     5.28e-13        2.69e-14               .
listed_dom~p |    .0001293     .0001524       -.0000231        1.38e-06
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -79.69    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

.  xtregar  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health1  Health1_t
trade_n_re
> al listed_dom_comp ,fe

FE (within) regression with AR(1) disturbances  Number of obs      =       578
Group variable (i): country                     Number of groups   =        67

R-sq:  within  = 0.9369                         Obs per group: min =         1
       between = 0.6996                                        avg =       8.6
       overall = 0.6986                                        max =        12

                                                F(8,503)           =    933.83
corr(u_i, Xb)  = -0.8582                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .0048309   .0114879     0.42   0.674    -.0177393    .0274011
```

```
        logL |   1.648992    .037755    43.68   0.000     1.574815    1.723169
    lit_rate |  -.0118656   .0042001    -2.83   0.005    -.0201175   -.0036136
  lit_rate_t |  -.0131715   .0057007    -2.31   0.021    -.0243716   -.0019713
     Health1 |   .0039815   .0050489     0.79   0.431     -.005938    .0139011
   Health1_t |   .0348253   .0290692     1.20   0.231    -.0222866    .0919373
trade_n_real |   6.94e-14   6.24e-14     1.11   0.267    -5.32e-14    1.92e-13
listed_dom~p |  -5.44e-06   .0000287    -0.19   0.850    -.0000619     .000051
       _cons |  -.0789885   .0632479    -1.25   0.212    -.2032512    .0452742
-------------+----------------------------------------------------------------
      rho_ar |  .82033262
     sigma_u |  1.6773732
     sigma_e |  .03608793
     rho_fov |  .99953734   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(66,503) =    60.44            Prob > F = 0.0000

.  xi:  reg  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health1  Health1_t
trade_n_re
> al listed_dom_comp i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     647
-------------+------------------------------           F( 76,   570) = 4982.37
       Model |  1567.23988    76  20.6215774           Prob > F      =  0.0000
    Residual |  2.35918029   570  .004138913           R-squared     =  0.9985
-------------+------------------------------           Adj R-squared =  0.9983
       Total |  1569.59906   646  2.42971991           Root MSE      =  .06433

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1680286   .0154077    10.91   0.000     .1377659    .1982914
        logL |   .8100157   .0608027    13.32   0.000      .690591    .9294405
    lit_rate |  -.0015189   .0023738    -0.64   0.523    -.0061814    .0031436
  lit_rate_t |   .1488788   .0493403     3.02   0.003     .0519678    .2457898
     Health1 |   .0144996   .0068152     2.13   0.034     .0011136    .0278856
   Health1_t |   .0177999   .0466398     0.38   0.703     -.073807    .1094068
trade_n_real |   5.55e-13   6.09e-14     9.12   0.000     4.35e-13    6.74e-13
listed_dom~p |   .0001293    .000037     3.49   0.001     .0000566     .000202
 _............................................................................
       _cons |  -6.732624   5.014772    -1.34   0.180    -16.58231    3.117062
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     1.85
         Prob > chi2  =   0.1743
```

HEALTH 2

SPECIFICATION (2.1)

```
. xtreg logY_real  logK_real logL lit_rate Health2, fe

Fixed-effects (within) regression               Number of obs      =       589
Group variable (i): country                     Number of groups   =        97

R-sq:  within  = 0.6057                         Obs per group: min =         1
       between = 0.8195                                        avg =       6.1
```

```
       overall = 0.8167                                        max =        13

                                                F(4,488)           =    187.43
corr(u_i, Xb)  = -0.3892                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3062068   .0237507    12.89   0.000     .2595406     .352873
        logL |   .8651951   .1067183     8.11   0.000     .6555111    1.074879
    lit_rate |  -.0041665   .0036828    -1.13   0.258    -.0114026    .0030695
     Health2 |   .0176358   .0101306     1.74   0.082    -.0022693    .0375408
       _cons |   3.665579   1.348147     2.72   0.007      1.01669    6.314468
-------------+----------------------------------------------------------------
     sigma_u |  .79776541
     sigma_e |  .10064747
         rho |  .98433259   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(96, 488) =   233.20            Prob > F = 0.0000

. est store fixed
. xtreg logY_real  logK_real logL lit_rate Health2, re

Random-effects GLS regression                   Number of obs      =       589
Group variable (i): country                     Number of groups   =        97

R-sq:  within  = 0.5998                         Obs per group: min =         1
       between = 0.8795                                        avg =       6.1
       overall = 0.8592                                        max =        13

Random effects u_i ~ Gaussian                   Wald chi2(4)       =   1455.36
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .331103   .0228867    14.47   0.000      .286246      .37596
        logL |   .6177891   .0401131    15.40   0.000     .5391688    .6964093
    lit_rate |   .0045556   .0020497     2.22   0.026     .0005383     .008573
     Health2 |   .0279658     .00973     2.87   0.004     .0088954    .0470361
       _cons |   6.023489   .5305623    11.35   0.000     4.983606    7.063372
-------------+----------------------------------------------------------------
     sigma_u |  .57963087
     sigma_e |  .10064747
         rho |  .97073141   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .3062068      .331103       -.0248962        .0063478
        logL |    .8651951     .6177891        .2474061        .0988925
    lit_rate |   -.0041665     .0045556       -.0087222        .0030597
     Health2 |    .0176358     .0279658         -.01033        .0028209
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg
```

```
    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        8.76
                Prob>chi2 =      0.0674
                (V_b-V_B is not positive definite)

. xtregar logY_real  logK_real logL lit_rate Health2, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       492
Group variable (i): country                     Number of groups   =        95

R-sq:  within  = 0.9928                         Obs per group: min =         1
       between = 0.8251                                        avg =       5.2
       overall = 0.8232                                        max =        12

                                                F(4,393)           =  13597.07
corr(u_i, Xb)  = -0.6327                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .0471319   .0216086     2.18   0.030      .004649    .0896149
        logL |   1.286217   .0388606    33.10   0.000     1.209816    1.362618
    lit_rate |   .0344647   .0048545     7.10   0.000     .0249207    .0440087
     Health2 |   .0173389   .0086169     2.01   0.045     .0003979    .0342799
       _cons |   .4703239   .0172344    27.29   0.000     .4364407    .5042072
-------------+----------------------------------------------------------------
      rho_ar |   .8736307
     sigma_u |  .94788993
     sigma_e |  .05877118
     rho_fov |  .99617046   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(94,393) =    18.98              Prob > F = 0.0000

. xi: reg logY_real  logK_real logL lit_rate Health2 i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)


      Source |       SS       df       MS              Number of obs =     589
-------------+------------------------------           F(100,   488) = 1740.52
       Model |    1763.131   100    17.63131           Prob > F      =  0.0000
    Residual |  4.94339722   488  .010129912           R-squared     =  0.9972
-------------+------------------------------           Adj R-squared =  0.9966
       Total |   1768.0744   588  3.00692924           Root MSE      =  .10065

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3062068   .0237507    12.89   0.000     .2595406     .352873
        logL |   .8651951   .1067183     8.11   0.000     .6555111    1.074879
    lit_rate |  -.0041665   .0036828    -1.13   0.258    -.0114026    .0030695
     Health2 |   .0176358   .0101306     1.74   0.082    -.0022693    .0375408
..............................................................................
..........
       _cons |   3.391146   1.239671     2.74   0.006     .9553935    5.826898
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
 Ho: Constant variance
Variables: fitted values of logY_real
```

```
        chi2(1)      =    17.54
        Prob > chi2  =   0.0000
```

SPECIFICATION (2.2)

```
. xtreg logY_real logK_real logL lit_rate Health2 trade_n_real, fe

Fixed-effects (within) regression               Number of obs      =       572
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8784                         Obs per group: min =         9
       between = 0.8179                                        avg =      40.9
       overall = 0.8793                                        max =        93

                                                F(5,553)           =    798.92
corr(u_i, Xb)  = -0.1642                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3764023   .0362381    10.39   0.000     .3052212    .4475834
        logL |   .5309345   .0408864    12.99   0.000     .4506228    .6112461
    lit_rate |  -.0002319   .0024198    -0.10   0.924    -.0049851    .0045213
     Health2 |   .1444168   .0270738     5.33   0.000     .0912367    .1975969
trade_n_real |   1.07e-12   2.27e-13     4.69   0.000     6.19e-13    1.51e-12
       _cons |   6.675983   .4901596    13.62   0.000     5.713181    7.638785
-------------+----------------------------------------------------------------
     sigma_u |  .18013086
     sigma_e |  .60248121
         rho |  .08205515   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 553) =     1.94             Prob > F = 0.0233

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health2 trade_n_real, re

Random-effects GLS regression                   Number of obs      =       572
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8782                         Obs per group: min =         9
       between = 0.8202                                        avg =      40.9
       overall = 0.8798                                        max =        93

Random effects u_i ~ Gaussian                   Wald chi2(5)       =   1868.28
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3722195   .0360722    10.32   0.000     .3015193    .4429196
        logL |   .5343432    .040952    13.05   0.000     .4540789    .6146076
    lit_rate |  -.0005812   .0024105    -0.24   0.809    -.0053057    .0041433
     Health2 |   .1317087   .0268551     4.90   0.000     .0790737    .1843438
trade_n_real |   1.01e-12   2.28e-13     4.41   0.000     5.59e-13    1.45e-12
       _cons |   6.757474   .4858808    13.91   0.000     5.805165    7.709783
-------------+----------------------------------------------------------------
     sigma_u |  .05189548
     sigma_e |  .60248121
         rho |  .00736481   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random
```

```
. hausman fixed random

Note: the rank of the differenced variance matrix (4) does not equal the number
of
        coefficients being tested (5); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .3764023     .3722195        .0041828        .0034635
        logL |    .5309345     .5343432       -.0034088               .
    lit_rate |   -.0002319    -.0005812        .0003493        .0002123
     Health2 |    .1444168     .1317087         .012708        .0034344
trade_n_real |    1.07e-12     1.01e-12        5.92e-14               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =    -9.74    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

. xtregar logY_real logK_real logL lit_rate Health2 trade_n_real, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       558
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9618                         Obs per group: min =         8
       between = 0.9347                                        avg =      39.9
       overall = 0.8583                                        max =        92

                                                F(5,539)           =   2710.75
corr(u_i, Xb)  = -0.2612                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .6700915   .0313507    21.37   0.000      .608507     .731676
        logL |   .4847788   .0435895    11.12   0.000     .3991526    .5704051
    lit_rate |   .0049798   .0025578     1.95   0.052    -.0000447    .0100043
     Health2 |   .0353893   .0277155     1.28   0.202    -.0190542    .0898329
trade_n_real |  -6.04e-13   2.09e-13    -2.89   0.004    -1.01e-12   -1.94e-13
       _cons |   -.559797   .1495513    -3.74   0.000    -.8535719   -.2660221
-------------+----------------------------------------------------------------
      rho_ar |   .4743161
     sigma_u |  .21931357
     sigma_e |  .67877575
     rho_fov |   .0945266   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13,539) =    -6.17              Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate Health2 trade_n_real i.country
```

```
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     572
-------------+------------------------------           F(100,   471) = 2137.84
       Model |  1742.63305   100  17.4263305           Prob > F      =  0.0000
    Residual |   3.8392939   471  .008151367           R-squared     =  0.9978
-------------+------------------------------           Adj R-squared =  0.9973
       Total |  1746.47235   571  3.05862057           Root MSE      =  .09028

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2460528   .0222765    11.05   0.000     .2022791    .2898265
        logL |   .8952442   .0985404     9.09   0.000     .7016109    1.088877
    lit_rate |  -.0063832    .003346    -1.91   0.057    -.0129581    .0001918
     Health2 |   .0142215   .0091208     1.56   0.120    -.0037011    .0321441
trade_n_real |   5.72e-13   7.66e-14     7.48   0.000     4.22e-13    7.23e-13
 _
       _cons |    4.55814   1.145817     3.98   0.000     2.306594    6.809686
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =    26.41
         Prob > chi2  =   0.0000
```

SPECIFICATION (2.3)

. xtreg logY_real logK_real logL lit_rate Health2 trade_n_real listed_dom_comp, fe

```
Fixed-effects (within) regression               Number of obs      =       377
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8886                         Obs per group: min =         5
       between = 0.2271                                        avg =      26.9
       overall = 0.8793                                        max =        64

                                                F(6,357)           =    474.78
corr(u_i, Xb)  = -0.0412                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4606687   .0438145    10.51   0.000     .3745017    .5468357
        logL |    .420689   .0512827     8.20   0.000     .3198347    .5215432
    lit_rate |  -.0000517   .0029676    -0.02   0.986    -.0058879    .0057845
     Health2 |   .0778933   .0392242     1.99   0.048     .0007537    .1550329
trade_n_real |   4.69e-13   2.34e-13     2.01   0.046     9.33e-15    9.28e-13
listed_dom~p |   .0006773   .0001678     4.04   0.000     .0003473    .0010073
       _cons |   6.287062    .604789    10.40   0.000     5.097665    7.476459
-------------+----------------------------------------------------------------
     sigma_u |  .20982949
     sigma_e |  .53158974
         rho |  .13480174   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 357) =     2.58             Prob > F = 0.0020

. est store fixed
```

```
. xtreg logY_real logK_real logL lit_rate Health2 trade_n_real listed_dom_comp,
re

Random-effects GLS regression                   Number of obs      =       377
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8880                         Obs per group: min =         5
       between = 0.2664                                        avg =      26.9
       overall = 0.8801                                        max =        64

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   1169.14
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4510351   .0443609    10.17   0.000     .3640893    .5379809
        logL |    .427025      .0522     8.18   0.000      .324715    .5293351
    lit_rate |   .0007375   .0030132     0.24   0.807    -.0051682    .0066433
     Health2 |   .0327033   .0377143     0.87   0.386    -.0412155     .106622
trade_n_real |   4.63e-13   2.38e-13     1.95   0.052    -3.11e-15    9.29e-13
listed_dom~p |   .0006654   .0001707     3.90   0.000     .0003309        .001
       _cons |   6.373408   .6133378    10.39   0.000     5.171288    7.575528
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .53158974
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (5) does not equal the number
of
        coefficients being tested (6); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .4606687     .4510351        .0096336               .
        logL |     .420689      .427025       -.0063361               .
    lit_rate |   -.0000517     .0007375       -.0007892               .
     Health2 |    .0778933     .0327033          .04519        .0107782
trade_n_real |    4.69e-13     4.63e-13        5.62e-15               .
listed_dom~p |    .0006773     .0006654        .0000119               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =    -8.30    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test
```

```
. xtregar logY_real logK_real logL lit_rate Health2 trade_n_real
listed_dom_comp, f
> e

FE (within) regression with AR(1) disturbances  Number of obs      =       363
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9801                         Obs per group: min =         4
       between = 0.3856                                        avg =      25.9
       overall = 0.8612                                        max =        63

                                                F(6,343)           =   2821.09
corr(u_i, Xb)  = -0.0715                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7210841   .0388063    18.58   0.000     .6447559    .7974123
        logL |   .4264152   .0551969     7.73   0.000     .3178482    .5349822
    lit_rate |   .0049811   .0032192     1.55   0.123    -.0013508     .011313
     Health2 |   .0458596   .0421118     1.09   0.277    -.0369703    .1286895
trade_n_real |  -8.11e-13   1.99e-13    -4.07   0.000    -1.20e-12   -4.19e-13
listed_dom~p |   .0001514   .0001919     0.79   0.431     -.000226    .0005289
       _cons |  -1.076761   .1412118    -7.63   0.000    -1.354511    -.799011
-------------+----------------------------------------------------------------
      rho_ar |  .52127343
     sigma_u |  .23967882
     sigma_e |  .57199006
     rho_fov |  .14935821   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13,343) =    -2.31              Prob > F = 1.0000

. xtregar logY_real logK_real logL lit_rate Health2 trade_n_real
listed_dom_comp, r
> e

RE GLS regression with AR(1) disturbances       Number of obs      =       377
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8876                         Obs per group: min =         5
       between = 0.2539                                        avg =      26.9
       overall = 0.8790                                        max =        64

                                                Wald chi2(7)       =   1344.07
corr(u_i, Xb)      = 0 (assumed)                Prob > chi2        =    0.0000

------------------- theta --------------------
  min      5%       median        95%      max
0.0133   0.0269     0.0626     0.0890   0.0890

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .510248   .0425951    11.98   0.000     .4267632    .5937328
        logL |   .4244051   .0508198     8.35   0.000     .3248001    .5240101
    lit_rate |   .0009832   .0029864     0.33   0.742      -.00487    .0068364
     Health2 |    .046926   .0379726     1.24   0.217     -.027499    .1213509
trade_n_real |   2.25e-13   2.24e-13     1.01   0.313    -2.13e-13    6.64e-13
listed_dom~p |   .0005702   .0001745     3.27   0.001     .0002282    .0009122
       _cons |   4.915761   .5971431     8.23   0.000     3.745382     6.08614
-------------+----------------------------------------------------------------
      rho_ar |  .52127343   (estimated autocorrelation coefficient)
```

```
     sigma_u |  .04964459
     sigma_e |  .53187481
     rho_fov |   .0086369   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xi: reg logY_real logK_real logL lit_rate Health2 trade_n_real
listed_dom_comp i.
> country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     377
-------------+------------------------------           F( 72,   304) = 2734.85
       Model |  919.311169    72  12.7682107           Prob > F      =  0.0000
    Residual |  1.41928642   304  .004668705           R-squared     =  0.9985
-------------+------------------------------           Adj R-squared =  0.9981
       Total |  920.730455   376  2.44875121           Root MSE      =  .06833

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1848404   .0236473     7.82   0.000     .1383074    .2313735
        logL |   1.084335   .1013791    10.70   0.000      .884842    1.283829
    lit_rate |  -.0057686   .0043047    -1.34   0.181    -.0142393    .0027021
     Health2 |   .0084105   .0120871     0.70   0.487    -.0153744    .0321955
trade_n_real |   4.78e-13   7.48e-14     6.39   0.000     3.31e-13    6.25e-13
listed_dom~p |   .0000602   .0000416     1.45   0.149    -.0000216     .000142
 _
       _cons |   5.224042   1.011626     5.16   0.000     3.233366    7.214719
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     8.64
         Prob > chi2  =   0.0033
```

SPECIFICATION (2.4)

```
xtreg logY_real logK_real logL lit_rate  lit_rate_t Health2 Health2_t
trade_n_rea
> l listed_dom_comp, fe

Fixed-effects (within) regression               Number of obs      =       377
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9193                         Obs per group: min =         5
       between = 0.6342                                        avg =      26.9
       overall = 0.9162                                        max =        64

                                                F(8,355)           =    505.70
corr(u_i, Xb)  = -0.0011                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .5433558   .0380795    14.27   0.000     .4684661    .6182456
        logL |   .3812284    .043912     8.68   0.000      .294868    .4675888
    lit_rate |   .0048449   .0025681     1.89   0.060    -.0002057    .0098954
  lit_rate_t |  -.0112317   .0018149    -6.19   0.000    -.0148011   -.0076623
     Health2 |    .105868   .0338899     3.12   0.002     .0392177    .1725182
```

```
   Health2_t |    .387154   .2012147     1.92   0.055    -.0085688    .7828768
trade_n_real |   2.62e-13   2.01e-13     1.31   0.193    -1.33e-13    6.57e-13
listed_dom~p |   .0001917   .0001497     1.28   0.201    -.0001028    .0004861
       _cons |    4.61846   .5365894     8.61   0.000     3.563167    5.673754
-------------+----------------------------------------------------------------
     sigma_u |  .12202986
     sigma_e |  .45371265
         rho |  .06745878   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 355) =     1.34            Prob > F = 0.1865

. est store fixed

. xtreg logY_real logK_real logL lit_rate  lit_rate_t Health2 Health2_t
trade_n_rea
> l listed_dom_comp, re

Random-effects GLS regression                   Number of obs      =       377
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9189                         Obs per group: min =         5
       between = 0.7058                                        avg =      26.9
       overall = 0.9167                                        max =        64

Random effects u_i ~ Gaussian                   Wald chi2(8)       =   1835.73
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .5415512   .0377629    14.34   0.000     .4675372    .6155651
        logL |   .3851469   .0437592     8.80   0.000     .2993804    .4709134
    lit_rate |    .005531   .0025486     2.17   0.030     .0005358    .0105262
  lit_rate_t |  -.0110062   .0017875    -6.16   0.000    -.0145097   -.0075027
     Health2 |   .0880268    .032282     2.73   0.006     .0247553    .1512984
   Health2_t |   .2894135   .1969039     1.47   0.142     -.096511     .675338
trade_n_real |   2.44e-13   2.00e-13     1.22   0.223    -1.49e-13    6.37e-13
listed_dom~p |   .0001414   .0001487     0.95   0.342    -.0001501    .0004329
       _cons |   4.568822   .5324632     8.58   0.000     3.525214    5.612431
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .45371265
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (7) does not equal the number
of
        coefficients being tested (8); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .5433558     .5415512        .0018047        .0049001
```

```
        logL |    .3812284     .3851469       -.0039185        .0036599
    lit_rate |    .0048449      .005531       -.0006861        .0003157
  lit_rate_t |   -.0112317    -.0110062       -.0002255        .0003143
     Health2 |     .105868     .0880268        .0178411        .0103151
   Health2_t |     .387154     .2894135        .0977405        .0414275
trade_n_real |    2.62e-13     2.44e-13        1.83e-14        1.63e-14
listed_dom~p |    .0001917     .0001414        .0000503        .0000174
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       14.18
                Prob>chi2 =      0.0481
                (V_b-V_B is not positive definite)
xtregar logY_real logK_real logL lit_rate  lit_rate_t Health2 Health2_t
trade_n_r
> eal listed_dom_comp, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       363
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9891                         Obs per group: min =         4
       between = 0.7611                                        avg =      25.9
       overall = 0.9050                                        max =        63

                                                F(8,341)           =   3874.13
corr(u_i, Xb)  = -0.0371                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7095302   .0297211    23.87   0.000     .6510704      .76799
        logL |   .4427138   .0420214    10.54   0.000     .3600601    .5253675
    lit_rate |   .0102592   .0025215     4.07   0.000     .0052995    .0152189
  lit_rate_t |  -.0117067   .0018139    -6.45   0.000    -.0152745   -.0081388
     Health2 |   .1299957   .0327665     3.97   0.000     .0655458    .1944455
   Health2_t |   .1178829   .2048449     0.58   0.565    -.2850358    .5208015
trade_n_real |  -6.61e-13   1.50e-13    -4.41   0.000    -9.56e-13   -3.66e-13
listed_dom~p |  -.0004998   .0001553    -3.22   0.001    -.0008053   -.0001944
       _cons |  -1.367242   .0843699   -16.21   0.000    -1.533193   -1.201291
-------------+----------------------------------------------------------------
      rho_ar |  .65897364
     sigma_u |  .13233433
     sigma_e |  .43984682
     rho_fov |  .08300585   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13,341) =    -0.10             Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate  lit_rate_t Health2 Health2_t
trade_n_r
> eal listed_dom_comp i.country, robust
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

Regression with robust standard errors                 Number of obs =     377
                                                       F( 68,   302) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.9985
                                                       Root MSE      =  .06691

------------------------------------------------------------------------------
```

logY_real	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
logK_real	.1968904	.0269327	7.31	0.000	.1438909	.24989
logL	1.127201	.13743	8.20	0.000	.856759	1.397642
lit_rate	-.0072979	.0046959	-1.55	0.121	-.0165388	.001943
lit_rate_t	.1881423	.0590562	3.19	0.002	.0719286	.304356
Health2	.0020768	.0115773	0.18	0.858	-.0207056	.0248592
Health2_t	.0477865	.0461048	1.04	0.301	-.0429408	.1385137
trade_n_real	5.07e-13	5.09e-14	9.97	0.000	4.07e-13	6.07e-13
listed_dom~p	.0000117	.0000455	0.26	0.798	-.0000778	.0001012
_cons	4.557073	1.44152	3.16	0.002	1.720378	7.393768

HEALTH 3

SPECIFICATION (3.1)

. xtreg logY_real logK_real logL lit_rate Health4, fe

```
Fixed-effects (within) regression               Number of obs      =       425
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8857                         Obs per group: min =         3
       between = 0.8390                                        avg =      30.4
       overall = 0.8813                                        max =        93

                                                F(4,407)           =    788.11
corr(u_i, Xb)  = -0.1527                        Prob > F           =    0.0000
```

logY_real	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logK_real	**.2830601**	.0428925	6.60	0.000	.1987417	.3673785
logL	**.696687**	.0465959	14.95	0.000	.6050883	.7882858
lit_rate	**-.0057209**	.0027107	-2.11	0.035	-.0110496	-.0003921
Health4	**.2578014**	.0285035	9.04	0.000	.201769	.3138338
_cons	**7.065502**	.5242256	13.48	0.000	6.034974	8.09603
sigma_u	.22483602					
sigma_e	.58283272					
rho	.12953711	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(13, 407) =     2.42            Prob > F = 0.0037
```

.xtreg logY_real logK_real logL lit_rate Health4, fe

```
Fixed-effects (within) regression               Number of obs      =       425
Group variable (i): country                     Number of groups   =        96

R-sq:  within  = 0.5133                         Obs per group: min =         1
       between = 0.8015                                        avg =       4.4
       overall = 0.7957                                        max =        13

                                                F(4,325)           =     85.69
corr(u_i, Xb)  = -0.1872                        Prob > F           =    0.0000
```

logY_real	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logK_real	.2610937	.030546	8.55	0.000	.2010008	.3211866
logL	.853716	.1487175	5.74	0.000	.5611456	1.146287
lit_rate	-.0065126	.0046294	-1.41	0.160	-.01562	.0025948

```
     Health4 |   .0268595   .0162315     1.65   0.099    -.0050726    .0587916
       _cons |   5.141076   1.909609     2.69   0.007      1.38432    8.897831
-------------+----------------------------------------------------------------
     sigma_u |   .8079611
     sigma_e |  .10452416
         rho |  .98353945   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(95, 325) =   140.09             Prob > F = 0.0000

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health4, re

Random-effects GLS regression                   Number of obs      =       425
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8847                         Obs per group: min =         3
       between = 0.8567                                        avg =      30.4
       overall = 0.8826                                        max =        93

Random effects u_i ~ Gaussian                   Wald chi2(4)       =   3156.70
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .252017   .0420023     6.00   0.000     .1696939    .3343401
        logL |   .7291325   .0459474    15.87   0.000     .6390773    .8191877
    lit_rate |  -.0066364    .002744    -2.42   0.016    -.0120145   -.0012583
     Health4 |   .2532776   .0286512     8.84   0.000     .1971223     .309433
       _cons |   7.420308   .5185111    14.31   0.000     6.404045    8.436571
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .58283272
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .2830601      .252017        .0310431        .0086929
        logL |     .696687     .7291325       -.0324455        .0077473
    lit_rate |   -.0057209    -.0066364        .0009155               .
     Health4 |    .2578014     .2532776        .0045238               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        9.03
                Prob>chi2 =      0.0603
                (V_b-V_B is not positive definite)

. xtregar logY_real logK_real logL lit_rate Health4, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       411
```

```
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9489                         Obs per group: min =         2
       between = 0.8327                                        avg =      29.4
       overall = 0.8526                                        max =        92

                                                F(4,393)           =   1825.77
corr(u_i, Xb)  = -0.2474                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .6956775   .0341769    20.36   0.000      .628485      .76287
        logL |   .4184287   .0455816     9.18   0.000     .3288144    .5080431
    lit_rate |   .0039834    .002638     1.51   0.132    -.0012028    .0091697
     Health4 |   .0175027     .02488     0.70   0.482    -.0314118    .0664172
       _cons |  -.1108935   .1439932    -0.77   0.442    -.3939868    .1721998
-------------+----------------------------------------------------------------
      rho_ar |  .67916066
     sigma_u |  .30306865
     sigma_e |  .65726888
     rho_fov |  .17533661   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13,393) =    -7.57            Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate Health4 i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     425
-------------+------------------------------           F( 99,   325) = 1169.50
       Model |  1264.93721    99  12.7771435           Prob > F      =  0.0000
    Residual |  3.55072276   325  .010925301           R-squared     =  0.9972
-------------+------------------------------           Adj R-squared =  0.9963
       Total |  1268.48793   424  2.99171681           Root MSE      =  .10452

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2610937    .030546     8.55   0.000     .2010008    .3211866
        logL |    .853716   .1487175     5.74   0.000     .5611456    1.146287
    lit_rate |  -.0065126   .0046294    -1.41   0.160      -.01562    .0025948
     Health4 |   .0268595   .0162315     1.65   0.099    -.0050726    .0587916
 _
       _cons |   4.825713   1.760585     2.74   0.006     1.362131    8.289294
------------------------------------------------------------------------------

.  hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real
         chi2(1)      =     6.29
         Prob > chi2  =   0.0121
```

SPECIFICATION (3.2)

```
xtreg logY_real logK_real logL lit_rate Health4 trade_n_real, fe

Fixed-effects (within) regression               Number of obs      =       414
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8991                         Obs per group: min =         3
       between = 0.8481                                        avg =      29.6
```

```
       overall = 0.8952                                         max =         92

                                                F(5,395)           =    703.82
corr(u_i, Xb)  = -0.1582                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2594821    .041462     6.26   0.000     .1779682    .3409959
        logL |   .6226619   .0457576    13.61   0.000     .5327029    .7126208
    lit_rate |  -.0045919   .0026169    -1.75   0.080    -.0097367     .000553
     Health4 |   .2267043   .0278141     8.15   0.000     .1720221    .2813865
trade_n_real |   1.87e-12   3.01e-13     6.20   0.000     1.28e-12    2.46e-12
       _cons |   8.555457   .5780096    14.80   0.000     7.419097    9.691817
-------------+----------------------------------------------------------------
     sigma_u |  .21431999
     sigma_e |   .5524853
         rho |  .13079892   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 395) =     2.46             Prob > F = 0.0032

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health4 trade_n_real, re

Random-effects GLS regression                   Number of obs      =       414
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8987                         Obs per group: min =         3
       between = 0.8574                                        avg =      29.6
       overall = 0.8962                                        max =        92

Random effects u_i ~ Gaussian                   Wald chi2(5)       =   1523.11
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2425085   .0408336     5.94   0.000     .1624762    .3225408
        logL |   .6401031   .0453314    14.12   0.000     .5512552     .728951
    lit_rate |  -.0051527   .0026337    -1.96   0.050    -.0103146    9.23e-06
     Health4 |   .2217366   .0278361     7.97   0.000     .1671789    .2762943
trade_n_real |   1.88e-12   3.03e-13     6.20   0.000     1.28e-12    2.47e-12
       _cons |   8.743644   .5763236    15.17   0.000     7.614071    9.873218
-------------+----------------------------------------------------------------
     sigma_u |  .06275033
     sigma_e |   .5524853
         rho |  .01273573   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (4) does not equal the number
of
        coefficients being tested (5); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.
```

```
                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .2594821     .2425085        .0169736        .0071916
        logL |    .6226619     .6401031       -.0174412        .0062309
    lit_rate |   -.0045919    -.0051527        .0005608               .
     Health4 |    .2267043     .2217366        .0049677               .
trade_n_real |    1.87e-12     1.88e-12       -1.20e-14               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                         =        4.74
               Prob>chi2 =      0.3145
               (V_b-V_B is not positive definite)
Random effect is more preferable.

. xtregar logY_real logK_real logL lit_rate Health4 trade_n_real, re

RE GLS regression with AR(1) disturbances       Number of obs      =       414
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8969                         Obs per group: min =         3
       between = 0.8435                                        avg =      29.6
       overall = 0.8921                                        max =        92

                                                Wald chi2(6)       =   1671.38
corr(u_i, Xb)      = 0 (assumed)                Prob > chi2        =    0.0000

------------------- theta --------------------
  min      5%       median        95%      max
0.0017   0.0046     0.0160     0.0168   0.0168

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3365764   .0374651     8.98   0.000     .2631461    .4100066
        logL |   .5693234   .0420878    13.53   0.000     .4868327     .651814
    lit_rate |  -.0037038    .002303    -1.61   0.108    -.0082176      .00081
     Health4 |    .191217   .0252571     7.57   0.000      .141714      .24072
trade_n_real |   1.17e-12   2.82e-13     4.14   0.000     6.14e-13    1.72e-12
       _cons |   7.350754   .5582308    13.17   0.000     6.256642    8.444866
-------------+----------------------------------------------------------------
      rho_ar |  .62485496   (estimated autocorrelation coefficient)
     sigma_u |  .02378435
     sigma_e |  .54482035
     rho_fov |  .00190217   (fraction of variance due to u_i)
------------------------------------------------------------------------------


. xi: reg logY_real logK_real logL lit_rate Health4 trade_n_real i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     414
-------------+------------------------------           F( 99,   314) = 1386.75
       Model |    1253.418    99  12.6607879           Prob > F      =  0.0000
    Residual |  2.86677091   314  .009129844           R-squared     =  0.9977
-------------+------------------------------           Adj R-squared =  0.9970
       Total |  1256.28477   413  3.04185175           Root MSE      =  .09555
```

```
------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2164128   .0285638     7.58   0.000     .1602121    .2726134
        logL |   .8275381   .1389414     5.96   0.000     .5541642    1.100912
    lit_rate |  -.0059909   .0042749    -1.40   0.162    -.0144019      .00242
     Health4 |   .0227176   .0149117     1.52   0.129    -.0066218     .052057
trade_n_real |   6.21e-13   1.08e-13     5.75   0.000     4.09e-13    8.34e-13
       _cons |   6.210222   1.651116     3.76   0.000     2.961572    9.458872
------------------------------------------------------------------------------
```

SPECIFICATION (3.3)

```
. xtreg logY_real logK_real logL lit_rate Health4 trade_n_real listed_dom_comp,
fe

Fixed-effects (within) regression               Number of obs      =       250
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8939                         Obs per group: min =         1
       between = 0.9519                                        avg =      17.9
       overall = 0.8844                                        max =        63

                                                F(6,230)           =    322.90
corr(u_i, Xb)  = 0.0588                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3039242   .0596471     5.10   0.000     .1863997    .4214488
        logL |    .559021   .0664425     8.41   0.000     .4281073    .6899347
    lit_rate |  -.0036707   .0036053    -1.02   0.310    -.0107744     .003433
     Health4 |   .1869534   .0438602     4.26   0.000     .1005342    .2733726
trade_n_real |   1.28e-12   3.43e-13     3.75   0.000     6.09e-13    1.96e-12
listed_dom~p |   .0006186   .0002187     2.83   0.005     .0001877    .0010495
       _cons |   8.386773   .8391087     9.99   0.000     6.733451     10.0401
-------------+----------------------------------------------------------------
     sigma_u |  .32312436
     sigma_e |  .52900128
         rho |  .27172124   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 230) =     2.35             Prob > F = 0.0058

. est store fixed
```

. xtreg logY_real logK_real logL lit_rate Health4 trade_n_real listed_dom_comp, re

```
Random-effects GLS regression                   Number of obs      =       250
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8933                         Obs per group: min =         1
       between = 0.9571                                        avg =      17.9
       overall = 0.8852                                        max =        63

Random effects u_i ~ Gaussian                   Wald chi2(6)       =    725.71
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3075167   .0590409     5.21   0.000     .1917986    .4232348
```

```
        logL |   .5654373   .0665772     8.49   0.000     .4349484    .6959262
    lit_rate |  -.0036252   .0036973    -0.98   0.327    -.0108718    .0036213
     Health4 |   .1556393   .0434301     3.58   0.000     .0705179    .2407608
trade_n_real |   1.30e-12   3.48e-13     3.74   0.000     6.21e-13    1.98e-12
listed_dom~p |   .0006163   .0002211     2.79   0.005     .0001829    .0010497
       _cons |   8.192264   .8415011     9.74   0.000     6.542952    9.841576
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .52900128
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (5) does not equal the number
of
        coefficients being tested (6); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .3039242     .3075167       -.0035924        .0084819
        logL |     .559021     .5654373       -.0064163               .
    lit_rate |   -.0036707    -.0036252       -.0000454               .
     Health4 |    .1869534     .1556393        .0313141        .0061275
trade_n_real |    1.28e-12     1.30e-12       -1.90e-14               .
listed_dom~p |    .0006186     .0006163        2.24e-06               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =   -89.89    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test
Random will be more preferable at this point.

.  xtregar  logY_real  logK_real  logL  lit_rate  Health4  trade_n_real
listed_dom_comp, r
> e

RE GLS regression with AR(1) disturbances       Number of obs      =       250
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8898                         Obs per group: min =         1
       between = 0.9503                                        avg =      17.9
       overall = 0.8811                                        max =        63

                                                Wald chi2(7)       =    875.31
corr(u_i, Xb)      = 0 (assumed)                Prob > chi2        =    0.0000

------------------- theta --------------------
```

```
  min      5%       median        95%      max
0.0000   0.0000     0.0000     0.0000   0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4205688   .0531809     7.91   0.000     .3163361    .5248015
        logL |   .4583808   .0612376     7.49   0.000     .3383573    .5784042
    lit_rate |  -.0022302   .0032599    -0.68   0.494    -.0086194     .004159
     Health4 |   .1115769   .0388434     2.87   0.004     .0354451    .1877087
trade_n_real |   6.09e-13   3.01e-13     2.02   0.043     1.89e-14    1.20e-12
listed_dom~p |   .0006923   .0002208     3.14   0.002     .0002596    .0011251
       _cons |   6.893492   .7686585     8.97   0.000     5.386949    8.400035
-------------+----------------------------------------------------------------
      rho_ar |  .74004531   (estimated autocorrelation coefficient)
     sigma_u |          0
     sigma_e |   .4784402
     rho_fov |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Checking for heteroskedasticity:
.  xi:  reg  logY_real  logK_real  logL  lit_rate  Health4  trade_n_real
listed_dom_comp i.
> country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     250
-------------+------------------------------           F( 71,   178) = 1830.98
       Model |  634.414145    71  8.93541049           Prob > F      =  0.0000
    Residual |  .868662771   178  .004880128           R-squared     =  0.9986
-------------+------------------------------           Adj R-squared =  0.9981
       Total |  635.282808   249  2.55133658           Root MSE      =  .06986

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1284241   .0321456     4.00   0.000     .0649886    .1918597
        logL |   .9003557   .1563332     5.76   0.000     .5918506    1.208861
    lit_rate |    .000965   .0060476     0.16   0.873    -.0109691    .0128991
     Health4 |   .0252084   .0200474     1.26   0.210    -.0143527    .0647694
trade_n_real |   5.73e-13   9.52e-14     6.02   0.000     3.85e-13    7.61e-13
listed_dom~p |   .0000392   .0000492     0.80   0.426    -.0000578    .0001363

       _cons |   7.415001   1.797256     4.13   0.000      3.86833    10.96167
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     6.81
         Prob > chi2  =   0.0091
```

SPECIFICATION (3.4)

```
xtreg  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health4  Health4_t
trade_n_real
>  listed_dom_comp, fe

Fixed-effects (within) regression              Number of obs      =       250
Group variable (i): year                       Number of groups   =        14

R-sq:  within  = 0.9278                        Obs per group: min =         1
```

```
       between = 0.9858                                         avg =       17.9
       overall = 0.9258                                         max =         63

                                                F(8,228)           =     366.43
corr(u_i, Xb)  = 0.0889                         Prob > F           =     0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4107209   .0504807     8.14   0.000     .3112526    .5101892
        logL |   .5203793   .0551585     9.43   0.000     .4116938    .6290649
    lit_rate |   .0037558   .0030736     1.22   0.223    -.0023005    .0098121
  lit_rate_t |  -.0166738   .0024314    -6.86   0.000    -.0214647   -.0118829
     Health4 |    .151061   .0366823     4.12   0.000     .0787813    .2233408
   Health4_t |    .863144   .2258249     3.82   0.000     .4181734    1.308115
trade_n_real |   7.79e-13   2.91e-13     2.68   0.008     2.06e-13    1.35e-12
listed_dom~p |   .0001289   .0001872     0.69   0.492    -.0002399    .0004978
       _cons |   5.928442   .7353055     8.06   0.000     4.479579    7.377305
-------------+----------------------------------------------------------------
     sigma_u |  .17408118
     sigma_e |  .43814733
         rho |  .13633534   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 228) =     1.28             Prob > F = 0.2263

. est store fixed

.  xtreg  logY_real  logK_real  logL  lit_rate  lit_rate_t  Health4  Health4_t
trade_n_real
>  listed_dom_comp, re

Random-effects GLS regression                   Number of obs      =       250
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.9276                         Obs per group: min =         1
       between = 0.9880                                        avg =      17.9
       overall = 0.9261                                        max =        63

Random effects u_i ~ Gaussian                   Wald chi2(8)       =   1250.66
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4271656   .0487016     8.77   0.000     .3317123    .5226189
        logL |   .5085159   .0539056     9.43   0.000     .4028629    .6141688
    lit_rate |   .0038158   .0030485     1.25   0.211    -.0021592    .0097907
  lit_rate_t |   -.016208   .0023852    -6.80   0.000    -.0208829   -.0115331
     Health4 |   .1517899   .0353824     4.29   0.000     .0824417    .2211382
   Health4_t |   .7561535   .2191975     3.45   0.001     .3265344    1.185773
trade_n_real |   7.73e-13   2.86e-13     2.70   0.007     2.12e-13    1.33e-12
listed_dom~p |   .0000633   .0001848     0.34   0.732    -.0002989    .0004254
       _cons |   5.712739   .7134001     8.01   0.000     4.314501    7.110978
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .43814733
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random
```

```
Note: the rank of the differenced variance matrix (7) does not equal the number
of
        coefficients being tested (8); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .4107209     .4271656       -.0164446        .0132837
        logL |    .5203793     .5085159        .0118635        .0116896
    lit_rate |    .0037558     .0038158        -.00006         .0003921
  lit_rate_t |   -.0166738     -.016208       -.0004658        .0004718
     Health4 |     .151061     .1517899       -.0007289        .0096787
   Health4_t |     .863144     .7561535        .1069905        .0543081
trade_n_real |    7.79e-13     7.73e-13        5.88e-15        5.18e-14
listed_dom~p |    .0001289     .0000633        .0000656        .0000301
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       11.07
                Prob>chi2 =      0.1355
                (V_b-V_B is not positive definite)
```

Fixed effect could not be rejected at 15 % s.l., along with the better results in probabilities, so fixed effect would be chosen in this model specification.

```
. xtregar logY_real logK_real logL lit_rate lit_rate_t Health4 Health4_t
trade_n_re
> al listed_dom_comp, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       236
Group variable (i): year                        Number of groups   =        13

R-sq:  within  = 0.9817                         Obs per group: min =         1
       between = 0.8828                                        avg =      18.2
       overall = 0.9090                                        max =        62

                                                F(8,215)           =   1437.80
corr(u_i, Xb)  = 0.0092                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7061512   .0392012    18.01   0.000     .6288832    .7834191
        logL |   .4212892   .0559008     7.54   0.000     .3111055     .531473
    lit_rate |   .0092481   .0029708     3.11   0.002     .0033924    .0151038
  lit_rate_t |  -.0166857   .0024912    -6.70   0.000     -.021596   -.0117753
     Health4 |   .0649358    .034316     1.89   0.060     -.002703    .1325746
   Health4_t |   .6531804   .2363879     2.76   0.006     .1872459    1.119115
trade_n_real |  -8.19e-13   2.40e-13    -3.41   0.001    -1.29e-12   -3.46e-13
listed_dom~p |  -.0005634   .0002089    -2.70   0.008    -.0009751   -.0001517
       _cons |  -.5871646   .1030652    -5.70   0.000    -.7903121   -.3840171
-------------+----------------------------------------------------------------
      rho_ar |  .78361656
     sigma_u |  .11580581
```

```
     sigma_e |  .43679663
     rho_fov |    .065675   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(12,215) =    -3.70             Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate lit_rate_t Health4 Health4_t
trade_n_re
> al listed_dom_comp i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     250
-------------+------------------------------           F( 73,   176) = 1849.54
       Model |  634.455765    73  8.69117486           Prob > F      =  0.0000
    Residual |  .827042807   176  .004699107           R-squared     =  0.9987
-------------+------------------------------           Adj R-squared =  0.9982
       Total |  635.282808   249  2.55133658           Root MSE      =  .06855

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .143185   .0320496     4.47   0.000     .0799341    .2064359
        logL |    .938087   .1539332     6.09   0.000     .6342945     1.24188
    lit_rate |   .0004935   .0059497     0.08   0.934    -.0112484    .0122354
  lit_rate_t |   .1195136   .0804151     1.49   0.139    -.0391883    .2782155
     Health4 |   .0086232    .020718     0.42   0.678    -.0322644    .0495108
   Health4_t |   .1467713   .0706718     2.08   0.039     .0072982    .2862444
trade_n_real |   6.14e-13   9.44e-14     6.50   0.000     4.28e-13    8.00e-13
listed_dom~p |  -5.08e-06   .0000525    -0.10   0.923    -.0001087    .0000986
 ............................................................................
       _cons |   6.597763    1.78492     3.70   0.000     3.075162    10.12036
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     2.33
         Prob > chi2  =   0.1269
```

SPECIFICATION (4.1)

. xtreg logY_real logK_real logL lit_rate Health5, fe

```
Fixed-effects (within) regression               Number of obs      =       301
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8610                         Obs per group: min =         1
       between = 0.7548                                        avg =      21.5
       overall = 0.8539                                        max =        64

                                                F(4,283)           =    438.24
corr(u_i, Xb)  = -0.1549                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .196325   .0569319     3.45   0.001     .0842614    .3083886
        logL |   .7995843   .0617437    12.95   0.000     .6780491    .9211195
    lit_rate |  -.0062873   .0041278    -1.52   0.129    -.0144125    .0018378
     Health5 |   .2393755   .0372869     6.42   0.000     .1659807    .3127703
```

```
       _cons |   7.790743   .7398063    10.53   0.000     6.334522    9.246964
-------------+----------------------------------------------------------------
     sigma_u |   .2233667
     sigma_e |  .64073495
         rho |  .10836013   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 283) =     1.58             Prob > F = 0.0895

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health5, re

Random-effects GLS regression                   Number of obs      =       301
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8593                         Obs per group: min =         1
       between = 0.8036                                        avg =      21.5
       overall = 0.8564                                        max =        64

Random effects u_i ~ Gaussian                   Wald chi2(4)       =   1764.67
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1664136   .0562134     2.96   0.003     .0562375    .2765898
        logL |   .8340141      .0607    13.74   0.000     .7150443    .9529838
    lit_rate |  -.0056543   .0041385    -1.37   0.172    -.0137657     .002457
     Health5 |   .2101373   .0357127     5.88   0.000     .1401416     .280133
       _cons |   7.949893   .7414878    10.72   0.000     6.496603    9.403182
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .64073495
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |     .196325     .1664136        .0299114        .0090164
        logL |    .7995843     .8340141       -.0344297        .0113049
    lit_rate |   -.0062873    -.0056543        -.000633               .
     Health5 |    .2393755     .2101373        .0292382        .0107197
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       10.07
                Prob>chi2 =      0.0392
                (V_b-V_B is not positive definite)

. xtregar logY_real logK_real logL lit_rate Health5, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       287
Group variable (i): year                        Number of groups   =        12
```

```
R-sq:  within  = 0.9486                         Obs per group: min =         1
       between = 0.7558                                        avg =      23.9
       overall = 0.8160                                        max =        63

                                                F(4,271)           =   1249.97
corr(u_i, Xb)  = -0.1865                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .6361601   .0466082    13.65   0.000        .5444    .7279203
        logL |   .5024626   .0595442     8.44   0.000     .3852346    .6196906
    lit_rate |   .0097732   .0038571     2.53   0.012     .0021796    .0173668
     Health5 |  -.0316701   .0327281    -0.97   0.334    -.0961038    .0327635
       _cons |  -1.140595    .131782    -8.66   0.000    -1.400042   -.8811485
-------------+----------------------------------------------------------------
      rho_ar |  .81735215
     sigma_u |  .28518364
     sigma_e |  .65601256
     rho_fov |  .15894575   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(11,271) =    -6.26              Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate Health5 i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     301
-------------+------------------------------           F( 90,   210) =  889.83
       Model |  865.345519    90  9.61495021           Prob > F      =  0.0000
    Residual |  2.26911776   210  .010805323           R-squared     =  0.9974
-------------+------------------------------           Adj R-squared =  0.9963
       Total |  867.614636   300  2.89204879           Root MSE      =  .10395

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .3790364   .0452261     8.38   0.000      .289881    .4681919
        logL |   .5529081   .2015702     2.74   0.007     .1555478    .9502685
    lit_rate |   .0083157   .0080548     1.03   0.303    -.0075629    .0241942
     Health5 |   .0229638   .0226945     1.01   0.313    -.0217744     .067702_
..............................................................................
      _cons |   5.166566   2.351393      2.20   0.029      .5312059    9.801926
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     5.07
         Prob > chi2  =   0.0244
```

SPECIFICATION (4.2)

```
. xtreg logY_real logK_real logL lit_rate Health5 trade_n_real, fe

Fixed-effects (within) regression               Number of obs      =       293
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8742                         Obs per group: min =         1
       between = 0.8089                                        avg =      20.9
```

```
       overall = 0.8691                                         max =         63

                                                F(5,274)           =    380.64
corr(u_i, Xb)  = -0.1555                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1854205   .0556104     3.33   0.001     .0759425    .2948985
        logL |   .7114467   .0628737    11.32   0.000     .5876699    .8352235
    lit_rate |  -.0025597   .0040646    -0.63   0.529    -.0105615     .005442
     Health5 |   .1848557   .0375616     4.92   0.000     .1109097    .2588018
trade_n_real |   1.64e-12   3.63e-13     4.53   0.000     9.27e-13    2.36e-12
       _cons |   8.942101   .8027652    11.14   0.000     7.361729    10.52247
-------------+----------------------------------------------------------------
     sigma_u |  .19526175
     sigma_e |   .6147578
         rho |  .09163985   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(13, 274) =     1.35            Prob > F = 0.1847

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health5 trade_n_real, re

Random-effects GLS regression                   Number of obs      =       293
Group variable (i): year                        Number of groups   =        14

R-sq:  within  = 0.8728                         Obs per group: min =         1
       between = 0.8448                                        avg =      20.9
       overall = 0.8710                                        max =        63

Random effects u_i ~ Gaussian                   Wald chi2(5)       =    785.58
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1644782   .0548086     3.00   0.003     .0570552    .2719011
        logL |   .7341624   .0618784    11.86   0.000     .6128829    .8554418
    lit_rate |  -.0016678   .0040487    -0.41   0.680    -.0096031    .0062676
     Health5 |   .1534041    .035706     4.30   0.000     .0834216    .2233866
trade_n_real |   1.67e-12   3.63e-13     4.60   0.000     9.59e-13    2.38e-12
       _cons |   9.025572   .8029195    11.24   0.000     7.451879    10.59927
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |   .6147578
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (4) does not equal the number
of
        coefficients being tested (5); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.
```

```
                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .1854205     .1644782        .0209424        .0094092
        logL |    .7114467     .7341624       -.0227157        .0111428
    lit_rate |   -.0025597    -.0016678       -.0008919        .0003587
     Health5 |    .1848557     .1534041        .0314516        .0116601
trade_n_real |    1.64e-12     1.67e-12       -2.95e-14               .
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        5.78
                Prob>chi2 =      0.2160
                (V_b-V_B is not positive definite)

. xtregar logY_real logK_real logL lit_rate Health5 trade_n_real, fe

FE (within) regression with AR(1) disturbances  Number of obs      =       279
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.9570                         Obs per group: min =         1
       between = 0.8124                                        avg =      23.3
       overall = 0.8219                                        max =        62

                                                F(5,262)           =   1167.28
corr(u_i, Xb)  = -0.1911                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .633331    .047357    13.37   0.000     .5400822    .7265799
        logL |   .5344876   .0648783     8.24   0.000     .4067384    .6622369
    lit_rate |   .0117737   .0038665     3.05   0.003     .0041603    .0193872
     Health5 |  -.0436443   .0351327    -1.24   0.215    -.1128227     .025534
trade_n_real |  -5.78e-13   3.57e-13    -1.62   0.107    -1.28e-12    1.25e-13
       _cons |  -2.043534   .1378423   -14.83   0.000    -2.314953   -1.772114
-------------+----------------------------------------------------------------
      rho_ar |  .79357178
     sigma_u |  .27769147
     sigma_e |  .64049318
     rho_fov |  .15823021   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(11,262) =    -5.67             Prob > F = 1.0000

. xi: reg logY_real logK_real logL lit_rate Health5 trade_n_real i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     293
-------------+------------------------------           F( 90,   202) = 1052.05
       Model |  852.251199    90  9.46945777           Prob > F      =  0.0000
    Residual |  1.81819985   202  .009000989           R-squared     =  0.9979
-------------+------------------------------           Adj R-squared =  0.9969
       Total |  854.069399   292   2.9248952           Root MSE      =  .09487

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2990674   .0433581     6.90   0.000     .2135749    .3845599
```

```
        logL |   .6127892   .1899498     3.23   0.001     .2382505    .9873278
    lit_rate |    .004665   .0074887     0.62   0.534     -.010101     .019431
     Health5 |   .0223609    .020844     1.07   0.285    -.0187388    .0634606
trade_n_real |   4.74e-13   1.17e-13     4.04   0.000     2.43e-13    7.05e-13
...............................................................................
       _cons |   6.488792   2.223303     2.92   0.004     2.104934    10.87265
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     4.91
         Prob > chi2  =   0.0267
```

SPECIFICATION (4.3)

```
. xtreg logY_real logK_real logL lit_rate Health5 trade_n_real listed_dom_comp,
fe

Fixed-effects (within) regression               Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.8747                         Obs per group: min =         1
       between = 0.7989                                        avg =      15.4
       overall = 0.8654                                        max =        44

                                                F(6,167)           =    194.24
corr(u_i, Xb)  = 0.0573                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1643164   .0832032     1.97   0.050     .0000508     .328582
        logL |   .7000006   .0972311     7.20   0.000       .50804    .8919613
    lit_rate |   .0023807   .0053044     0.45   0.654    -.0080916     .012853
     Health5 |   .1434642    .050042     2.87   0.005     .0446677    .2422607
trade_n_real |   1.14e-12   4.10e-13     2.78   0.006     3.29e-13    1.95e-12
listed_dom~p |   .0008484   .0002714     3.13   0.002     .0003126    .0013841
       _cons |   9.280612   1.133244     8.19   0.000     7.043282    11.51794
-------------+----------------------------------------------------------------
     sigma_u |  .23233935
     sigma_e |  .57175233
         rho |   .1417277   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(11, 167) =     1.73             Prob > F = 0.0703

. est store fixed

. xtreg logY_real logK_real logL lit_rate Health5 trade_n_real listed_dom_comp,
re

Random-effects GLS regression                   Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.8736                         Obs per group: min =         1
       between = 0.8249                                        avg =      15.4
       overall = 0.8668                                        max =        44

Random effects u_i ~ Gaussian                   Wald chi2(6)       =    416.53
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

```
------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1615207   .0833793     1.94   0.053    -.0018996    .3249411
        logL |   .7196796   .0971637     7.41   0.000     .5292423    .9101169
    lit_rate |    .002527   .0053272     0.47   0.635    -.0079141    .0129681
     Health5 |   .1143988    .048544     2.36   0.018     .0192542    .2095433
trade_n_real |   1.13e-12   4.10e-13     2.75   0.006     3.24e-13    1.93e-12
listed_dom~p |     .00078   .0002662     2.93   0.003     .0002583    .0013017
       _cons |   9.040647   1.138418     7.94   0.000     6.809389    11.27191
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .57175233
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (5) does not equal the number
of
        coefficients being tested (6); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .1643164     .1615207        .0027957               .
        logL |    .7000006     .7196796       -.0196789        .0036216
    lit_rate |    .0023807      .002527       -.0001462               .
     Health5 |    .1434642     .1143988        .0290655        .0121524
trade_n_real |    1.14e-12     1.13e-12        1.05e-14               .
listed_dom~p |    .0008484       .00078        .0000683        .0000528
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.09
                Prob>chi2 =      0.6867
                (V_b-V_B is not positive definite)
```

xtregar logY_real logK_real logL lit_rate Health5 trade_n_real listed_dom_comp, r
> e

```
RE GLS regression with AR(1) disturbances       Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.8698                         Obs per group: min =         1
       between = 0.8154                                        avg =      15.4
       overall = 0.8636                                        max =        44

                                                Wald chi2(7)       =    543.83
```

```
corr(u_i, Xb)      = 0 (assumed)              Prob > chi2        =    0.0000

------------------- theta --------------------
  min      5%       median        95%      max
0.0000   0.0000     0.0000     0.0000   0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2479885   .0719991     3.44   0.001     .1068729    .3891041
        logL |   .6329586   .0836464     7.57   0.000     .4690147    .7969025
    lit_rate |   .0024063   .0044826     0.54   0.591    -.0063794     .011192
     Health5 |   .0702979   .0416991     1.69   0.092    -.0114309    .1520267
trade_n_real |   6.24e-13   3.54e-13     1.76   0.078    -6.92e-14    1.32e-12
listed_dom~p |   .0009863   .0002818     3.50   0.000      .000434    .0015387
       _cons |   8.161152   .9685091     8.43   0.000     6.262909     10.0594
-------------+----------------------------------------------------------------
      rho_ar |  .85315724   (estimated autocorrelation coefficient)
     sigma_u |          0
     sigma_e |  .43775695
     rho_fov |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

xi:reg logY_real logK_real logL lit_rate Health5 trade_n_real listed_dom_comp
i.c
> ountry
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     185
-------------+------------------------------           F( 62,   122) = 1804.58
       Model |  456.171745    62  7.35760878           Prob > F      =  0.0000
    Residual |  .497417103   122  .004077189           R-squared     =  0.9989
-------------+------------------------------           Adj R-squared =  0.9984
       Total |  456.669162   184  2.48189762           Root MSE      =  .06385

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .077739   .0443812     1.75   0.082     -.010118    .1655959
        logL |   .7329656     .24467     3.00   0.003     .2486168    1.217314
    lit_rate |   .0235689   .0103255     2.28   0.024     .0031285    .0440092
     Health5 |   .0080754   .0218462     0.37   0.712    -.0351714    .0513222
trade_n_real |   5.22e-13   9.47e-14     5.51   0.000     3.35e-13    7.10e-13
listed_dom~p |  -7.81e-06   .0000466    -0.17   0.867    -.0001001    .0000844
 _...........................................................................
       _cons |   9.196266    2.86506     3.21   0.002     3.524593    14.86794
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =    12.22
         Prob > chi2  =   0.0005.
```

SPECIFICATION (4.4)

```
. xtreg logY_real logK_real logL lit_rate lit_rate_t Health5 Health5_t
trade_n_real
>  listed_dom_comp, fe
```

```
Fixed-effects (within) regression               Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.9208                         Obs per group: min =         1
       between = 0.9586                                        avg =      15.4
       overall = 0.9210                                        max =        44

                                                F(8,165)           =    239.83
corr(u_i, Xb)  = 0.0852                         Prob > F           =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2070035     .06707     3.09   0.002     .0745775    .3394296
        logL |   .7178344   .0786014     9.13   0.000     .5626401    .8730287
    lit_rate |   .0084853    .004314     1.97   0.051    -.0000325    .0170031
  lit_rate_t |  -.0124884   .0021585    -5.79   0.000    -.0167502   -.0082265
     Health5 |   .1890855   .0403819     4.68   0.000     .1093536    .2688173
   Health5_t |   .3485109   .1971724     1.77   0.079    -.0407952     .737817
trade_n_real |   4.30e-13   3.36e-13     1.28   0.202    -2.33e-13    1.09e-12
listed_dom~p |   .0002696   .0002258     1.19   0.234    -.0001762    .0007154
       _cons |   7.832877    .918993     8.52   0.000     6.018376    9.647379
-------------+----------------------------------------------------------------
     sigma_u |  .10349939
     sigma_e |  .45721574
         rho |  .04874501   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(11, 165) =     0.64             Prob > F = 0.7919

. est store fixed

. xtreg logY_real logK_real logL lit_rate lit_rate_t Health5 Health5_t
trade_n_real
>  listed_dom_comp, re

Random-effects GLS regression                   Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.9206                         Obs per group: min =         1
       between = 0.9651                                        avg =      15.4
       overall = 0.9212                                        max =        44

Random effects u_i ~ Gaussian                   Wald chi2(8)       =    818.07
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2170669   .0650605     3.34   0.001     .0895506    .3445831
        logL |   .7132855   .0760551     9.38   0.000     .5642204    .8623507
    lit_rate |   .0083082   .0041783     1.99   0.047      .000119    .0164975
  lit_rate_t |  -.0121623    .002055    -5.92   0.000      -.01619   -.0081346
     Health5 |   .1935083   .0383658     5.04   0.000     .1183128    .2687038
   Health5_t |   .2665207   .1835854     1.45   0.147    -.0933001    .6263415
trade_n_real |   4.04e-13   3.24e-13     1.25   0.213    -2.31e-13    1.04e-12
listed_dom~p |   .0002043   .0002154     0.95   0.343    -.0002177    .0006264
       _cons |   7.690472   .8898181     8.64   0.000      5.94646    9.434483
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .45721574
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. est store random

. hausman fixed random

Note: the rank of the differenced variance matrix (7) does not equal the number
of
        coefficients being tested (8); be sure this is what you expect, or
there
        may be problems computing the test.  Examine the output of your
estimators
        for anything unexpected and possibly consider scaling your variables so
        that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
   logK_real |    .2070035     .2170669       -.0100634        .0162946
        logL |    .7178344     .7132855        .0045488        .0198448
    lit_rate |    .0084853     .0083082        .0001771        .0010737
  lit_rate_t |   -.0124884    -.0121623       -.0003261        .0006605
     Health5 |    .1890855     .1935083       -.0044228        .0126002
   Health5_t |    .3485109     .2665207        .0819902        .0719259
trade_n_real |    4.30e-13     4.04e-13        2.65e-14        8.80e-14
listed_dom~p |    .0002696     .0002043        .0000653        .0000678
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.93
                Prob>chi2 =      0.7873

. xtregar logY_real logK_real logL lit_rate lit_rate_t Health5 Health5_t
trade_n_re
> al listed_dom_comp, re

RE GLS regression with AR(1) disturbances       Number of obs      =       185
Group variable (i): year                        Number of groups   =        12

R-sq:  within  = 0.9179                         Obs per group: min =         1
       between = 0.9553                                        avg =      15.4
       overall = 0.9183                                        max =        44

                                                Wald chi2(9)       =   1031.02
corr(u_i, Xb)      = 0 (assumed)                Prob > chi2        =    0.0000

------------------- theta --------------------
  min      5%       median        95%      max
0.0000   0.0000     0.0000     0.0000   0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |    .245984   .0574145     4.28   0.000     .1334537    .3585143
        logL |   .6899813   .0673354    10.25   0.000     .5580064    .8219561
    lit_rate |   .0104469   .0035404     2.95   0.003     .0035079     .017386
  lit_rate_t |  -.0098503    .001738    -5.67   0.000    -.0132567   -.0064439
     Health5 |   .1331372   .0328811     4.05   0.000     .0686914     .197583
   Health5_t |   .0907965   .1639746     0.55   0.580    -.2305879    .4121809
trade_n_real |   1.43e-13   2.75e-13     0.52   0.604    -3.97e-13    6.82e-13
```

```
listed_dom~p |    .000182   .0002371     0.77   0.443    -.0002827    .0006467
       _cons |   7.090843   .7517881     9.43   0.000     5.617365    8.564321
-------------+----------------------------------------------------------------
      rho_ar |  .90421987   (estimated autocorrelation coefficient)
     sigma_u |          0
     sigma_e |  .33684736
     rho_fov |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xi:reg logY_real logK_real logL lit_rate lit_rate_t Health5 Health5_t
trade_n_rea
> l listed_dom_comp i.country
i.country         _Icountry_1-135     (naturally coded; _Icountry_1 omitted)

      Source |       SS       df       MS              Number of obs =     185
-------------+------------------------------           F( 64,   120) = 1864.65
       Model |  456.210418    64  7.12828778           Prob > F      =  0.0000
    Residual |   .45874347   120  .003822862           R-squared     =  0.9990
-------------+------------------------------           Adj R-squared =  0.9985
       Total |  456.669162   184  2.48189762           Root MSE      =  .06183

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .1047621   .0443367     2.36   0.020     .0169784    .1925457
        logL |   .8890516   .2419667     3.67   0.000     .4099743    1.368129
    lit_rate |   .0211319   .0100776     2.10   0.038     .0011791    .0410848
  lit_rate_t |   .0964052   .0756714     1.27   0.205     -.053419    .2462294
     Health5 |  -.0200019   .0231776    -0.86   0.390    -.0658919    .0258881
   Health5_t |   .1465359   .0603248     2.43   0.017      .027097    .2659748
trade_n_real |   5.59e-13   9.25e-14     6.04   0.000     3.76e-13    7.42e-13
listed_dom~p |  -.0000528   .0000493    -1.07   0.286    -.0001503    .0000448
 .............................................................................
       _cons |  -4.391776   8.802352    -0.50   0.619    -21.81982    13.03627
------------------------------------------------------------------------------

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logY_real

         chi2(1)      =     3.37
         Prob > chi2  =   0.0665
```

IV ESTIOMATION OUTPUT

. . xtivreg logY_real logK_real logL (lit_rate lit_rate_t Health1 Health1_t trade_n
> _real listed_dom_comp=l.lit_rate l.lit_rate_t l.Health1 l.Health1_t l.trade_n_r
> eal l.listed_dom_comp), fe

```
Fixed-effects (within) IV regression         Number of obs      =         573
Group variable: country                      Number of groups   =          66

R-sq:  within  = 0.7635                      Obs per group: min =           2
       between = 0.0397                                     avg =         8.7
       overall = 0.0885                                     max =          12

                                             Wald chi2(8)       =  1.26e+07
corr(u_i, Xb)  = -0.9175                     Prob > chi2        =    0.0000
```

```
------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lit_rate |  -.0056105   .0026662    -2.10   0.035    -.0108361   -.0003849
  lit_rate_t |   .1129176   .0708227     1.59   0.111    -.0258924    .2517275
     Health1 |     .03288   .0147727     2.23   0.026      .003926     .061834
   Health1_t |   .0034788   .1254027     0.03   0.978    -.2423059    .2492635
trade_n_real |   6.31e-13   1.05e-13     5.99   0.000     4.25e-13    8.38e-13
listed_dom~p |     .00016   .0000626     2.56   0.011     .0000374    .0002826
   logK_real |   .1558408   .0173543     8.98   0.000      .121827    .1898545
        logL |   .8552711   .0706096    12.11   0.000     .7168788    .9936634
       _cons |   6.374027   1.363195     4.68   0.000     3.702215    9.045839
-------------+----------------------------------------------------------------
     sigma_u |  4.7321252
     sigma_e |  .06031813
         rho |  .99983755   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(65,499) =   344.63          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lit_rate lit_rate_t Health1 Health1_t trade_n_real
                listed_dom_comp
Instruments:    logK_real logL L.lit_rate L.lit_rate_t L.Health1 L.Health1_t
                L.trade_n_real L.listed_dom_comp

. xtivreg logY_real logK_real logL (lit_rate lit_rate_t Health1 Health1_t
trade_n
> _real listed_dom_comp=l.lit_rate l.lit_rate_t l.Health1 l.Health1_t
l.trade_n_r
> eal l.listed_dom_comp), re

G2SLS random-effects IV regression              Number of obs      =       573
Group variable: country                         Number of groups   =        66

R-sq:  within  = 0.7539                         Obs per group: min =         2
       between = 0.8492                                        avg =       8.7
       overall = 0.8611                                        max =        12

                                                Wald chi2(8)       =   1258.94
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lit_rate |   .0016808   .0017295     0.97   0.331     -.001709    .0050705
  lit_rate_t |  -.0051023   .0021404    -2.38   0.017    -.0092975   -.0009072
     Health1 |   .0414116   .0146753     2.82   0.005     .0126484    .0701747
   Health1_t |   .1065414    .136731     0.78   0.436    -.1614464    .3745291
trade_n_real |   6.01e-13   1.11e-13     5.41   0.000     3.83e-13    8.19e-13
listed_dom~p |   .0001683   .0000622     2.71   0.007     .0000464    .0002902
   logK_real |   .1760102   .0181096     9.72   0.000     .1405161    .2115044
        logL |   .6650815   .0333936    19.92   0.000     .5996312    .7305317
       _cons |   9.581085   .4834232    19.82   0.000     8.633593    10.52858
-------------+----------------------------------------------------------------
     sigma_u |  .41050738
     sigma_e |  .06001819
         rho |  .97907149   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Instrumented:   lit_rate lit_rate_t Health1 Health1_t trade_n_real
                listed_dom_comp
Instruments:    logK_real logL L.lit_rate L.lit_rate_t L.Health1 L.Health1_t
                L.trade_n_real L.listed_dom_comp

.
```

```
. . xtivreg logY_real logK_real logL (lit_rate lit_rate_t Health2 Health2_t
trade_n
> _real listed_dom_comp=l.lit_rate l.lit_rate_t l.Health2 l.Health2_t
l.trade_n_r
> eal l.listed_dom_comp), fe

Fixed-effects (within) IV regression         Number of obs      =        256
Group variable: country                      Number of groups   =         40

R-sq:  within  = 0.7811                      Obs per group: min =          1
       between = 0.0002                                     avg =        6.4
       overall = 0.0007                                     max =         12

                                             Wald chi2(8)       =   4.82e+06
corr(u_i, Xb)  = -0.9902                     Prob > chi2        =     0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lit_rate |   -.001393   .0063911    -0.22   0.827    -.0139194    .0111333
  lit_rate_t |   .2542259   .0876547     2.90   0.004     .0824259    .4260259
     Health2 |   -.088049   .0512999    -1.72   0.086    -.1885949     .012497
   Health2_t |   .1147141   .1138554     1.01   0.314    -.1084383    .3378666
trade_n_real |   6.52e-13   1.27e-13     5.13   0.000     4.03e-13    9.01e-13
listed_dom~p |  -.0000939   .0000835    -1.12   0.261    -.0002576    .0000697
   logK_real |     .21192   .0338505     6.26   0.000     .1455741    .2782658
        logL |   1.456362   .2145398     6.79   0.000     1.035872    1.876852
       _cons |  -9.582737   4.245322    -2.26   0.024    -17.90342   -1.262058
-------------+----------------------------------------------------------------
     sigma_u |  12.444054
     sigma_e |  .05972283
         rho |  .99997697   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(39,208) =   353.47         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lit_rate lit_rate_t Health2 Health2_t trade_n_real
                listed_dom_comp
Instruments:    logK_real logL L.lit_rate L.lit_rate_t L.Health2 L.Health2_t
                L.trade_n_real L.listed_dom_comp

. . xtivreg logY_real logK_real logL (lit_rate lit_rate_t Health4 Health4_t
trade_n
> _real listed_dom_comp=l.lit_rate l.lit_rate_t l.Health4 l.Health4_t
l.trade_n_r
> eal l.listed_dom_comp), fe

Fixed-effects (within) IV regression         Number of obs      =        121
Group variable: country                      Number of groups   =         20

R-sq:  within  =      .                      Obs per group: min =          1
       between = 0.2094                                     avg =        6.0
       overall = 0.2312                                     max =         12

                                             Wald chi2(8)       = 468014.49
corr(u_i, Xb)  = -0.9933                     Prob > chi2        =     0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lit_rate |    .036172   .0288186     1.26   0.209    -.0203114    .0926554
  lit_rate_t |  -.2702018   .6493501    -0.42   0.677    -1.542905    1.002501
     Health4 |  -.4168186   .2991662    -1.39   0.164    -1.003174    .1695364
```

```
   Health4_t |    .803844    .662692     1.21   0.225    -.4950084    2.102696
trade_n_real |   2.09e-12   1.02e-12     2.04   0.042     8.02e-14    4.10e-12
listed_dom~p |   .0001644   .0004722     0.35   0.728    -.0007612    .0010899
   logK_real |  -.0832367   .1615959    -0.52   0.606    -.3999587    .2334854
        logL |   1.693536   .7663299     2.21   0.027     .1915568    3.195515
       _cons |   8.699445   29.98834     0.29   0.772    -50.07661     67.4755
-------------+----------------------------------------------------------------
     sigma_u |  12.934226
     sigma_e |  .09560835
         rho |  .99994536   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(19,93) =    75.18          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lit_rate lit_rate_t Health4 Health4_t trade_n_real
                listed_dom_comp
Instruments:    logK_real logL L.lit_rate L.lit_rate_t L.Health4 L.Health4_t
                L.trade_n_real L.listed_dom_comp
```

. . xtivreg logY_real logK_real logL (lit_rate lit_rate_t Health5 Health5_t trade_n
> _real listed_dom_comp=l.lit_rate l.lit_rate_t l.Health5 l.Health5_t l.trade_n_r
> eal l.listed_dom_comp), fe

```
Fixed-effects (within) IV regression         Number of obs      =        97
Group variable: country                      Number of groups   =        19

R-sq:  within  =      .                      Obs per group: min =         1
       between = 0.4231                                     avg =       5.1
       overall = 0.4758                                     max =        10

                                             Wald chi2(8)       =  63526.90
corr(u_i, Xb)  = -0.9983                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lit_rate |   .0017493   .0705717     0.02   0.980    -.1365686    .1400672
  lit_rate_t |  -.3772936   1.490985    -0.25   0.800    -3.299571    2.544983
     Health5 |  -1.156268   2.379902    -0.49   0.627    -5.820791    3.508255
   Health5_t |   1.488202   2.884759     0.52   0.606    -4.165823    7.142227
trade_n_real |   3.23e-12   4.41e-12     0.73   0.465    -5.42e-12    1.19e-11
listed_dom~p |    .000368    .001292     0.28   0.776    -.0021643    .0029003
   logK_real |   -.066652   .3550389    -0.19   0.851    -.7625153    .6292114
        logL |   5.737047   10.44436     0.55   0.583    -14.73353    26.20762
       _cons |  -43.33777   127.5982    -0.34   0.734    -293.4256      206.75
-------------+----------------------------------------------------------------
     sigma_u |  20.677055
     sigma_e |  .22073419
         rho |  .99988605   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(18,70) =    12.52          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lit_rate lit_rate_t Health5 Health5_t trade_n_real
                listed_dom_comp
Instruments:    logK_real logL L.lit_rate L.lit_rate_t L.Health5 L.Health5_t
                L.trade_n_real L.listed_dom_comp


. xtivreg logY_real logK_real logL lit_rate lit_rate_t trade_n_real listed_dom_co
> mp (Health1 Health1_t = l.Health1  l.Health1_t), fe
```

```
Fixed-effects (within) IV regression         Number of obs      =       613
Group variable: country                      Number of groups   =        69

R-sq:  within  = 0.7575                      Obs per group: min =         1
       between = 0.0126                                     avg =       8.9
       overall = 0.0254                                     max =        12

                                             Wald chi2(8)       =  2.03e+07
corr(u_i, Xb)  = -0.9618                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health1 |   .0288384   .0146743     1.97   0.049     .0000774    .0575994
   Health1_t |   .2220278   .1321388     1.68   0.093    -.0369596    .4810152
  logK_real |   .1591376   .0164042     9.70   0.000      .126986    .1912892
        logL |     .84121   .0687431    12.24   0.000      .706476    .9759439
    lit_rate |   -.002985   .0025293    -1.18   0.238    -.0079422    .0019723
  lit_rate_t |   .1598891   .0566296     2.82   0.005     .0488971     .270881
trade_n_real |   5.27e-13   7.07e-14     7.46   0.000     3.88e-13    6.65e-13
listed_dom~p |   .0000891   .0000385     2.31   0.021     .0000136    .0001646
       _cons |   5.437993   1.269552     4.28   0.000     2.949716    7.926269
-------------+----------------------------------------------------------------
     sigma_u |  6.7938648
     sigma_e |   .0622949
         rho |  .99991593   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(68,536) =   369.78          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   Health1 Health1_t
Instruments:    logK_real logL lit_rate lit_rate_t trade_n_real listed_dom_comp
                L.Health1 L.Health1_t
. xtivreg logY_real logK_real logL lit_rate trade_n_real listed_dom_comp
(Health2
>  Health2_t = l.Health2 l. Health2_t),fe

Fixed-effects (within) IV regression         Number of obs      =       275
Group variable: country                      Number of groups   =        40

R-sq:  within  = 0.7524                      Obs per group: min =         1
       between = 0.8260                                     avg =       6.9
       overall = 0.8404                                     max =        12

                                             Wald chi2(7)       =  6.26e+06
corr(u_i, Xb)  = -0.7008                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health2 |   .0197119   .0533152     0.37   0.712     -.084784    .1242078
   Health2_t |    .067008    .067875     0.99   0.324    -.0660245    .2000405
   logK_real |   .1758371   .0337498     5.21   0.000     .1096888    .2419854
        logL |   1.173279   .2034569     5.77   0.000     .7745106    1.572047
    lit_rate |   .0011318   .0058068     0.19   0.845    -.0102493     .012513
trade_n_real |   3.77e-13   1.02e-13     3.68   0.000     1.76e-13    5.77e-13
listed_dom~p |  -8.47e-06   .0000435    -0.19   0.846    -.0000937    .0000768
       _cons |   2.049792   2.797056     0.73   0.464    -3.432337    7.531921
-------------+----------------------------------------------------------------
     sigma_u |  1.0060199
     sigma_e |  .06384632
         rho |  .99598844   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(39,228) =   434.10          Prob > F    = 0.0000
```

```
------------------------------------------------------------------------------
Instrumented:   Health2 Health2_t
Instruments:    logK_real logL lit_rate trade_n_real listed_dom_comp L.Health2
                Health2_t

.
. xtivreg logY_real logK_real logL lit_rate trade_n_real listed_dom_comp
(Health4
>  Health4_t = l.Health4 l. Health4_t),fe

Fixed-effects (within) IV regression         Number of obs      =       133
Group variable: country                      Number of groups   =        21

R-sq:  within  = 0.5335                      Obs per group: min =         1
       between = 0.8177                                     avg =       6.3
       overall = 0.8698                                     max =        12

                                             Wald chi2(7)       =  1.62e+06
corr(u_i, Xb)  = -0.3781                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health4 |   .1734932   .1807205     0.96   0.337    -.1807126    .5276989
   Health4_t |   .0014025   .1818197     0.01   0.994    -.3549576    .3577625
   logK_real |   .0756229   .0780127     0.97   0.332    -.0772791     .228525
        logL |   1.210065   .4151123     2.92   0.004     .3964594    2.02367
    lit_rate |  -.0027465   .0154926    -0.18   0.859    -.0331114    .0276183
trade_n_real |   2.21e-13   4.24e-13     0.52   0.602    -6.10e-13    1.05e-12
listed_dom~p |  -.0000722   .0000533    -1.36   0.175    -.0001766    .0000322
       _cons |   4.433817   5.333996     0.83   0.406    -6.020623    14.88826
-------------+----------------------------------------------------------------
     sigma_u |  .80810277
     sigma_e |  .06626612
         rho |  .99332057   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(20,105) =   239.14          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   Health4 Health4_t
Instruments:    logK_real logL lit_rate trade_n_real listed_dom_comp L.Health4
                Health4_t


. xtivreg logY_real logK_real logL lit_rate lit_rate_t trade_n_real
listed_dom_co
> mp (Health2 Health2_t = l.Health2  l.Health2_t), fe

Fixed-effects (within) IV regression         Number of obs      =       275
Group variable: country                      Number of groups   =        40

R-sq:  within  = 0.7165                      Obs per group: min =         1
       between = 0.0001                                     avg =       6.9
       overall = 0.0007                                     max =        12

                                             Wald chi2(8)       =  5.45e+06
corr(u_i, Xb)  = -0.9867                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health2 |  -.0405764   .0553147    -0.73   0.463    -.1489912    .0678384
   Health2_t |   .4301945   .1414608     3.04   0.002     .1529363    .7074526
   logK_real |   .2266902   .0377098     6.01   0.000     .1527804       .3006
```

```
        logL |   1.336102   .2180381     6.13   0.000     .9087552    1.763449
    lit_rate |     -.0022   .0063077    -0.35   0.727    -.0145628    .0101628
  lit_rate_t |   .2067395   .0721922     2.86   0.004     .0652454    .3482336
trade_n_real |   3.76e-13   1.13e-13     3.34   0.001     1.55e-13    5.96e-13
listed_dom~p |  -.0000756   .0000495    -1.53   0.126    -.0001725    .0000213
       _cons |   -7.46369   3.909466    -1.91   0.056     -15.1261    .1987219
-------------+----------------------------------------------------------------
     sigma_u |  10.333776
     sigma_e |  .06847752
         rho |  .99995609   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(39,227) =   324.53         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   Health2 Health2_t
Instruments:    logK_real logL lit_rate lit_rate_t trade_n_real listed_dom_comp
                L.Health2 L.Health2_t

. xtivreg logY_real logK_real logL lit_rate lit_rate_t trade_n_real
listed_dom_co
> mp (Health4 Health4_t = l.Health4  l.Health4_t), fe

Fixed-effects (within) IV regression        Number of obs      =         133
Group variable: country                     Number of groups   =          21

R-sq:  within  = 0.5036                     Obs per group: min =           1
       between = 0.3231                                    avg =         6.3
       overall = 0.3327                                    max =          12

                                            Wald chi2(8)       =  1.51e+06
corr(u_i, Xb)  = -0.7805                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health4 |  -.1139511   .1571082    -0.73   0.468    -.4218776    .1939754
   Health4_t |   .6263482   .1923788     3.26   0.001     .2492926    1.003404
   logK_real |   .0806289   .0859479     0.94   0.348    -.0878259    .2490836
        logL |   1.491152   .4089982     3.65   0.000     .6895298    2.292773
    lit_rate |   .0125734   .0154147     0.82   0.415    -.0176388    .0427856
  lit_rate_t |   .0288157    .120039     0.24   0.810    -.2064565    .2640879
trade_n_real |   7.90e-13   3.91e-13     2.02   0.043     2.43e-14    1.56e-12
listed_dom~p |  -.0001061   .0000617    -1.72   0.086     -.000227    .0000149
       _cons |  -2.855979   7.153094    -0.40   0.690    -16.87579    11.16383
-------------+----------------------------------------------------------------
     sigma_u |  2.4260146
     sigma_e |  .06868367
         rho |  .99919911   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(20,104) =   172.12         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   Health4 Health4_t
Instruments:    logK_real logL lit_rate lit_rate_t trade_n_real listed_dom_comp
                L.Health4 L.Health4_t

. xtivreg logY_real logK_real logL lit_rate lit_rate_t trade_n_real
listed_dom_co
> mp (Health5 Health5_t = l.Health5  l.Health5_t), fe

Fixed-effects (within) IV regression        Number of obs      =         108
Group variable: country                     Number of groups   =          20

R-sq:  within  = 0.0764                     Obs per group: min =           1
       between = 0.3563                                    avg =         5.4
```

```
      overall = 0.3675                                        max =           10

                                             Wald chi2(8)       = 859448.64
corr(u_i, Xb)  = -0.7628                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     Health5 |  -.2202045   .8895686    -0.25   0.804    -1.963727    1.523318
   Health5_t |   .6009778   .9397467     0.64   0.522    -1.240892    2.442847
   logK_real |   .0778554   .1122452     0.69   0.488    -.1421412     .297852
        logL |   1.625782   3.662652     0.44   0.657    -5.552885    8.804448
    lit_rate |    .012585   .0238663     0.53   0.598    -.0341921    .0593621
  lit_rate_t |   .0273895   .1397365     0.20   0.845     -.246489    .3012679
trade_n_real |   1.12e-12   1.52e-12     0.74   0.459    -1.85e-12    4.10e-12
listed_dom~p |  -.0000993   .0000753    -1.32   0.188    -.0002469    .0000484
       _cons |  -5.203495   54.24874    -0.10   0.924    -111.5291    101.1221
-------------+----------------------------------------------------------------
     sigma_u |   2.237777
     sigma_e |   .0777124
         rho |  .99879545   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(19,80) =   113.80           Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   Health5 Health5_t
Instruments:    logK_real logL lit_rate lit_rate_t trade_n_real listed_dom_comp
                L.Health5 L.Health5_t
```

FRONTIER ESTIMATION

```
. xtfrontier  logY_real logK_real logL lit_rate, tvd i(country) t(year)
iterate(20
> )

Time-varying decay inefficiency model           Number of obs      =      1368
Group variable (i): country                     Number of groups   =        99

Time variable (t): year                         Obs per group: min =         1
                                                               avg =      13.8
                                                               max =        15

                                                Wald chi2(3)       =   7469.62
Log likelihood  = -226.22037                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .7526089   .0125226    60.10   0.000     .7280651    .7771528
        logL |   .1607604   .0251834     6.38   0.000     .1114019     .210119
    lit_rate |  -.0011088   .0013869    -0.80   0.424    -.0038271    .0016095
       _cons |   3.601787   .3128495    11.51   0.000     2.988613    4.214961
-------------+----------------------------------------------------------------
         /mu |  -3.960116   7.108935    -0.56   0.577    -17.89337     9.97314
        /eta |  -.0107699   .0021929    -4.91   0.000    -.0150678   -.0064719
   /lnsigma2 |   1.244525   1.337789     0.93   0.352    -1.377493    3.866542
  /ilgtgamma |   4.001878   1.360913     2.94   0.003     1.334537    6.669219
-------------+----------------------------------------------------------------
      sigma2 |   3.471285   4.643845                      .2522102    47.77689
       gamma |   .9820469   .0239939                      .7915901    .9987322
    sigma_u2 |   3.408965   4.643727                     -5.692574     12.5105
    sigma_v2 |   .0623202   .0024838                      .0574521    .0671883
------------------------------------------------------------------------------
```

```
. predict te0, te
(793 missing values generated)

. xtfrontier  logY_real logK_real logL lit_rate Health1, tvd i(country) t(year)
it
> erate(20)


Time-varying decay inefficiency model           Number of obs      =      1162
Group variable (i): country                     Number of groups   =        98

Time variable (t): year                         Obs per group: min =         1
                                                               avg =      11.9
                                                               max =        13

                                                Wald chi2(4)       =   1462.86
Log likelihood  =  766.53475                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2796857   .0144331    19.38   0.000     .2513972    .3079741
        logL |   .6800843   .0393957    17.26   0.000     .6028701    .7572984
    lit_rate |   .0007268   .0017136     0.42   0.671    -.0026318    .0040855
     Health1 |   .0176797   .0058691     3.01   0.003     .0061764     .029183
       _cons |   8.042952   .6070782    13.25   0.000     6.853101    9.232803
-------------+----------------------------------------------------------------
         /mu |   1.410736   .1259636    11.20   0.000     1.163852     1.65762
        /eta |  -.0007426   .0008827    -0.84   0.400    -.0024726    .0009873
   /lnsigma2 |  -.6335874   .1891424    -3.35   0.001      -1.0043   -.2628751
  /ilgtgamma |   4.037351   .1986649    20.32   0.000     3.647975    4.426727
-------------+----------------------------------------------------------------
      sigma2 |   .5306846    .100375                      .3663011    .7688379
       gamma |   .9826618   .0033848                      .9746173    .9881877
    sigma_u2 |   .5214835   .1003864                      .3247298    .7182371
    sigma_v2 |   .0092011   .0004011                      .0084151    .0099872
------------------------------------------------------------------------------

. predict te1, te
(999 missing values generated)

. xtfrontier  logY_real logK_real logL lit_rate Health2, tvd i(country) t(year)
it
> erate(20)

convergence not achieved

Time-varying decay inefficiency model           Number of obs      =       589
Group variable (i): country                     Number of groups   =        97

Time variable (t): year                         Obs per group: min =         1
                                                               avg =       6.1
                                                               max =        13

                                                Wald chi2(4)       = 538765.67
Log likelihood  = -10542.368                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4485952   .0044543   100.71   0.000      .439865    .4573254
        logL |   .6442638   .0050337   127.99   0.000     .6343979    .6541297
    lit_rate |  -.0238443   .0003732   -63.90   0.000    -.0245756   -.0231129
```

```
     Health2 |  -.0682521   .0015237   -44.79   0.000    -.0712386   -.0652657
       _cons |   5.487912    .054595   100.52   0.000     5.380907    5.594916
-------------+----------------------------------------------------------------
         /mu |  -1.224656   .2636153    -4.65   0.000    -1.741333     -.70798
        /eta |   .0210759   .0002785    75.67   0.000     .0205301    .0216218
   /lnsigma2 |   .2221243          .        .       .            .           .
  /ilgtgamma |   8.494355          .        .       .            .           .
-------------+----------------------------------------------------------------
      sigma2 |   1.248727          .                               .           .
       gamma |   .9997954          .                               .           .
    sigma_u2 |   1.248471          .                               .           .
    sigma_v2 |   .0002555          .                               .           .
------------------------------------------------------------------------------

. predict te2, te
(1786 missing values generated)

. xtfrontier  logY_real logK_real logL lit_rate Health4, tvd i(country) t(year)
it
> erate(20)

Time-varying decay inefficiency model           Number of obs      =       425
Group variable (i): country                     Number of groups   =        96

Time variable (t): year                         Obs per group: min =         1
                                                               avg =       4.4
                                                               max =        13

                                                Wald chi2(4)       =   1200.29
Log likelihood  =  127.31666                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .2854082   .0289474     9.86   0.000     .2286722    .3421441
        logL |   .6682787    .044282    15.09   0.000     .5814875    .7550698
    lit_rate |    .004885   .0022776     2.14   0.032      .000421    .0093489
     Health4 |   .0568743   .0156519     3.63   0.000     .0261971    .0875516
       _cons |    7.63533   .6315087    12.09   0.000     6.397596    8.873064
-------------+----------------------------------------------------------------
         /mu |   1.208869   .1188538    10.17   0.000     .9759198    1.441818
        /eta |  -.0050471   .0017134    -2.95   0.003    -.0084053   -.0016889
   /lnsigma2 |  -.8599736   .1881193    -4.57   0.000    -1.228681   -.4912666
  /ilgtgamma |   3.623285   .2109947    17.17   0.000     3.209743    4.036827
-------------+----------------------------------------------------------------
      sigma2 |   .4231733    .079607                      .2926785    .6118509
       gamma |   .9739992   .0053434                      .9611993    .9826528
    sigma_u2 |   .4121704   .0796298                      .2560988     .568242
    sigma_v2 |   .0110028   .0008683                      .0093011    .0127046
------------------------------------------------------------------------------

. predict te3,te
(1736 missing values generated)

. xtfrontier  logY_real logK_real logL lit_rate Health5, tvd i(country) t(year)
it
> erate(20)


Time-varying decay inefficiency model           Number of obs      =       301
Group variable (i): country                     Number of groups   =        87

Time variable (t): year                         Obs per group: min =         1
```

```
                                                     avg =        3.5
                                                     max =         13

                                                Wald chi2(4)       =    1391.77
Log likelihood  =  70.179519                    Prob > chi2        =     0.0000

------------------------------------------------------------------------------
   logY_real |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   logK_real |   .4237905   .0427595     9.91   0.000     .3399834    .5075976
        logL |   .5409519   .0579009     9.34   0.000     .4274683    .6544356
    lit_rate |   .0033438   .0032824     1.02   0.308    -.0030896    .0097773
     Health5 |   .0567774   .0225187     2.52   0.012     .0126416    .1009133
       _cons |   6.019432   .6517599     9.24   0.000     4.742006    7.296858
-------------+----------------------------------------------------------------
         /mu |   .6946064    .288272     2.41   0.016     .1296037    1.259609
        /eta |  -.0022903    .002598    -0.88   0.378    -.0073824    .0028017
  /lnsigma2 |   -.548473   .3424799    -1.60   0.109    -1.219721    .1227752
 /ilgtgamma |   3.962494   .3510204    11.29   0.000     3.274507    4.650482
-------------+----------------------------------------------------------------
      sigma2 |   .5778315   .1978957                      .2953125     1.13063
       gamma |   .9813392   .0064281                      .9635438    .9905335
    sigma_u2 |   .5670487   .1977662                      .1794341    .9546632
    sigma_v2 |   .0107828    .001066                      .0086935    .0128721
------------------------------------------------------------------------------

. predict te4,te
(1860 missing values generated)

. sum te*

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         te0 |      1368    .6131948    .2258853   .0220008   .9717745
         te1 |      1162    .2952289    .1906515   .0356164   .9666941
         te2 |       375     .488863     .271127   .0282066   .9972136
         te3 |       425    .3664094    .2056599   .0353162   .9612878
         te4 |       301    .4390954    .2261963   .0312448   .9626191
```