Paths to Success: The Relationship Between Human Development and Economic Growth[1]

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Comments Welcome

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ABSTRACT

There is growing agreement in the economic development literature that human development (HD) is the basic objective of economic activity with economic growth (EG) as the necessary instrument. However, the precise form of how an economy should attain this objective remains imprecise. In this paper we argue that a large barrier to more precise development policy along these lines requires a more complete description of the inter-linkages between HD and EG. We first show that while the usual view that EG must precede HD has come up in endogenous growth theoretic models, its empirical importance has never been completely documented. Furthermore, the *necessity* of strong HD as a precursor to *sustained* growth implies that the uni-directional view of EG as causal to HD is mis-specified. The principal focus of the paper is in constructing an empirical strategy that allows substantial heterogeneity in preference and technology parameters across countries. We use country-specific time paths to summarize the overall 'chains' linking EG to HD and HD to EG. We find that, while the use of only one set of these reduced form parameters captures the sample paths of the joint (HD, EG) process rather poorly, the two indices used in tandem predicts the cross-country sample paths remarkably well.

1 Introduction

The ultimate goal of what is broadly termed 'economic development' has long been recognized to be the overall well-being and utility of a country's population. Economists studying development have, however, often focused their studies on the economic growth of countries. However, this focus implies that it is economic growth (EG) rather than human development (HD) that is the ultimate goal of development, perhaps reflecting that EG is viewed as necessary to produce the final goal of HD. In addition, the choice of *how* to allocate the proceeds of EG to HD tends to involve both the preferences of a given country as well as its current state of development. Such decisions are difficult to render unless a precise context is specified so that the costs and benefits of alternative policies can be examined.

While observers such as Srinivasan (1994) remind us that there is no *inherent* conflict between the dual goals of high HD and high EG, such a conflict persists in both the academic and policy literature. In our view such a debate seems to arise and persist largely because the dual relationship between HD and EG across countries and across time has received far less attention than the determinants of EG across countries. As a result, the debate over the precedence of HD versus EG and their proper place in development tends to be driven unduly by the preferences of the debaters and the relative weight of the World Bank's WDR and the UN's HDR. In this paper we take up the task of more carefully documenting the interrelationship between HD and EG for countries across time as well as measuring the *strength* of the dual linkages between them. While the vast array of resources, preferences, and institutions connecting them remains something of a 'black box', our research attempts a generalization of the vast literature focused on EG (the 'exogenous' growth literature). In addition, our work serves as a point of departure for future efforts to understand and explain the country-specific linkages that determine the strength of the links from EG to HD and vice versa.

Our research is inspired by the inductive evidence presented in the earlier work of Ranis, Stewart, and Ramirez (2000) (hereafter RSR) who examined country-specific paths in HD and EG measures over the period 1960 to 1992. While their work only began to address the *causal* factors of HD and EG across countries, their evidence makes for a compelling case that the time paths of HD and EG for a given country are not independent of each other. In particular, their evidence damages the traditional view of EG as predetermined relative to HD. They found that, while short run gains in EG may be gained independent of HD levels, such gains in EG appear to be short-lived unless HD levels are also upgraded prior to, or in tandem with, EG-centric policies. This finding alone means that the traditional approach of modeling EG as predetermined is mis-specified and that HD levels play an important 'feedback' role in the determination of subsequent growth. Thus even a social planner (or a policy maker in a decentralized economy) with EG-centric preferences would be remiss to ignore the role of HD upgrading on the sustainability of growth. This evidence implies that the debate over HD and EG outcomes as an 'either / or' debate is misplaced, but that research and data collection efforts should focus on modeling this *joint* process, and on the production of HD as an endogenously determined *input* into the production of future EG, just as EG is required for the production of HD. The use of the currently favored 'one way' path models are likely to lead to the adoption of policies focused excessively on EG, policies which may yield only transitory gains in EG (what RSR refer to as 'EG lopsided' outcomes) and steady-states which are unaltered in the long run.

The empirical strategy we develop in this paper is driven by the observation that the individual processes linking EG to HD and HD to EG are by no means homogeneous across countries. While assuming a common production function across countries was common in the early cross-country growth literature, most researchers now have serious misgivings about such assumptions and their approach.[5] Instead, we allow for country-specific strengths of the 'chains' linking EG to HD (Chain A) and HD to EG (Chain B). These chains are simply a description of factors that encompass the relationship between HD and EG in both directions, as shown in Figure 1. We rely heavily on the time series dimension of our data to identify such country-specific measures. We then pool this collection of the 196 reduced form parameters measuring the strength of the two chains for each of 98 countries to learn about the joint process of the two HD and EG chains. Our measure of the Chain B strength is a generalization of the 'exogenous' technological change variables that drive sustained growth in the neoclassical model. We find that levels of HD drive subsequent growth, a finding that was illustrated in the evidence of RSR, and is replicated in our framework. In other words, we allow human capital to be a causal factor of sustained growth, which may itself be endogenously produced.

In agreement with the earlier literature, we find that EG is an important, indeed an indispensable, input into the production of HD (Chain A). Far less research attention has been paid to date to this less conventional production function, the HD improvement function (HDIF), and thus our approach here is comparatively *ad hoc*. Our strategy for dealing with the HDIF differs in two important respects from our Chain B approach, for both data and conceptual reasons. On the data front, we tend to have less time series coverage on our measures of HD than for EG and can therefore really only examine HD changes over the latter half of our sample period. The conceptual difference stems from our prior that the building of HD infrastructure and the realization of its benefits (e.g. life expectancy) occurs with a longer and more uncertain lag than in improving EG, which is the Chain B outcome. We therefore use the country-specific relationship between predetermined 'early' EG and 'late' improvements in HD as our measure of the strength of Chain A.

[5] See Solow (2000) and Srinivasan (1995) for critiques, and Durlauf and Quah (1999) for an overview on approaches that abandon the strong form of this homogeneity.

While our empirical strategy for estimating the strength of Chain A is not quite as 'assumption free' as the strategy for Chain B, both rely on the time series dimension of the data to estimate country-specific summaries of the relationships between HD and EG. We therefore differ from the standard 'cross-country regressions' literature that places strong homogeneity restrictions on preference and technology processes across countries. Not using purely cross-sectional data on HD and EG implies that there are no 'simultaneous equations' in our framework. However, we do find that the *joint* sets of parameters across countries measuring the Chain A and Chain B linkages are essential for describing their joint time series paths. For example, were it the case that EG were 'instrumental' or predetermined for HD, while HD does not Granger cause EG, then the Chain B index would be sufficient to predict the performance of countries along the EG dimension. However, our empirical evidence indicates that it is essential to use the *simultaneous* strengths in the Chain A and Chain B linkages to predict the observed time series paths of these variables from 1960 to 2000. While it is true that many countries tend to score well or poorly on both of these measures if they score well or poorly on one of them, many other countries fail to reach the virtuous (and self-reinforcing) plateau of high EG and high HD. Countries with weak Chain A links but strong Chain B links tend to end up in the EG-lopsided state, with high EG but poor HD. This finding was foreshadowed by the RSR findings and it represents the strongest evidence in our paper against the view that the univariate process in EG is sufficient to describe the joint EG-HD process. In fact, even if we are interested in understanding only EG as an outcome, our evidence shows that the dual Chain A and Chain B measures are required. As per RSR, upgrades in HD via strong links in Chain A are a necessary precondition to *sustained* (i.e. non-decreasing) growth.

The rest of the paper is organized as follows. In Section 2, we update the RSR findings and then review some of the previous literature on the HD-EG relationship. Section 3 discusses our measurement framework for the strength of the links in Chain B, as well as generalizing it to encompass the neoclassical growth model as a special case. In Section 4 we discuss the analogous measurement framework for measuring the links in Chain A. In Section 5 we consider the two measurement devices in tandem and discuss their successes and shortcomings. Here we show how planning or decentralized policy making in an environment that ignores the role of HD in producing sustained EG can lead to EG-lopsided outcomes and failure to accomplish the long-run enhancement of development. Section 6 concludes.

2 Summary and Update of Previous Findings and Literature

The previous literature on HD, EG, and their inter-relationships is too vast to summarize here. Instead, we start by first updating the prior work by RSR on the two-way HD-EG relationship and, subsequently, referring only to the literature that relates directly to our paper.[6]

Prior work by RSR examined the inter-relationships between HD and EG for a large sample of developing countries for the period from 1960 to 1992. We now review the most important implications of this paper for our work, and update their results to 2000. RSR focused on documenting the two chains that, when mutually reinforcing, lead to higher growth and higher human development outcomes. These two Chains are illustrated in Figure 1 where we can see that the strength of the links in say Chain A can be hypothesized to depend on a number of factors, including, with respect to households, such factors as income distribution, poverty rates, the level of female control over income, and, with respect to governments, total expenditure, social expenditure and priority

[6] See Ranis, Stewart and Ramirez (2000) and Ranis and Stewart (2000).

ratios, plus factors that determine the efficiency of the human development improvement function. The reverse flow, Chain B, i.e. from HD back to EG, nests the more conventional production function, with the specific prediction that HD affects the trend or *sustained* component of growth, what we later refer to as the growth trajectory. While economic growth provides the resources to permit improvements in human development, human development is not only the final objective of an economy but also an input to additional increments in economic growth. RSR identify the mutually reinforcing state of high EG-high HD as a virtuous cycle and the opposing mutually depressing state as a vicious cycle. Two asymmetric alternatives are also possible, as outlined below.

INSERT FIGURE 1

This initial work made an effort to econometrically examine the significance of the various variables affecting both Chain A, from growth to human development, and Chain B, from human development to growth. RSR found that, for Chain A, GDP per capita growth, the social expenditure ratio and female school enrollment rates all had a significant effect on HD. Similarly, in the case of Chain B, the initial level of human development, as well as its change, the investment rate, and the distribution of income all had a significant effect on EG.

In the same analysis, they proposed that countries are likely to fall into four possible categories when their EG-HD performance is compared to the average developing country performance. Countries that exhibit above average improvement in both human development and in growth fall into the virtuous cycle, whereby strong links in both Chains A and B are mutually reinforcing. On the other hand, the vicious cycle describes countries with relatively poor performance on both growth and human development, with strong Chain A and B linkages reinforcing each other over time. Finally, there are two possible cases of lopsided performance, with some countries having better than average growth but worse than average human development improvement, while others do worse on growth and better than average on the human development dimension. Over time, such lopsided development is not likely to persist since eventually the weakly performing dimension will act as a brake on the other, leading to the vicious cycle case, or, if linkages are strengthened over time, possibly through policy change, a virtuous cycle.

Following RSR, Figure 2 shows the country classifications, by region, in HD and EG performance over the period 1960 to 2000. We use the infant mortality shortfall reduction (IMSR) as the measure of HD change. It is standard in the human development literature to measure changes in infant mortality, life expectancy, or adult literacy, as a shortfall (or gap) reduction. This helps account for 'ceiling (or floor) effects' for countries which near the theoretical boundaries of, for example, 3 percent for infant mortality and 85 years of age for life expectancy. As countries near those boundaries, their actual change in the HD measure may be small. However, using the fraction of the remaining shortfall from the theoretical limit can account for this boundary effect, by accounting for the size of the shortfall.[7] As the measure of EG, we use the annual growth rate in real per capita GDP. Figure 2 shows the relative HD-EG performance of our sample of developing countries, by region, not including the Eastern European countries. The averages that are used to define the virtuous, vicious, EG-lopsided and HD-lopsided cycles are population weighted developing world averages (again excluding Eastern Europe). We should note, not surprisingly, the dominance of East Asian countries in the virtuous cycle quadrant and that of Sub-Saharan Africa in the vicious cycle quadrant.

INSERT FIGURE 2

RSR also argue that the path taken by an economy over time is extremely important. It appears that only via the HD-lopsided cycle can a country in

[7]For example, if the underlying process is logistic, the shortfall reduction comes close to converting the logistic path into one of nearly constant slope. This is the property we seek if the goal is to abstract from ceiling or floor effects, where the slope of the logistic curve goes to zero as it approaches its upper and lower limits.

the vicious cycle transit to the virtuous cycle. If a country attempts to transit to the virtuous cycle via EG-lopsidedness its growth improvements will tend to be short-lived and it returns to the vicious cycle. The main implication of this is that a country first needs to improve its HD before growth can become sustained. While Figure 2 gave us a broad picture of the performance over forty years, we can break this down into a decade-by-decade analysis to study the transition of each of these countries (see Table 1 for the decades 1960-1970, 1970-1980, 1980-1990 and 1990-2000). Once again, the decomposition into virtuous, vicious, HD-lopsided and EG-lopsided cycles is based on population weighted averages. Figure 3 illustrates these same transitions by region. In this two-dimensional representation, the paths to 'success' for the countries that made it to the virtuous quadrant of high EG and high HD were non-linear. The number of countries that made that transition from low EG to sustained high EG was small. But the number of countries which tried the one-dimensional approach to reaching high EG - i.e. by not simultaneously upgrading their HD - were many, and without exception, their gains in higher EG were not sustained.

INSERT TABLE 1

INSERT FIGURE 3

To try and understand more about the roles played by underlying variables in Chains A and B, RSR performed some regression analysis. We replicate these here, once again updating our data set to the year 2000. Tables 2 and 3 report the results of these regressions. For Chain A, we use the infant mortality shortfall reduction 1960 to 2000 as the measure of HD improvement. As Table 2 illustrates, growth in GDP per capita over the early parts of the sample period, 1960-1970, is highly significant in determining HD performance. Moreover, the gross primary enrollment rate as well as the gross female primary enrollment rate, public expenditure ratios on education and health are all significant. Table 3 shows the results for Chain B. Both HD measures, i.e. life expectancy and the literacy rate, have significant effects on growth, as does the gross domestic investment rate.

INSERT TABLE 2

INSERT TABLE 3

This completes the replication exercise from RSR. The most important implications of their work are evident. It seems countries need to update their HD prior to EG in order to benefit from sustained growth. We now move on to a brief general literature review. Starting with Srinivasan (1994), his critique makes clear that, while EG provides the instrumental means by which HD capacities are improved, EG has historically not always been viewed as the sole objective of development. Srinivasan does, however, clearly adopt the separability between the EG and HD processes as portrayed in a standard budget line-indifference curve analysis when arguing against using an HD index as the sole standard by which development should be judged. While the notion that an index of HD, necessarily more arbitrary, should usurp EG as the ultimate measure of successful development is fraught with many measurement and conceptual issues, our empirical evidence contradicts the conventional view that the development process is one *solely* from EG to HD. Of course, if all countries tend to spend the proceeds of growth on HD in much the same way, then EG can serve as a simple summary statistic for the bivariate process. Aturupane, Glewwe, and Isenman (1994) analyze this question empirically and find that a single index based on EG accounts for only about one-third of the variation in HD improvements. Thus, even with the traditional view, that EG and HD form a one-directional path from means to ends, clearly *how* policies and infrastructures are developed matter for the ultimate increase in HD.

It is not hard to see why EG has retained its place as the focus, if not the ultimate goal, of development economics for so long. EG is more easily measurable and has the virtue that it has a tight theoretical basis (e.g. Solow (1956) and much of the literature which followed). However, the neo-classical growth model did not completely eliminate the *ad hoc* nature of the empirical specification efforts, as the large volume of cross-country growth regressions published from the late 1980's until the present illustrates. The sensitivity analysis performed by Levine and Renelt (1992) represents one early attempt to plow through the various empirical specifications suggested. In a related strain of the literature, work by Durlauf and Johnson (1995) raised issue with the stringent homogeneity assumptions implied by a strict interpretation of the Solow model. They stress that countries should only be pooled across 'clubs', which share a common form of steady-state income, and should not be all placed into a common cross-country regression.[8]

Meanwhile, the recent endogenous growth literature, primarily theoretical, along the lines of Romer (1986) and Lucas (1988) has further muddied the precision of the neoclassical growth model for the empirical specification of growth. In our empirical specification for EG and the Chain B links, we start with the specific aspects of EG we wish to measure, and then show how our framework fits in with the general characteristics of the neoclassical growth model. In so doing we want to capture the relevant lessons from both the heterogeneity (observed and unobserved) and the endogenous growth literature in starting with a flexible measurement framework.

The literature on HD and Chain A is by comparison much less voluminous. Indeed, uncertainty along many dimensions of Chain A pervades the development of a suitable measurement framework to measure the human development improvement function. There are, of course, a considerable number of microeconomic studies that illustrate the importance of various inputs, such as education, health, potable water, as well as of such variables as the proportion of income earned by women in the household, but a full analysis of the HDIF is still wanting (see Strauss and Thomas (1995)). We do not dwell on this intricate problem in the context of this paper, but instead try to characterize the heterogeneity

[8] Indeed, Solow (2000) himself provides a critique of the empirical convergence literature as well as of applying a homogeneous production function setup to explain growth *across* countries.

in HDIF ‘efficiency’ across countries as our summary measure of Chain A.

3 Income Paths: Measuring the Strength of the Links in Chain B

We begin the discussion of our measurement framework for the two chains with a focus on Chain B. This is because of the longer time series data available for each country on EG as well as because of the more advanced state of knowledge on that production function. The framework permits us to use the time series dimension of the data to construct a country-specific summary measure of the strength of the underlying linkages in Chain B. In addition, it highlights how flexible we can make the cross-country variation in the parameters and thus avoid the stringent homogeneity assumptions of the cross-country growth literature. We can then relate our measurement framework to the standard Solow-type neoclassical model and use this to modify our framework so as to not ‘penalize’ the high average growth countries. Our resulting strategy is then easily interpretable in a Solow context, albeit one in which the usual cross-country homogeneity assumptions are discarded and one in which the driving force behind sustained growth becomes an empirical question.

As discussed above, one of the more intriguing, and testable, implications of the RSR analysis is that countries that did not upgrade their HD levels in tandem or prior to their attempts at higher EG tended to find their gains in EG short-lived. This non-linear relationship is elegantly re-displayed for our data in Figure 3, which traces out the paths relating HD and EG over the 1960 to 2000 sample period.

Incorporating the information in a time series path of each country in the $(HD - EG)$ plane for a more statistical, and less qualitative, analysis is quite difficult. Approaching the problem directly, each country has its own unique non-linear path that it follows during our sample period 1960 to 2000, and such unique non-linearity makes for a difficult measurement problem. Our solution is to break the bivariate path in $(HD - EG)$ into the univariate path for EG for a given country over time, which we label the growth trajectory. This provides us with a univariate measure of the 'sustainability' of the EG path, and we can then see to what extent HD levels affect this EG trajectory. We emphasize from the outset that neither the concept nor our measure of sustainability should be equated to higher *average* growth. Both low growth and high growth countries can score well on sustainability. But a country which experiences only a few periods of higher EG, followed by a lapse to a lower growth state may have high average EG over our sample period, but still score lower on our sustainability measure. We should also note that our measure of sustainability, referred to as the growth trajectory, is far more general than the usual notion of sustained growth as it includes countries that may even have negative average EG over the period, but are on a positive EG trajectory.

To measure these paths, we propose a simplified approach that extracts the linear time path of EG. If growth is constant or rising, the slope of this time path will be zero or positive. We want transitory increases in EG not to be counted as a positive growth trajectory. To accomplish this, we use a simple decomposition from panel and hierarchical data methods that breaks down the sample path of growth rates g_{it} for country i over the period 1960 to 2000 into a country-specific mean, a country-specific trend, and idiosyncratic fluctuations around both of these parameters as follows:

$$g_{it} = \alpha_i + \beta_i t + u_{it} \tag{1}$$

Note that these are a set of country specific regressions yielding a collection of estimated $\hat{\alpha}_i$ and $\hat{\beta}_i$ fitted values for each country. Then, in a second-stage regression, we try to explain the country-specific slope parameters that capture the growth trajectory, $\hat{\beta}_i$ with our regressors of interest, here mainly HD measures.[9]

Note that if growth is simply random fluctuations around a constant mean rate, the estimated trend would be zero and the fluctuations would be absorbed into the error terms u_{it}. Non-sustained jumps in growth will tend to raise the estimated α_i for a country, but also associate it with a negative β_i. Empirically, there is a slight negative trend in growth rates for our entire sample of countries over this time period, although we can treat $\hat{\beta}_i = 0$ as our baseline, with countries with zero or positive $\hat{\beta}_i$'s being characterized as having a positive EG trajectory and countries with $\hat{\beta}_i < 0$ as having non-sustained or declining growth. Our eyeball examination of the 86 country-specific regression fits indicate that this HLM decomposition of growth rates provides a good measure of sustainability.

It is also useful to compare the relationship of our HLM procedure to the treatment of the time-series information in growth rates used in the literature on convergence (e.g. Barro and Sala-i-Martin (1992)). Many researchers in this literature 'average out' the time dimension in their samples, and focus on average growth rates over the sample period. Note that this information is contained in our HLM measures as well, as each country-specific OLS regression fits the mean. Thus, (using the over-bar to denote the time-averaged sample mean):

$$\bar{g}_i = \hat{\alpha}_i + \hat{\beta}_i \frac{T+1}{2} \tag{2}$$

since the mean of the time trend t in a sample of length T is $\frac{T+1}{2}$. Thus, by suitably combining the information in the HLM effects of $\hat{\alpha}_i$ and $\hat{\beta}_i$, we could simply reproduce the information typically used in cross-country growth regressions. However, the HLM factorization allows us to separate out the direction

[9] This procedure falls under the class of 'Hierarchical Linear Models' or HLM as advanced by Bryk and Raudenbusch (1992) in the field of psychometrics. See Boozer and Maloney (2001) for the relation of HLM to econometric methods more familiar in economics, as well as an application of the method for studying growth in individual-specific test score trajectories by age.

of the growth trajectory, which we *define* to be sustainability, from the average level of growth. Thus, a country which has a constant level of growth, be it low or high, would score a 0 on a measure of sustainability by this definition. Figure 4 shows the relationship between our measure of sustainability ($\hat{\beta}_i$) and the average growth rate for each country. Countries such as Korea and Singapore have high growth rates from 1960 to 2000, but score only average on this measure of sustainability. In fact, this 'pure' or mechanical HLM approach tends to actually penalize countries with high average growth rates as far as the sustainability measure goes. To see this, note the empirical plot of the fitted HLM coefficients of $\hat{\beta}_i$ versus $\hat{\alpha}_i$ in Figure 5. There is a strong negative relationship between the two estimates across countries, indicating that countries with higher average growth rates will tend to score poorer on our proposed sustainability measure of $\hat{\beta}_i$.

INSERT FIGURE 4

INSERT FIGURE 5

While we experimented with a few *ad hoc* modifications to our HLM-inspired measurement approach, we returned to the cross-country growth literature to incorporate an important omitted factor that plays a role in determining the time-series movements in cross-country growth rates.[10] Our goal is to revise our initial measure of sustainability in EG so as to not 'mechanically' penalize high-growth countries, as the pure HLM approach does. We devote the next sub-section to relating our statistical HLM framework to the neoclassical growth literature, and then propose a simple modification to our HLM procedure that does not suffer from these mechanical difficulties.

[10] One approach was to ask, for a *given* $\hat{\alpha}_i$, which countries had a higher $\hat{\beta}_i$? Here, countries like Singapore and Korea, which had only middling values of $\hat{\beta}_i$, due in part to their high average growth levels, had the highest values of the 'residual beta' measure, after factoring out their high $\hat{\alpha}_i$ values. The approach that we describe below has the same flavor as this approach, but is less *ad hoc* and ties in closely with the neoclassical growth literature.

3.1 The Relationship of Our Measurement Framework to the Neoclassical Model of Growth

The last 15 years have seen a resurgence in research on both the theoretical and empirical causes of economic growth across a broad spectrum of countries. It is a fair summary of both the theoretical and empirical literature to say that it has focused in particular on how the cluster of 'developed' countries is able to sustain growth, absent some force creating technological advances offsetting the declining marginal product of physical capital for a given country. Both strands of the research literature have focused intently on the technological progress explanation for differences in growth rates because it has important implications for how we revise the neoclassical growth model of Solow to allow for the possibility that the growth rates of clusters of countries actually diverge over the long run.

The empirical work that led to the renewed interest in the sources of growth focused on the trends in long run growth in the industrialized and nearly industrialized countries. Authors such as Baumol (1986) tended to find that growth rates converged in accord with the simplified neoclassical model within 'clubs' of countries, but diverged *across* such clusters of countries in the long run. This provided the impetus to try to document or refute this finding in a broader set of countries, as well as provide an explanation for how this could occur in a well-specified economic model, as in Romer (1986). What appears to have been left out of this renewed focus over the past 15 years, however, is that growth trajectories may well have a 'life-cycle' aspect to them, in that factors that matter early in the growth path for a given country may matter far less later in the life-cycle of that country. Indeed, the earlier literature on the factors affecting economic growth often had some threshold that constituted a "take-off" point, beyond which economic growth increased more rapidly. Kuznets, Lewis, and Rostow were among the authors who provided possible, if differing, explanations for why the life-cycle of economic growth was not purely constant. These authors were writing at a time when some countries were making the transition from low growth to high (sustained) growth before their very eyes, and so they were motivated to try to explain why some countries were able to attain this higher plateau, while other economies appeared to remain stagnant.

The data sources that were available to researchers in the 1980's offered a portrait of a broad cross-section of both developed and developing countries on a number of indicators. From 1960 to the present, only a few countries in the developing world have made the transition from a low growth state to a sustained high growth state. Thus, this time window does not permit so much a view into what allows this transition to be made as it allows us to examine the far more numerous examples of where attempts at high growth policies have failed to produce *sustained* success. When we look at the differences in the growth rates over this period, it is not at all clear whether the "new growth" literature and its focus on 'technological change' can explain why, for example, Botswana enjoyed greater success than other countries in Africa. We argue that with a suitably evolutionary notion of what is meant by 'labor augmenting technical change' we can place both developing and more developed countries on a unified life-cycle growth path. We wish to establish a bridge between the recent endogenous growth literature which focuses on the production of ideas and the role of technological diffusion and the earlier literature which focused on earlier stages in the growth transition of countries and considered elements of progress beyond that narrow focus. Uzawa (1965) represents a critical 'missing link' in this regard in that he presents a two-sector endogenous growth model in which the 'health and education' sector constitutes the reproducible input responsible for endogenous growth.

When we look at the conventional production function approach, we usually focus on growth rather than on income per capita or levels of output. While authors such as Barro (1997) and Quah (1996) have noted that the time-series movements in per-capita output are a trivial fraction of the cross-country variation in levels of output per capita, our focus here is more on describing the *trajectories* of growth that we observe during our sample period, as the levels are too much a function of initial conditions and a myriad of political and cultural factors. This combination of factors makes the attempt to explain the cross-country patterns of output *levels* a precarious venture at best. Instead, we ask what factors lead to *sustained* growth over the 1960 to 2000 period covered by our sample, as well as the contra-positive to this question, which is why do some countries fail to sustain attempts to reach a high level of growth. We focus in the next section on a framework for measuring what is meant by 'sustained' growth. As we will see, our measurement framework needs to confront the empirical fact that there is a strong propensity for growth *rates* to converge, as opposed to income *levels* that are the focus of the convergence literature.

To investigate an appropriate modification to our pure HLM framework that 'corrects' the penalty placed on our sustainability measure (i.e. a positive EG trajectory) for the high $\hat{\alpha}_i$ average growth countries, we consider the relationship of the HLM decomposition to the decomposition implied by a simple neoclassical approach. In Barro and Sala-i-Martin (1992), for example, the rate of growth in output per worker between period t and $t-1$ for country i in the stylized growth model is given by:

$$g_{it} = (1 - e^{-\lambda})[\log(\hat{y}_i^*) - \log(y_{i,t-1})] + e^{-\lambda} x_i + (1 + e^{-\lambda}) x_i t + \epsilon_{it} \qquad (3)$$

where x_i is the rate of labor-augmenting technical change, $\hat{y}_i^*$ is the country-specific steady-state level of output per effective worker, $y_{i,t-1}$ is the lagged level of output per worker, λ represents the speed of convergence to the steady state, and ϵ_{it} captures the stochastic fluctuations in growth rates. Before imposing various homogeneity assumptions, this implies that growth rates across countries can be decomposed into a country-specific intercept, a country-specific trend, and a time-by-country component that is the sum of the stochastic disturbance and the lagged level of output. In short, the Solow model of growth delivers precisely the decomposition of growth rates that we used above in our HLM framework to develop a measure of 'sustained growth'. We can see this by comparing equations (1) and (6) and noting the following equalities for the constant, trend coefficient, and error terms:

$$\alpha_i = (1 - e^{-\lambda})(\log(\hat{y}_i^*)) + e^{-\lambda} x_i \tag{4}$$

$$\beta_i = (1 + e^{-\lambda}) x_i \tag{5}$$

$$u_{it} = (1 - e^{-\lambda})(\log(y_{i,t-1})) + \epsilon_{it} \tag{6}$$

In fact, this last equality for the time-by-country error component u_{it} in the HLM framework suggests a useful modification to the pure factorization we saw earlier. As the lagged *level* of GDP per worker is pushed into the error term in the pure HLM approach, the HLM error will be highly serially correlated, as well as positively correlated, with the intercept of each country. Thus, a simple modification to the pure HLM approach is to estimate the set of country-specific regressions[11] given by:

$$g_{it} = \pi_i + \gamma_i t + \delta_i \log(y_{i,t-1}) + v_{it} \tag{7}$$

Equation 7 is simply the original HLM decomposition given in equation (1), but including the lagged level of GDP as an additional regressor. To avoid confusion, we have used different notations for the intercept, trend, and error term components in the two different decompositions. Thus, here $\hat{\gamma}_i$ represents the new measure from the trend term in equation (7). The effect of including the lagged level of output as an additional regressor has the largest effect on the set of estimated $\hat{\pi}_i$'s. However, this affects the estimated set of sustainability measures $\hat{\gamma}_i$, albeit indirectly, as well. The result is that countries such as Singapore and Korea in Asia, and Argentina and Chile in Latin America have

[11] While the strict interpretation of the neoclassical model implies that the coefficient on the lagged level of output should be homogeneous across countries (and a non-linear version of the convergence parameter λ), we continue in the spirit of the HLM and our interest in *measurement* and allow the coefficients to vary by country.

much higher sustainability measures when we use the modified framework than under the pure HLM framework that tended to penalize them for their high average growth rates and levels of output.

Figure 6 presents the relationship between this new measure of sustainability ($\hat{\gamma}_i$) and average growth rates. It is clear from this Figure that, whereas the original HLM measure of sustainability was slightly negatively correlated with average growth, as in Figure 4, Figure 6 shows the modified measure to be mildly *positively* correlated with average growth. Contrasting Figures 4 and 6, it is thus clear that, by using the modified HLM procedure, countries like Korea, Singapore, and Thailand are no longer penalized for their high growth. Likewise, countries such as Haiti, Bangladesh, and Cambodia are corrected downward under the modified procedure, and so do not score nearly so well on sustainability as under the original HLM framework. Figure 7 plots the original ($\hat{\beta}_i$) versus the modified ($\hat{\gamma}_i$) sustainability measure. While the two measures are certainly positively correlated, it is clear that the correlation is by no means perfect. As the modified procedure has fewer measurement problems and correctly captures the trend, level, and lagged output components of growth implied by the standard Solow model, we utilize only the modified sustainability measure, $\hat{\gamma}_i$, in what follows.

INSERT FIGURE 6

INSERT FIGURE 7

The mapping between this modified HLM approach and the stylized neoclassical model has another appeal. Notice that expressions for the intercept and trend effects of α_i and β_i hold, respectively, for π_i and γ_i as well. The striking implication from the underlying model for the trend effect δ_i versus the intercept effect π_i is that *only* sources of productivity enhancements for labor (denoted as x_i in the model above) should affect δ_i, whereas both x_i as well as variables which help explain the steady state level of output per worker should help describe the variations in the intercepts across countries. Put differently, the neoclassical model implies the important exclusion restriction that only factors which improve labor productivity should be associated with our sustainability measure, whereas factors which affect both steady-state levels as well as variations in labor productivity should explain the cross-country variations in the intercepts.

The modified HLM approach also removes one of the common criticisms of cross-country growth regressions, in that they have a 'kitchen sink' type flavor to them. It is common in cross-country regression studies for the researcher to simply pool the cross-section and time series dimensions of the data and treat it all as 'one kind' of variation. The modified HLM framework instead relies exclusively on the time-series path of the data in the first stage, breaking it into a linearized version. However, this decomposition meshes entirely with the stylized Solow model, a theory that delivers a very precise way on which variables should affect growth. Thus, if we take a variable such as the investment rate, which is well known to correlate with pooled growth rates in a standard cross-country growth regression, the Solow model predicts that it should not correlate with the estimated *trend* component within the HLM framework (see equation (5)). Only variables which are the empirical counterpart of x_i, which is technical progress in the traditional view, should affect the trend component of growth. The modified HLM framework allows us to be more broad-minded than the pure neoclassical model and ask the empirical question of *what* affects sustained growth. This exercise gains credibility because when the modified HLM framework is viewed via the stylized neoclassical model, variables such as the investment rate should help explain *only* the intercept (via its effect on steady-state output) and *not* the trend.

3.2 What Explains Sustained Growth in Developing Countries?

Now that we have a summary measure of the country-specific time series of growth paths via the modified HLM framework, $\hat{\gamma}_i$, we can test the hypothesis of RSR that attempts to increase EG without a prior or contemporaneous strengthening of HD levels implies that such gains will be short-lived. We can also ask, more generally, what explains sustainability in EG for our sample of developing countries. Largely for comparison purposes, we also examine the impacts of our variables on the average growth rate levels given by $\hat{\pi}_i$, where the distinction in what variables should determine $\hat{\pi}_i$ is less clear.

Having summarized the time series growth path by a single scalar, the specification question now is how to treat the time-series vector for each explanatory variable. We follow the usual practice in HLM-based models and use the time average of the explanatory factors, after finding that this appeared to be a good summary of the underlying period-by-period regressions. The second issue of specification is whether we want to use HD levels or HD growth rates. We work with levels because we feel they are more tightly associated with labor productivity. In addition, large HD upgrades may still leave a country with poor HD levels and *vice versa*, and so it is not clear that HD changes are the appropriate concept. In the language of RSR, the index that determines the non-linear point of 'takeoff' in the EG process is determined by the *level* of HD, and not purely its rate of growth.[12]

Thus we specify an empirical model relating sustainability in EG to HD as

[12] In this choice of modeling the dynamic interaction between HD and EG we are in concert with the endogenous growth literature. In those models since the *stock* of accumulated human capital or R & D helps determine the subsequent growth of these factors (e.g. Lucas (1988)), the implication is that the *change* in output is related to the *level* or stock of the knowledge-producing variable.

follows:

$$\hat{\gamma}_i = \eta + \tau HD_i + z_i'\theta + \zeta_i \tag{8}$$

where $i = 1, \ldots, 83$, as we lose three countries from our sample in moving to the HLM procedure. The presence of the error term ζ_i highlights another advantage of the HLM procedure in that it allows the heterogeneity in our sustainability measure to vary for reasons that are not purely due to differences in HD. Were that the case, the HLM procedure would have a one-step linear regression counterpart that would involve a multitude of interaction terms. Our focus is on the estimated value(s) of the coefficient τ, as we hypothesize that lower levels of HD lead to lower sustainability in EG and *vice versa*. In the vector of controls, z_i' we include a set of 3 region dummies, as well as two variables which affect growth generally, but which we think are *not* related to sustainability: the investment to GDP ratio, and the exports to GDP ratio.

INSERT TABLE 4

The results of the basic specification, using the Infant Mortality (IM) measure for HD, are shown in Column 1 of Table 4. As larger values of IM indicate a *lower* level of HD, we would expect to see an estimated τ less than zero. As the actual *value* of the HLM coefficient, the dependent variable in this regression, is rather difficult to interpret, we focus more on comparing the *relative* size of the coefficients on the regressors in Table 4, as well as observing their statistical significance. As we see from the results in Column 1, a higher infant mortality rate implies a country is less likely to have sustained growth. This is consistent with the observations of RSR in that countries with poorer performance in HD are less likely to experience sustained growth. Perhaps not surprisingly, neither the average investment rate nor the export ratio are significant in explaining sustained growth. This observation is also consistent with the predictions of the neoclassical model. However, this lends credibility to our empirical approach of measuring just the sustainability of growth, in that typically both investment and some measure of openness are generally highly correlated with growth itself.

In Column 2 we repeat this exercise, but now using Life Expectancy (LE). As IM and LE are highly negatively correlated across countries, trying to measure their separate influence is not feasible. We find a strong positive effect of greater LE on sustained growth. The coefficient is close to 8 times larger than the effect of IM in column 1, even though IM has roughly twice the mean of LE. However, average Infant Mortality rates vary much more across countries than average Life Expectancies. In fact, the ratio of the standard deviations of IM to LE is roughly 4, and this difference in the mean and variance properties explains the larger magnitude of the LE coefficient estimate.

Finally, in Column 3 we present the results using the average Gross Secondary Enrollment Ratio as a third measure of HD.[13] This effect is a little less statistically precise, although still of the same (adjusted) magnitude as the other 2 coefficients (the standard deviation of the enrollment ratio is about half that of IM), and distinct from zero at conventional levels. Here again the effect of investment is small and insignificant, and the effect of the export ratio is still of the opposite sign from what might be expected.

The graphical versions of Table 4 are displayed in Figures 8, 9 and 10 for IM, LE and Secondary Enrollment, respectively. It is worth commenting on some of the patterns within and between regions. First, as we can see from both Table 4 and from the three Figures, the Middle East (apart from Iraq) scores rather low in terms of sustained growth. As their growth is generally driven by a wealth in natural resources, the impact of the extended "Dutch Disease" plus declining marginal productivity of resources would suggest precisely this result for our measure of sustainability. Also of note is that, despite low average growth rates, Africa scores quite well on our measure of sustainability of growth. Across all 4 regions, Argentina and Chile score the highest, although Singapore

[13] Average Primary Enrollment Ratios vary much less across countries and they tend to 'top out' at values over 100 percent (as they are gross, as opposed to net, ratios). For these reasons, their estimated effects tend to be less precise and reliable, and so we do not report them.

and Korea in Asia are not far behind. Visual inspection of the underlying plots indicates that the high scores in sustainability for Iraq and Turkey may actually be artifacts of our measurement procedure, which can be sensitive to one period of exceptionally high growth. This suggests the need to develop a less susceptible alternative in future work.

INSERT FIGURE 8

INSERT FIGURE 9

INSERT FIGURE 10

4 Human Development Allocations and the Feedback to Growth: Measuring the Strength of the Links in Chain A and the HD Improvement Function

The virtues of the measurement framework we constructed for measuring the many links in Chain B are, first, that we were able to rely on the EG time series available for each country to allow quite a bit of country-specific heterogeneity. Secondly, we were able to show that our approach incorporates the familiar neoclassical growth framework as a special case. Unfortunately, when we turn to Chain A, the country-specific time series available for some of the HD measures are not nearly as long, and the theoretical and conceptual models for what generates HD improvement are not nearly as developed as is the case for Chain B. The result of these data and conceptual deficiencies is that our measurement framework for the strength of the Chain A links cannot incorporate so much country-specific heterogeneity as was the case for Chain A, and that we must still rely on the cross-sectional relationship between EG and HD *improvements* to generate a country-specific measure. We use lags in building HD infrastructure as a result of EG to avoid the simultaneous equations bias. The Chain A linkages are thus summarized by the residuals from a regression of 1980 to 2000 HD improvements, *given* EG from 1960 to 1980. While this only allows a 20 year lag to realize the benefits of HD infrastructure built from extra dollars of EG, this is close to the maximum lag time allowed by our data. Given initial growth, countries that have better HD at the end of the sample period (i.e. higher fitted residuals from the cross-sectional regression) are inferred to have invested more of the profits of their initial growth into developing their HD infrastructure, i.e. stronger links in Chain A. This measure is thus *orthogonal* to initial EG by construction, and yet when we test its usefulness as a measuring device we find that it has a strong positive correlation with growth over the end of the sample period. Here again, the lag time in producing HD rules out simultaneity as the source of this very clear positive relationship.

The empirical and theoretical microeconomic literature on the Human Development Improvement Function (HDIF) is vast - see the summary in Strauss and Thomas (1995). The theoretical aspects of the *macroeconomic* HDIF, however, have yet to reach the level of precision as, say, is given to Chain B by the Solow growth model and its followers. We know, at the level of the macroeconomy, that HD improvements require substantial infrastructural upgrading as well as professional training, etc. These can easily take several generations to achieve their full potential. While there is a lag time likely present also in Chain B, we are really only positing that the lag time in Chain A is longer than that for Chain B. A secondary consideration that affects our measurement strategy for Chain A is that for one of the measures of HD, Secondary School Enrollment, we only have the five-year time-series averages available, beginning in 1980. For both of these reasons, we chose 1980 - the midpoint of our 40 year sample - as the dividing line between the 'early' and 'late' observations in our sample. This leaves us with only 2 observations per country, on 'early' growth and 'late' improvements in HD. As a result, we cannot utilize country-specific regressions as we did with Chain B, although our focus here is not on country-specific trends. Instead we rely on the cross-country relationship from 1960-1980 EG to 1980-2000 HD shortfall reductions as the benchmark by which to measure the strength of the links in Chain A. We then use the fitted residuals from this regression as a measure of the overall strength of the links in Chain A. The residuals represent countries that have higher or lower improvements in HD *given* their initial level of growth. As we discuss more formally below, these residuals capture how efficiently countries convert dollars of early EG into later improvements in HD, as well as the tendency for larger improvements in HD even independent of early EG.

If we denote these periods by 0 and 1 respectively, in principle we could use the following equation to estimate the country-specific strengths of Chain A and the HDIF:

$$\Delta HD_{i1} = \kappa + \psi_i g_{i0} + \xi_i \tag{9}$$

where the country-specific conversion of dollars of early growth into HDIF is given by the country-specific slope ψ_i. Unfortunately, this regression has only 98 observations, but 99 parameters to estimate if the slope parameters are allowed to be heterogeneous. In principle we could push the data to its limits and extract 2 or 3 time periods per country, but in so doing we must make much more precise assumptions on the lag structure. In practice the small number of time series points makes this far too imprecise to be a viable approach, though it has the virtue of being more consistent with our measurement approach for Chain B.

Instead, we turn to the cross-sectional relationship between ΔHD_{i1} and g_{i0} and ask: for a *given* early growth g_{i0}, what is the later improvement in HD? The answer to this question is simply the *fitted* residual to the homogeneous slope coefficient regression:

$$\Delta HD_{i1} = \kappa + \psi g_{i0} + v_i \tag{10}$$

Call this fitted residual $\hat{v}_i$. Note that this measure is orthogonal to g_{i0} by construction and note further that interpreting this measure of the strength of Chain A as compared to the slope measure above implies that:

$$v_i = \xi_i + (\psi_i - \psi) g_{i0} \tag{11}$$

If the regression error in the heterogeneous HDIF ξ_i is small (i.e. if a *necessary* condition for HD improvement is growth in income EG, which is the view that EG is 'instrumental' for HD), then this cross-section based method using the fitted residuals will capture the efficiency of converting early EG into later HD improvements. Thus $\hat{v}_i$ will serve as a suitable measure of the strength of the links in Chain A, *given* the measure of HD. We turn next to the final issue of measuring Chain A versus Chain B, and that concerns the ambiguity of generalizing the HD outcome from the many possible measures of HD.

Here, HD is measured as either the infant mortality, life expectancy, adult literacy, or school enrollment shortfall reductions. Concerning the issue of the ambiguity in the best measure of HD, as well as the lag length issue, we focus on the Infant Mortality shortfall reduction (IMSR) and the Secondary School Gross Enrollment ratio shortfall reduction (ENSR) as our two measures of HD. IMSR has the virtue that the lag time from initial growth until the improvements in HD are realized are likely smallest for this measure. The downside of the IMSR is that reducing IM may be less of a target once the level of IM gets sufficiently small. For this reason, we also look at the secondary ENSR. Gross primary school enrollments are all near 100 percent for most of our countries by the end of the sample period. Tertiary enrollments, by contrast, are quite low for many of our countries, and are generally less reliable in terms of data availability. Enrollment data have the virtue of addressing the human capital element of HD, which is thought to be a key factor both as an input and as a result. It is crucial that we include some aspect of it in our analysis of the HDIF and the measurement of the strength of the links in Chain A. However, enrollments do have an appreciable lag time in developing the infrastructure to support enhanced higher level enrollments, i.e. teachers must be trained and schools must be built, etc. Enrollments also have the drawback of not accounting for the *quality* of schooling which is known to vary widely across countries. However, the measure of Chain A linkages based on both of these indices are likely to have compensating strengths and weaknesses, and so we look at an index based on their equally weighted linkage measures using the measurement framework just described.

Figure 11 plots the data on IMSR from 1980 to 2000 against early EG from 1960 to 1980, together with the fitted relationship of the regression shown in equation 10. The vertical distance of each data point from the regression line represents the fitted residual $\hat{v}_i$, which is our measure of the strength of the Chain A links in the IM direction. Singapore stands out as having the largest reduction in IM for a given amount of early growth, although one can also see Malaysia, Chile, El Salvador and Sri Lanka as lower early growth countries that nonetheless had very large reductions in IMSR. Because our Chain A measure conditions on initial growth, these countries actually score better by our measure than do Korea, Saudi Arabia, and Libya, which had about the same IMSR, but which had much higher early growth as well. For this reason, we infer that these three countries have weaker links in the IM aspect of HD than do Malaysia, Chile, El Salvador and Sri Lanka.

INSERT FIGURE 11

Figure 12 presents the same graph for the strength of Chain A links, but now using secondary ENSR in place of IMSR. Again, the cross-country fitted regression line is shown so that the reader can see the resulting fitted residuals which once again constitute our Chain A measure. In the case of secondary school enrollments, Korea scores best, while Singapore, the country with the strongest Chain A links when using IM as the measure of HD, is seen to be quite close to the fitted regression line, and thus only about average. Two Middle East countries, Libya and Egypt, also score quite well, although any correction for school quality across countries might dampen this conclusion. Sri Lanka again does quite well in terms of converting its lower initial EG into HD improvements, while Uruguay and China perform near the top on this measure. By contrast, Iraq scores the lowest of all countries, especially given its larger than average early growth.

INSERT FIGURE 12

It is clear by inspecting Figures 11 and 12 that while countries that tend to have strong linkages in the infant mortality shortfall reduction aspect of HD also tend to have strong linkages in the secondary school enrollment aspect, there are some countries for which these two aspects of HD improvement move in opposite directions. This observation, combined with the many factors of HD, compared to the scalar aspect of EG, leads us to propose an index of the strength of the Chain A linkages in the direction of infant mortality reduction and secondary school enrollment improvements. We focus on these two aspects of HD because they span the health infrastructure and education infrastructure between them. Also, they have very different time lags in that infant mortality can be altered relatively quickly, but school enrollment requires a longer delay before all of the staff and infrastructure can be in place. Since our goal is to measure the *overall* strength of the linkages in Chain A for HD in general, an index based on these two measures will be sensitive to the many underlying linkages in the overall HD infrastructure. Construction of the index is made relatively simple by the fact that the two measures are the country-specific fitted residuals just discussed in Figures 11 and 12. Thus, both series have zero mean by construction and are orthogonal to initial growth. Furthermore, they have roughly equal variances and for this reason we can use the unweighted average of the two measures as an index of the strength of Chain A links in the joint IMSR and ENSR directions. Since this index may appear somewhat *ad hoc* to the reader, in Figure 13 we show the relationship of our index to *later* growth from 1980-2000. As the strength of Chain A index measure is plotted on the x-axis, the reader can first observe simply the ranking of countries by this index by reading them from right to left. The countries with strong Chain A links are seen to be Korea, Sri Lanka, Uruguay, Chile, Egypt, and Singapore, and those with the weakest Chain A linkages are Rwanda, Zambia, and Cote d'Ivoire. Furthermore, the reader can see that this index of the strength of Chain A linkages correlates *very* strongly with subsequent growth - a finding in accord with the earlier analysis of RSR (2000) discussed in Section 2. This finding is somewhat surprising because the Chain A index is *orthogonal* to initial growth by its construction and so the strong relation to subsequent growth is by no means automatic. Finally, Figure 13 also helps highlight imperfections in our measurement strategy for the Chain A linkages. Departures from the regression line for subsequent growth represent failures to perfectly predict which countries will enjoy greater subsequent growth. While we did not expect this prediction to be perfect, noting the larger discrepancies could help refine future attempts to measure the Chain A linkages - e.g. Singapore seems to have performed better than our index would have suggested, and Algeria represents a case that we seem to have overstated.

INSERT FIGURE 13

5 Putting Together the Two Chains: Are they Mutually Reinforcing?

Our goal so far has been to measure the strength of chains tying together HD and EG in a simultaneous system. By making novel use of the data, we were able to measure the strength of the *chains*, while acknowledging that the variables themselves are jointly determined. The 'chain' metaphor helped us to sidestep the inherent simultaneity in the relationship between HD and EG by focusing instead on what made each chain strong, and in so doing we have estimated a set of country-specific parameters which summarized the Chain A and Chain B linkages. The question now is if there is any proof of the pudding? In this section we want to see if the joint relationship between our *measured* Chain A and Chain B linkages correspond to the countries that in fact experienced virtuous, vicious, HD-lopsided and EG-lopsided outcomes.

Plotting the modified HLM measure of the strength of Chain B from Section 3 on the x axis, and the index of the strength of Chain A links on the y axis, Figure 14 shows the relationship between the two. Countries like Korea, Argentina, Chile and Singapore have strong links in *both* Chains A and B, which is consistent with their reaching the high (HD, EG) plateau in the *empirical* figure 2 (the associated country names for Figure 2 are related indirectly to the country names in Table 1). On the 'vicious' side of the plot, countries like Cameroon, Rwanda, Afghanistan and Ecuador tend to score low on one or both measures. Figure 15 breaks this relationship out by region which also aids in clarifying some of the country labels. Not surprisingly, many of the countries in East Asia and Latin America have strong linkages in both chains. Indeed, outside of these two regions only Tunisia and Morocco in the Middle East, and Mauritius, Senegal, and Ghana in Africa are countries that we estimate to have strong dual linkages that would tend to push them to the virtuous (HD-EG) plateau. While the results of Figures 14 and 15 do not perfectly predict the observed outcomes as listed for the 1990-2000 decade in Table 1, the results are striking. There are, of course, some notable 'misses': we estimate Panama to have both weak Chain A and Chain B links, yet Table 1 indicates it is among the virtuous countries in the 1990-2000 decade. In Africa, we estimate Ghana and Senegal to have strong enough dual linkages to enable them to be in the virtuous category, yet Table 1 reveals the opposite. We estimate India to be in the HD lopsided category, yet empirically it appears to alternate between the vicious and EG-lopsided quadrants. Nevertheless, the results are encouraging overall.

INSERT FIGURE 14

INSERT FIGURE 15

6 Conclusion

The commonly held view in the economics profession is that while HD may represent the bottom line objective of a society EG is instrumental in the production of HD. This EG-centric view has led to the development of a rich theoretical literature on the determinants of growth, both in the neoclassical and endogenous growth theory contexts. But what appears to have garnered much less attention is the role that HD plays in generating growth. In an earlier paper that formed the basis for this effort Ranis, Stewart, and Ramirez (2000) provided evidence that strong HD was essential if growth was to be *sustained*. Countries could undertake policies that focused on EG, but the evidence presented by RSR indicated that, if HD levels were not also sufficiently high, the gains in EG would be short-lived. Growth today could lead to growth tomorrow, but only if HD was sufficiently strong to keep the fires burning.

In this paper we devised methods to measure the strength of the links from EG to HD and from HD to EG. As a by-product of these measurement schemes, we saw, for example, that the empirical observations of RSR conflicted with the pure neoclassical growth model. The sustained component in growth is the trend component, and in the neoclassical model that factor is driven by exogenous technological change. And while that trend component serves as a good summary measure of the strength of the linkages from HD to EG, we found *empirically* that levels of HD were significantly related to this trend component. This helped us reject the narrow view of the neoclassical model and move us in the direction of the modern endogenous growth theory where a broader range of variables can lead to sustained growth; moreover, those variables can be 'produced' by past EG and HD. This part of the evidence indicates the need to broaden the spectrum of variables that can lead to sustained growth - at least for developing countries - as well as to question the soundness of EG-centric policies which may buy short run benefits in EG, but appear to be futile in the purchase of long-run achievements. In our data, countries as diverse as Sri Lanka, Tunisia, Malaysia, El Salvador, Colombia, and the Philippines appear to have made significant economic gains in recent decades by focusing on their HD infrastructure, despite their only average economic performance during the early years of our sample.

The overall success of the measured strengths of the linkages in Chains A and B to reproduce the actual destinations of the countries in the (HD-EG) plane is striking. Given that these linkage measures are almost unrelated to the variables themselves (by construction), the ability to predict the empirical outcomes listed in Table 1 and displayed in Figure 2 was far from automatic. But the proximity of the predicted configurations in Figures 14 and 15 with the empirical outcomes in Table 1 lends some confidence in our ability to measure the strength of the linkages in Chains A and B and in their mutual feedback in leading countries to success or failure.

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Figure 1

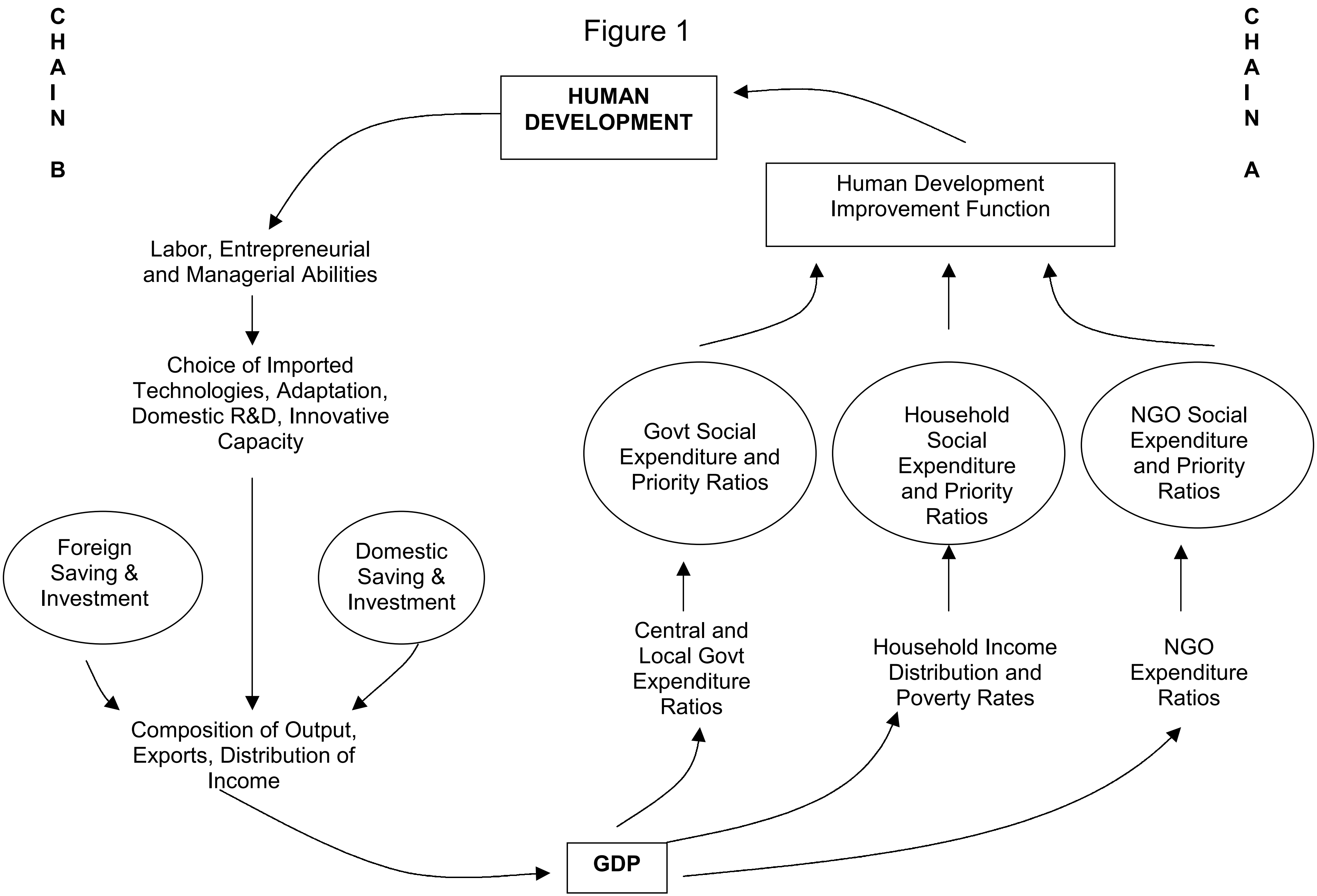
CHAIN B
CHAIN A
HUMAN DEVELOPMENT
Human Development Improvement Function
Labor, Entrepreneurial and Managerial Abilities
Choice of Imported Technologies, Adaptation, Domestic R&D, Innovative Capacity
Foreign Saving & Investment
Domestic Saving & Investment
Composition of Output, Exports, Distribution of Income
GDP
Govt Social Expenditure and Priority Ratios
Household Social Expenditure and Priority Ratios
NGO Social Expenditure and Priority Ratios
Central and Local Govt Expenditure Ratios
Household Income Distribution and Poverty Rates
NGO Expenditure Ratios

Figure 2: HD and EG Performance, 1960-2000

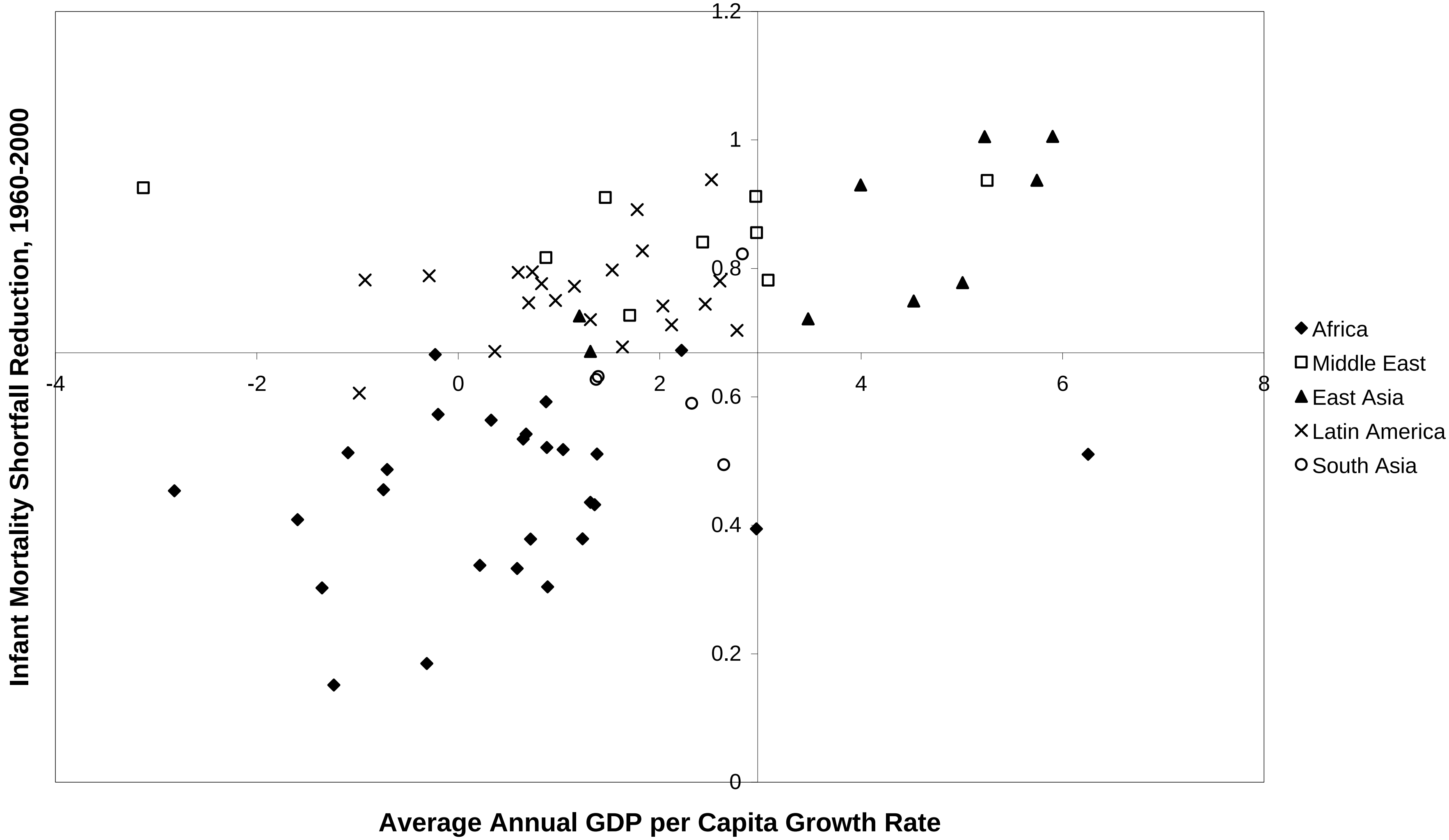

Figure 3: Country HD-EG Quadrant Changes over Four Decades, 1960-2000

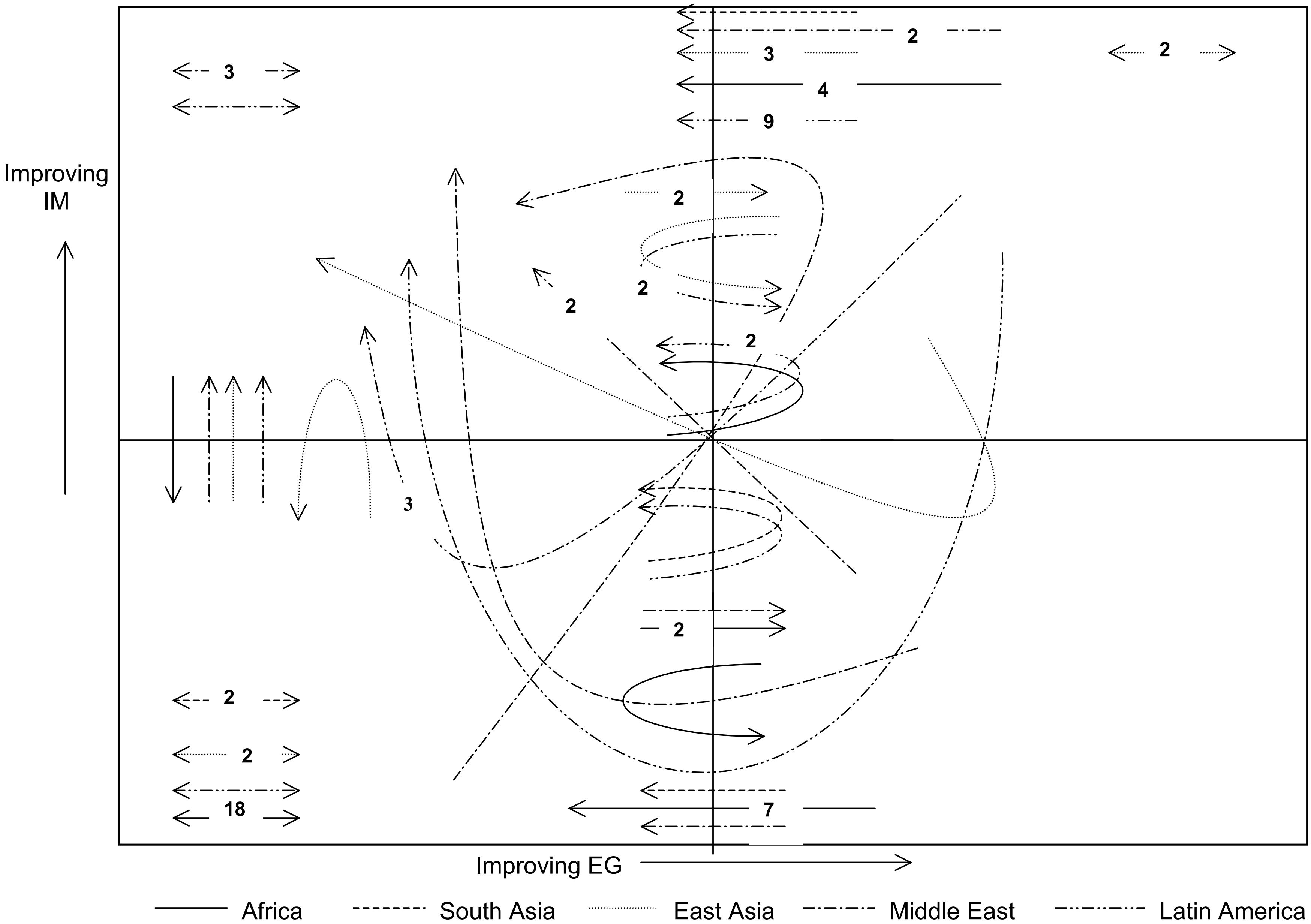

Figure 4: Relation Between Pure HLM Coefficient and Average EG

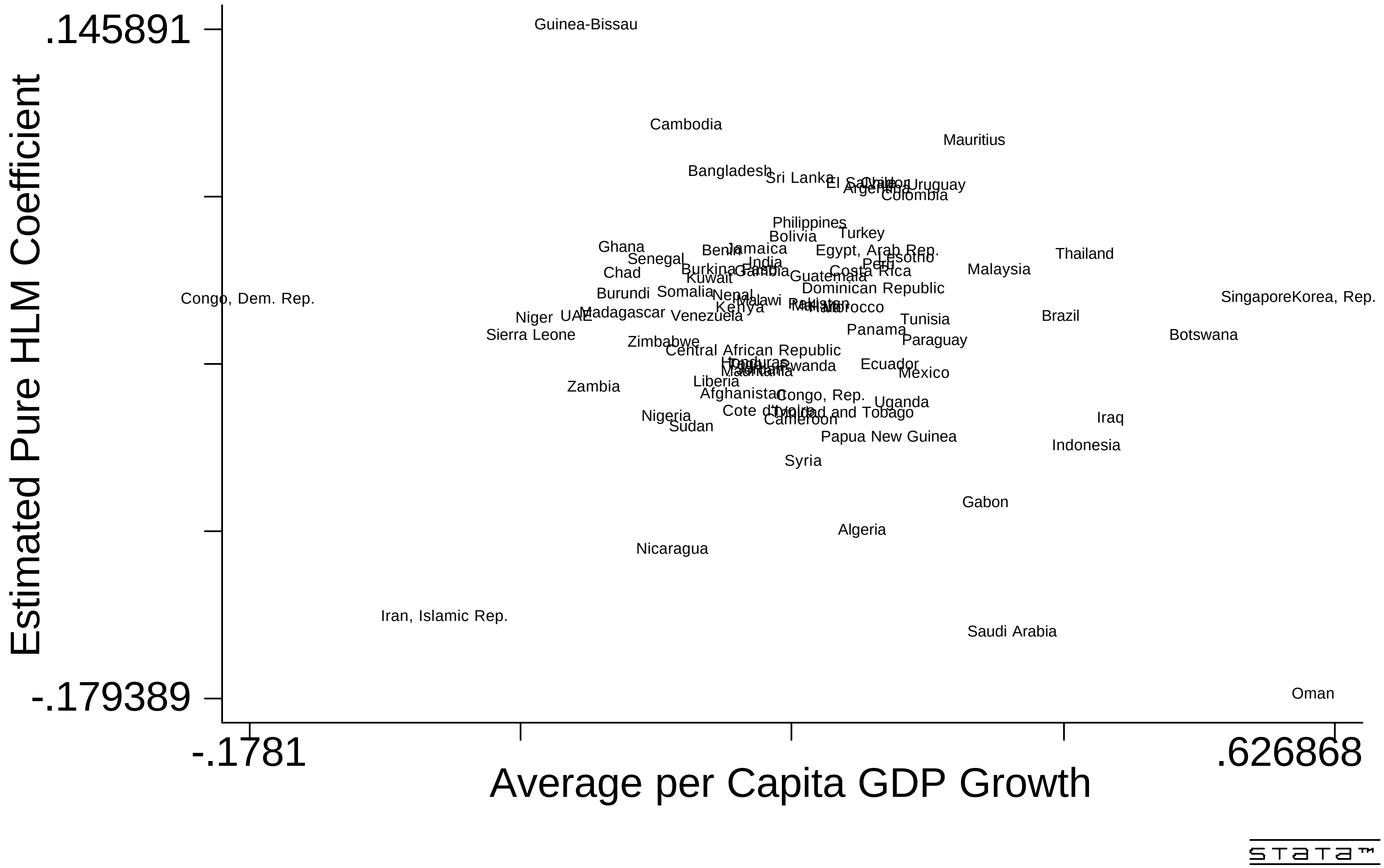

Figure 5: Relation Between Pure HLM Coefficient and Intercept

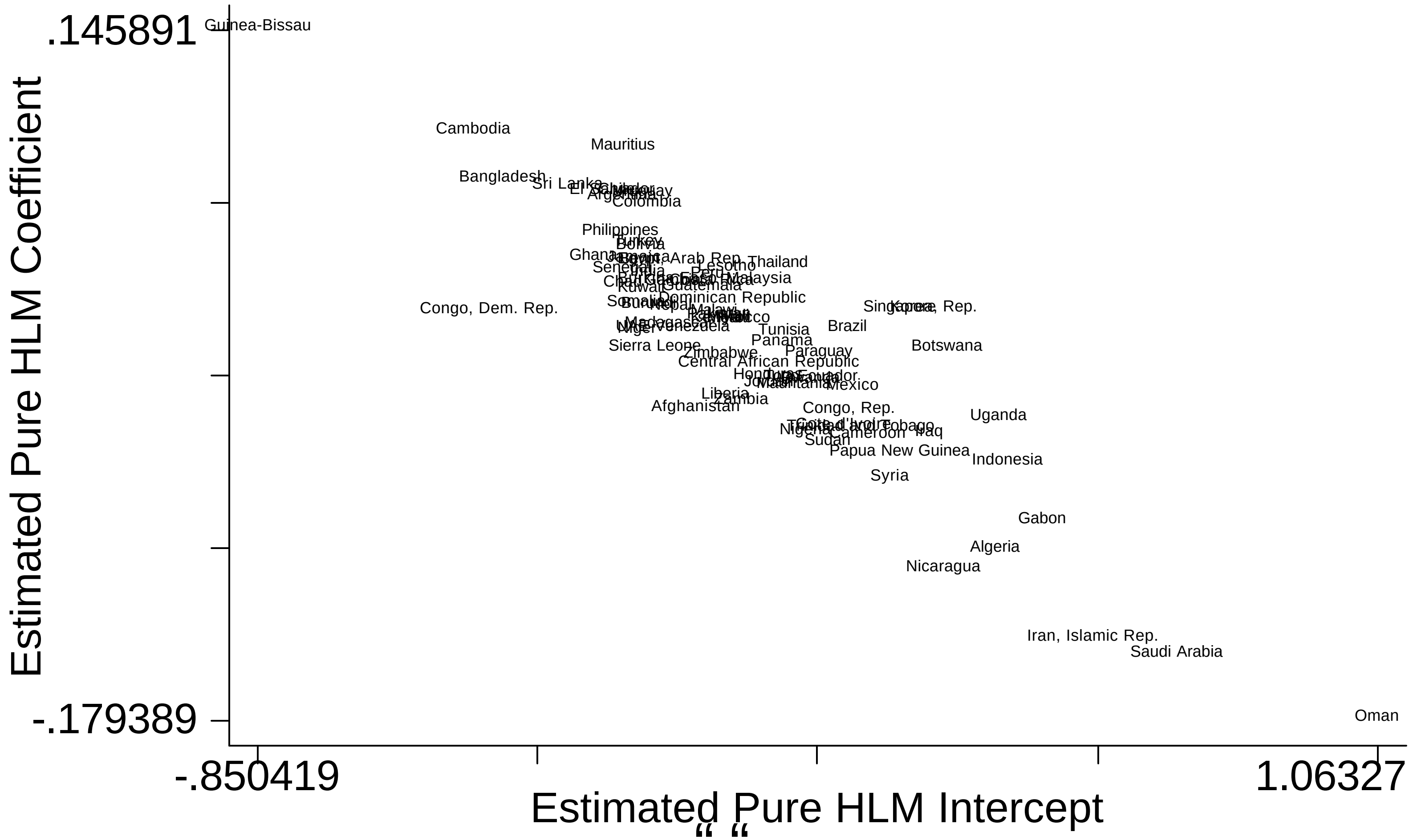

Figure 6: Relation Between Modified HLM Coefficient and Average EG

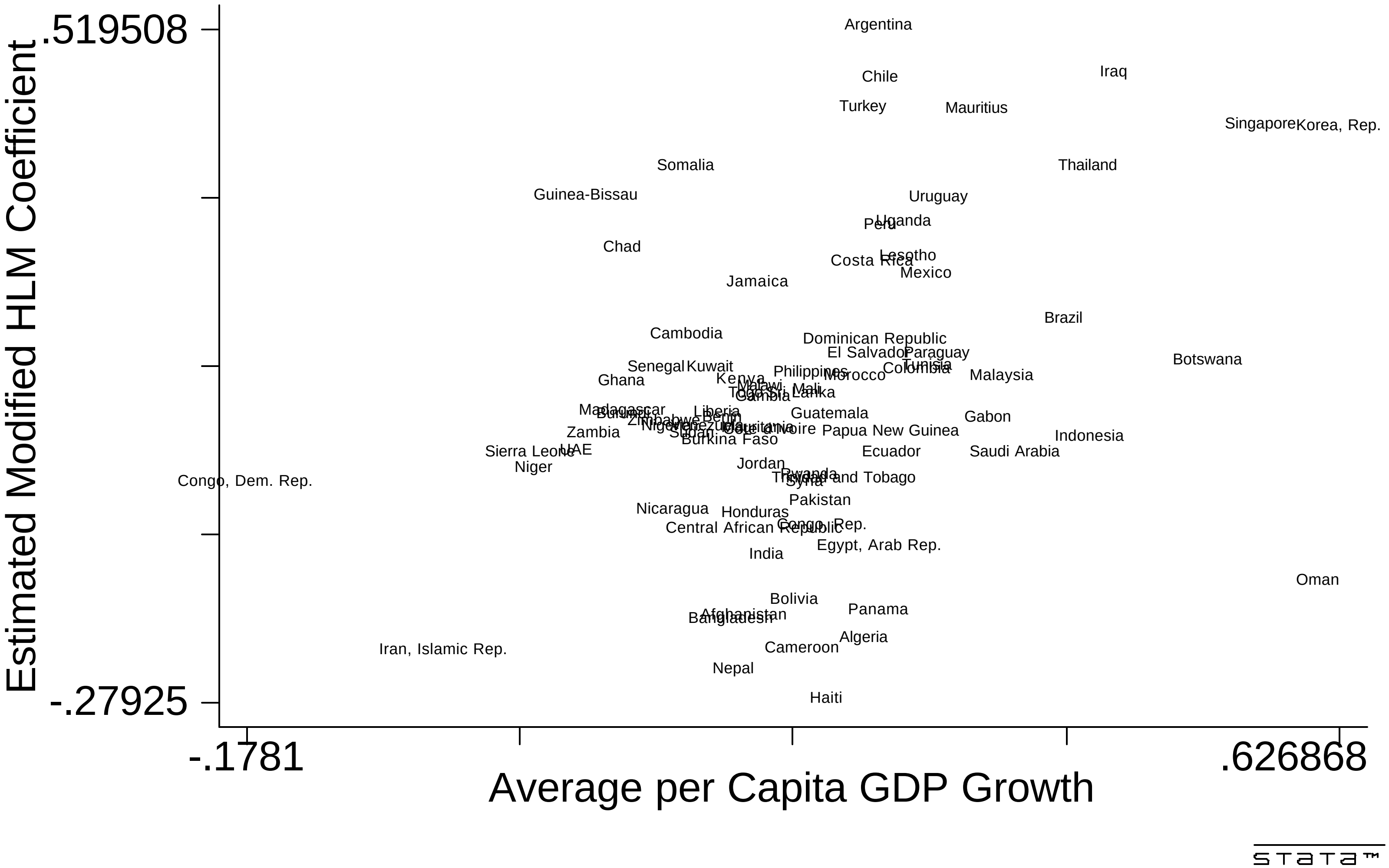

Figure 7: Relation Between the Pure and Modified HLM Coefficients

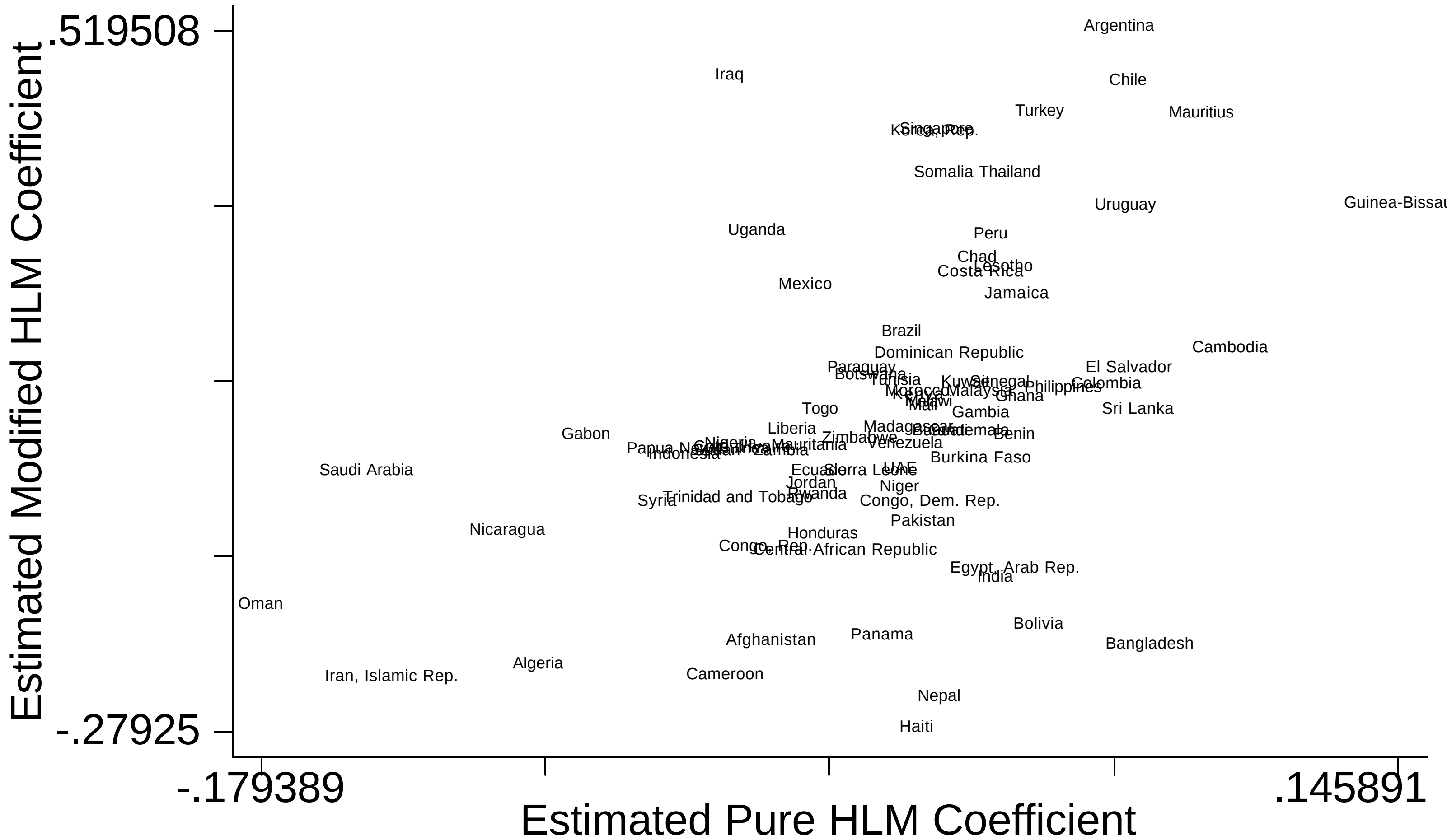

Figure 8: Explaining Sustainability of EG With IM

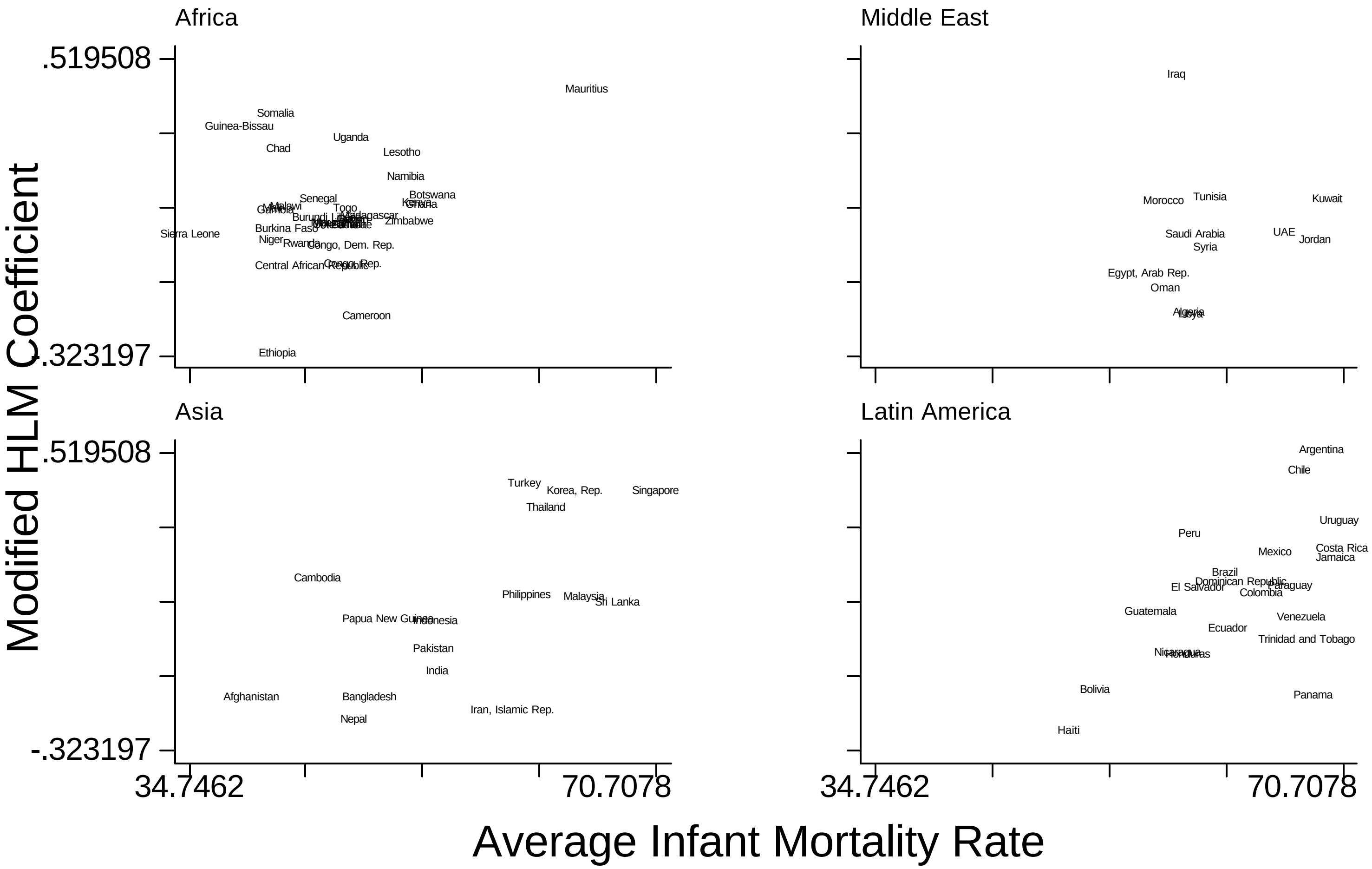

Figure 9: Explaining Sustainiability of EG With LE

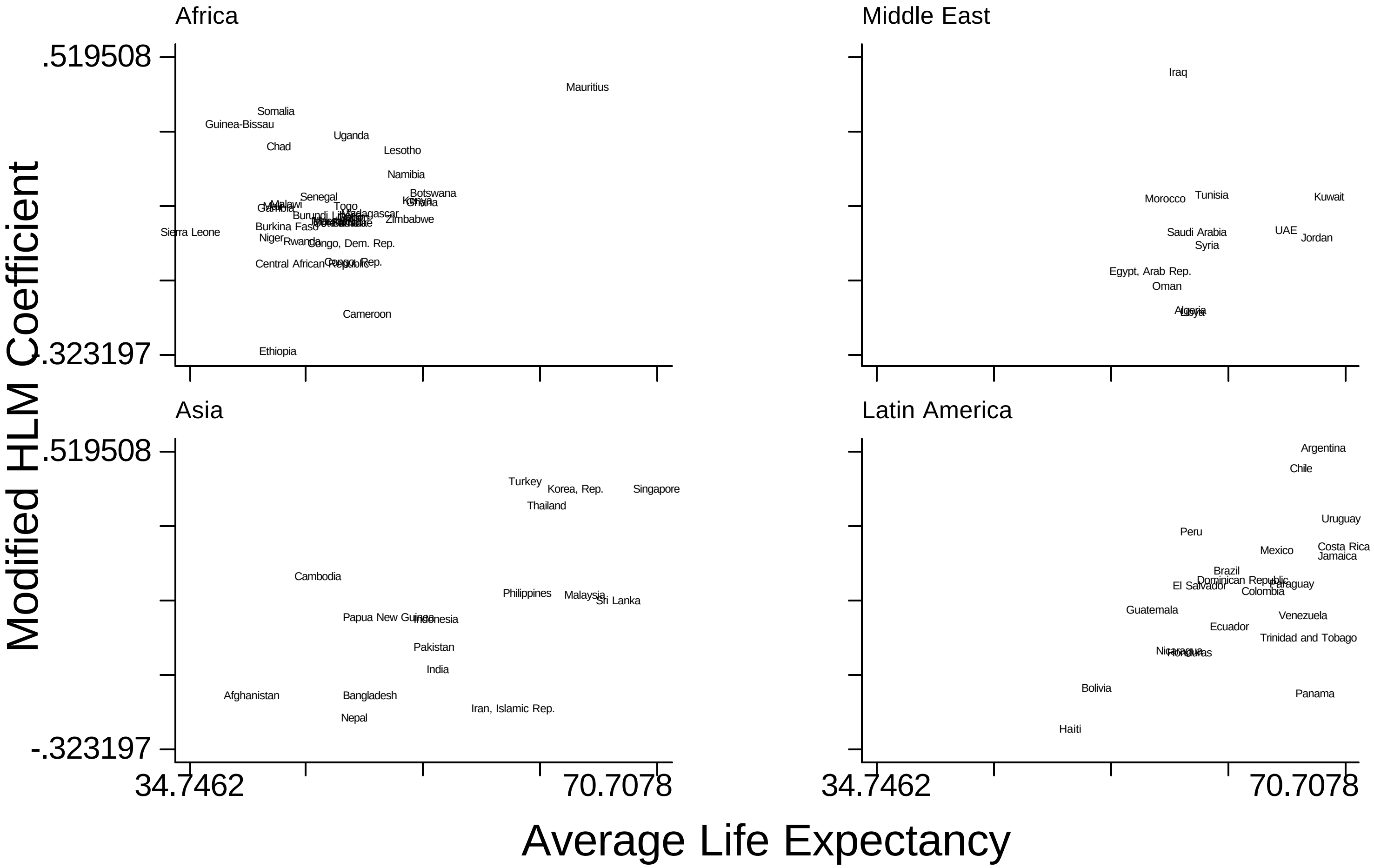

Figure 10: Explaining Sustainiability of EG With Secondary Enrollment

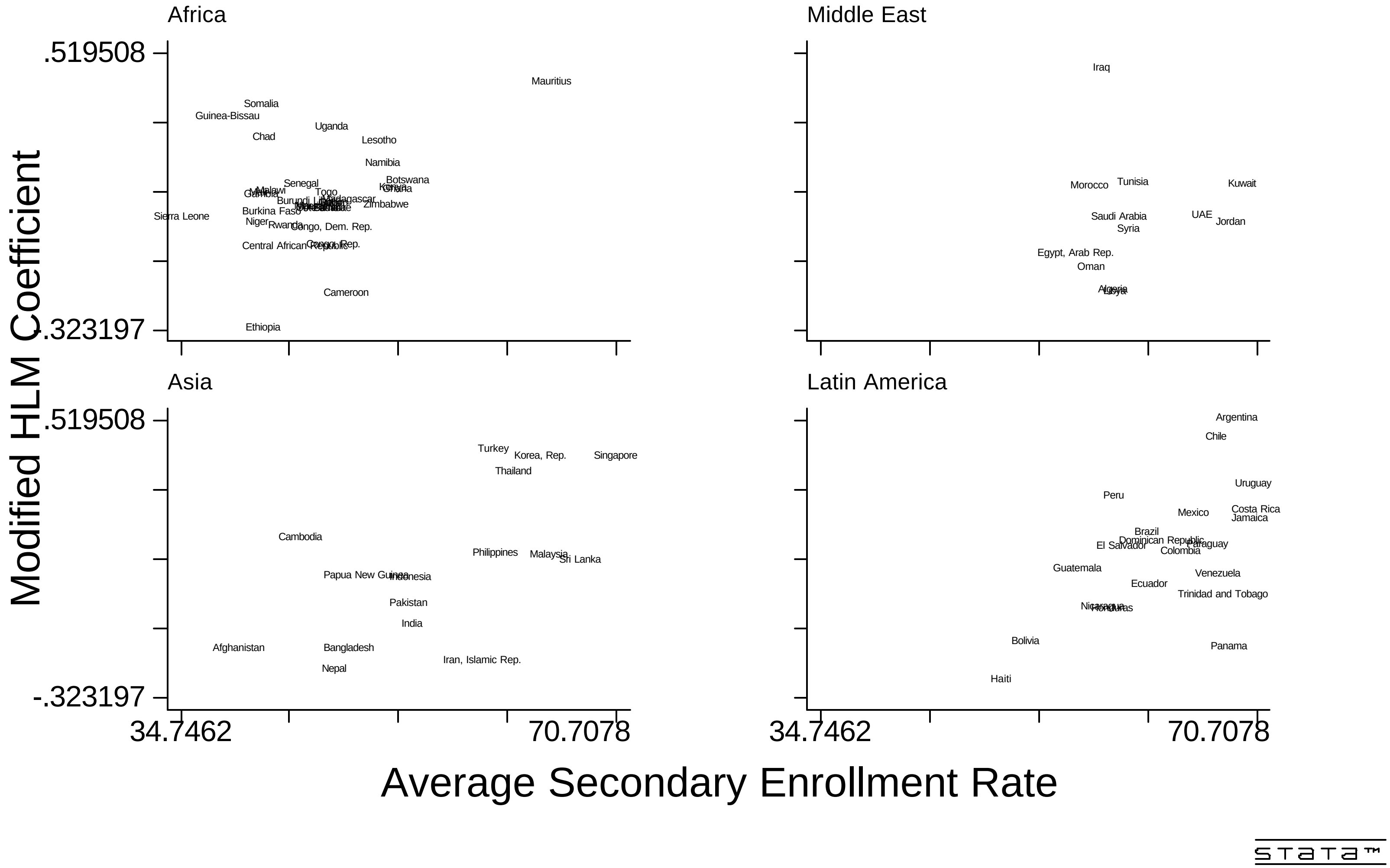

Figure 11: Chain A: From EG 1960-1980 to HD 1980-2000

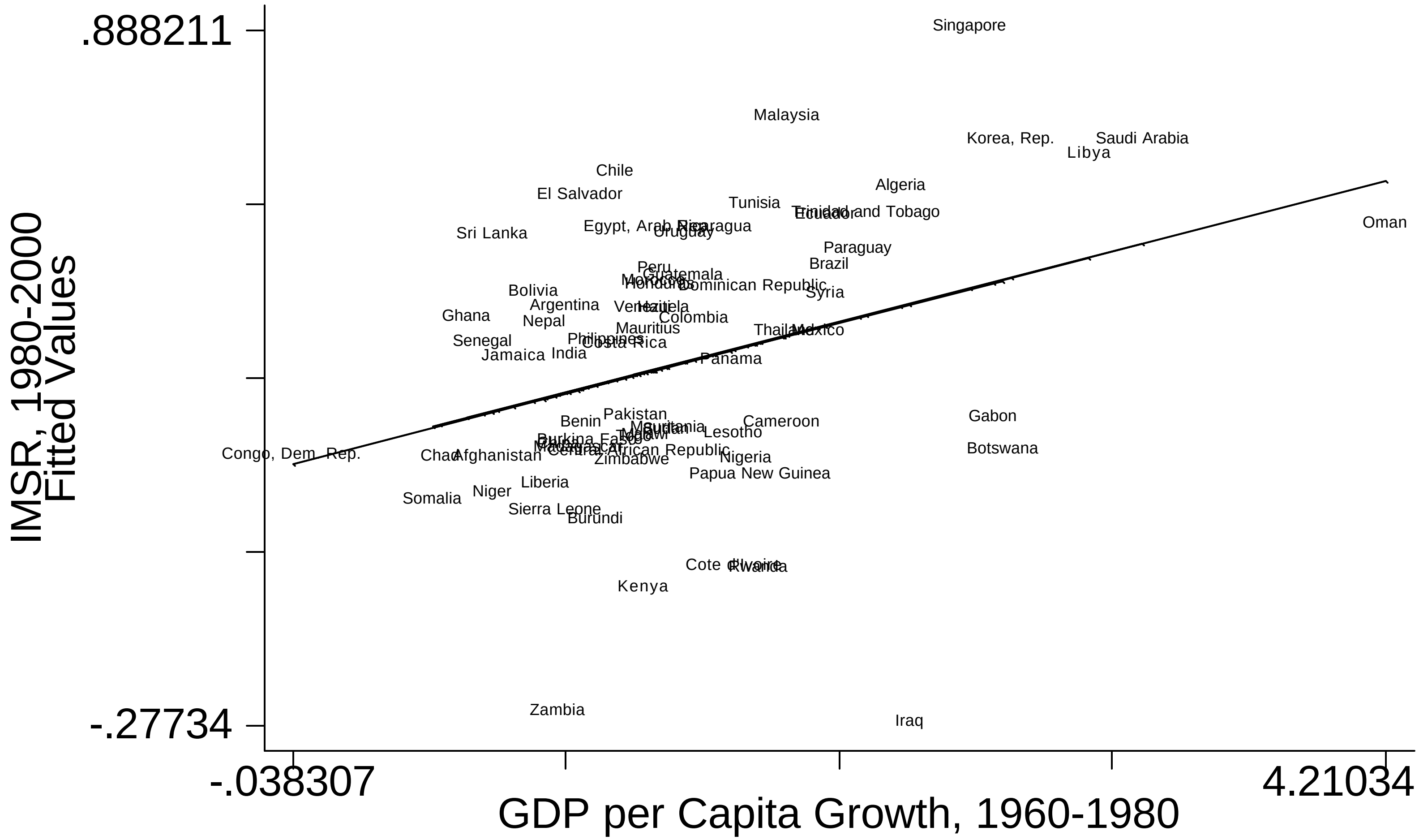

Figure 12: Chain A: From EG 1960-1980 to HD 1980-2000

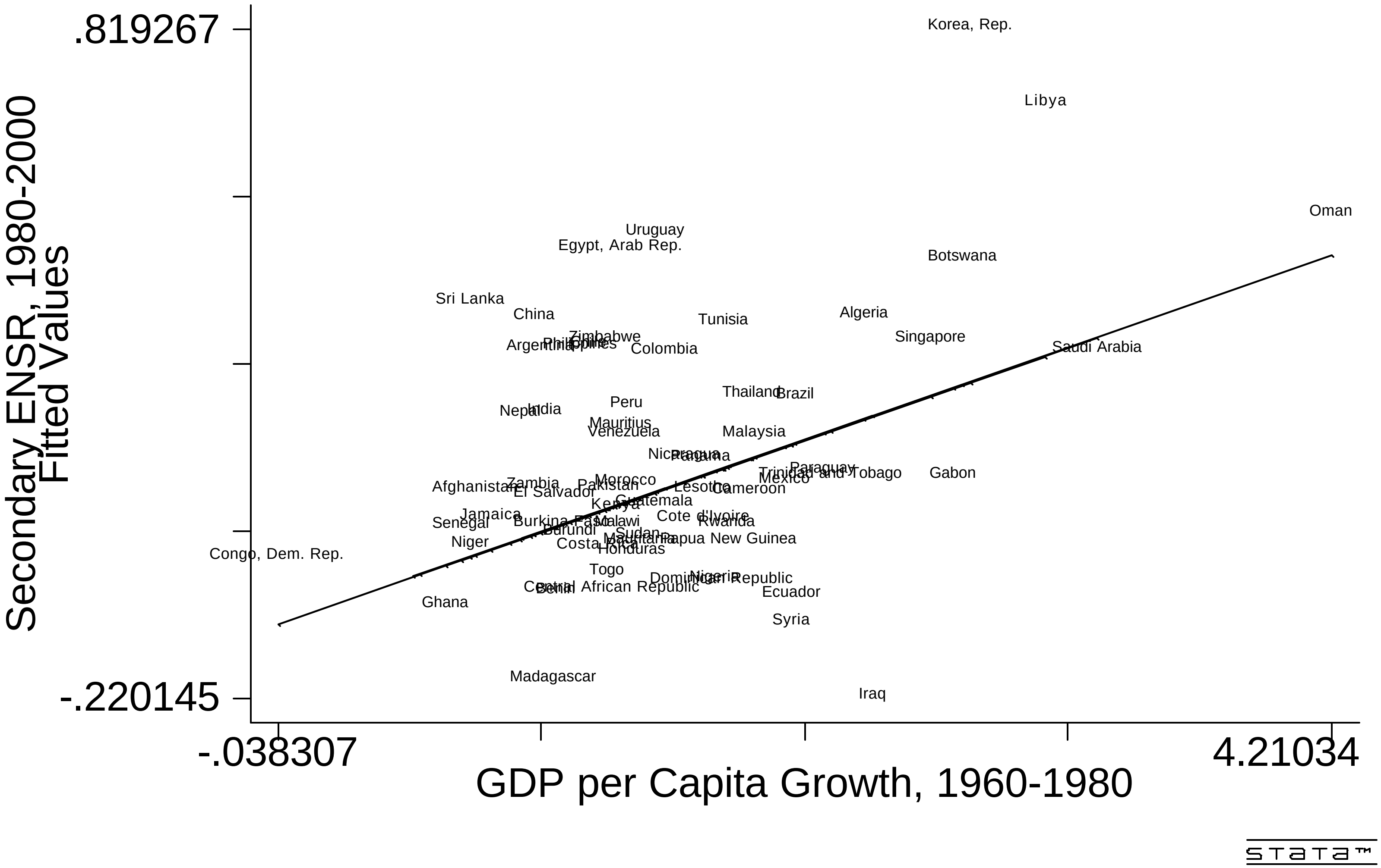

Figure 13: Relation Between Strength of Chain A and EG, 1980-2000

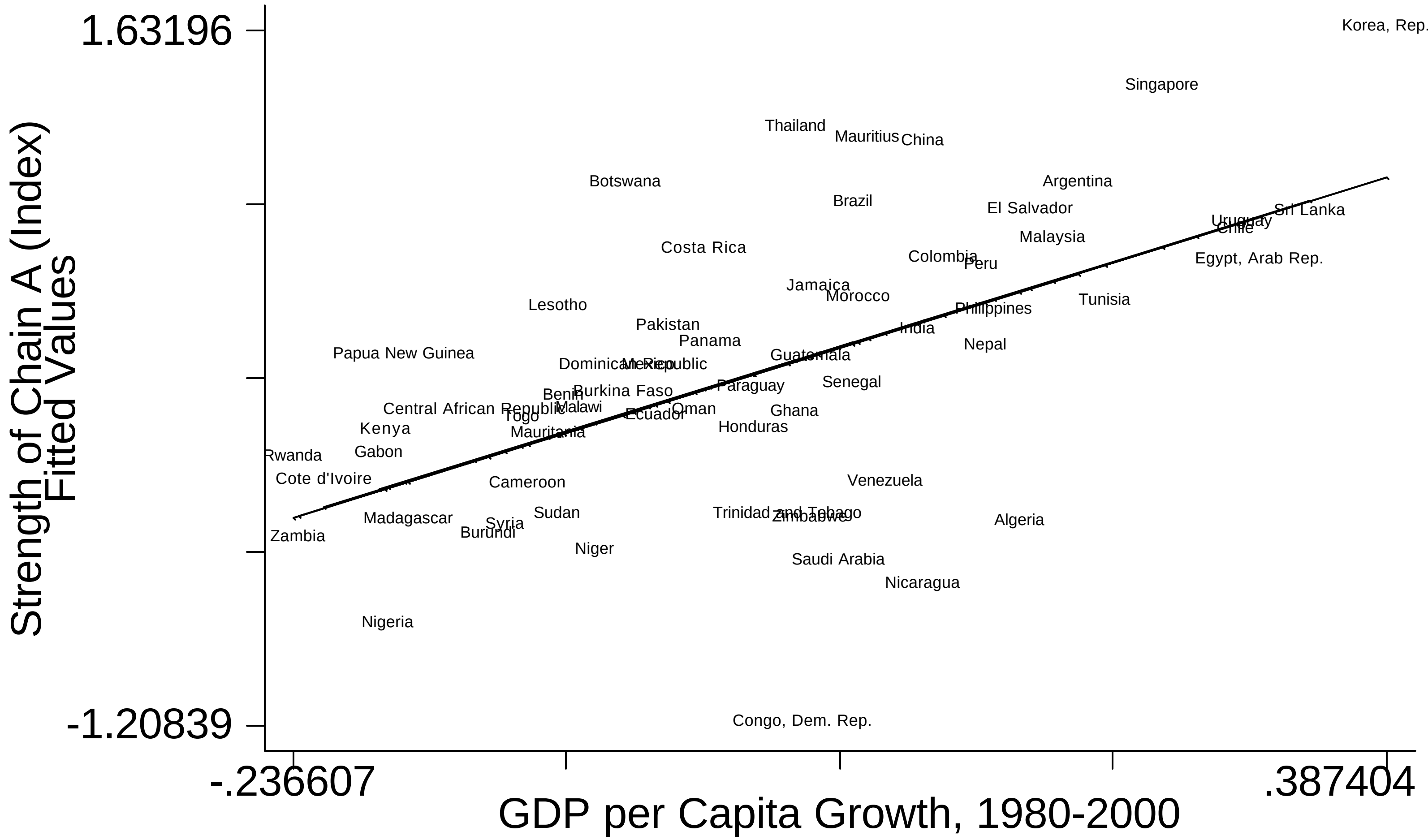

Figure 14: Strength of Chain A and Chain B Links

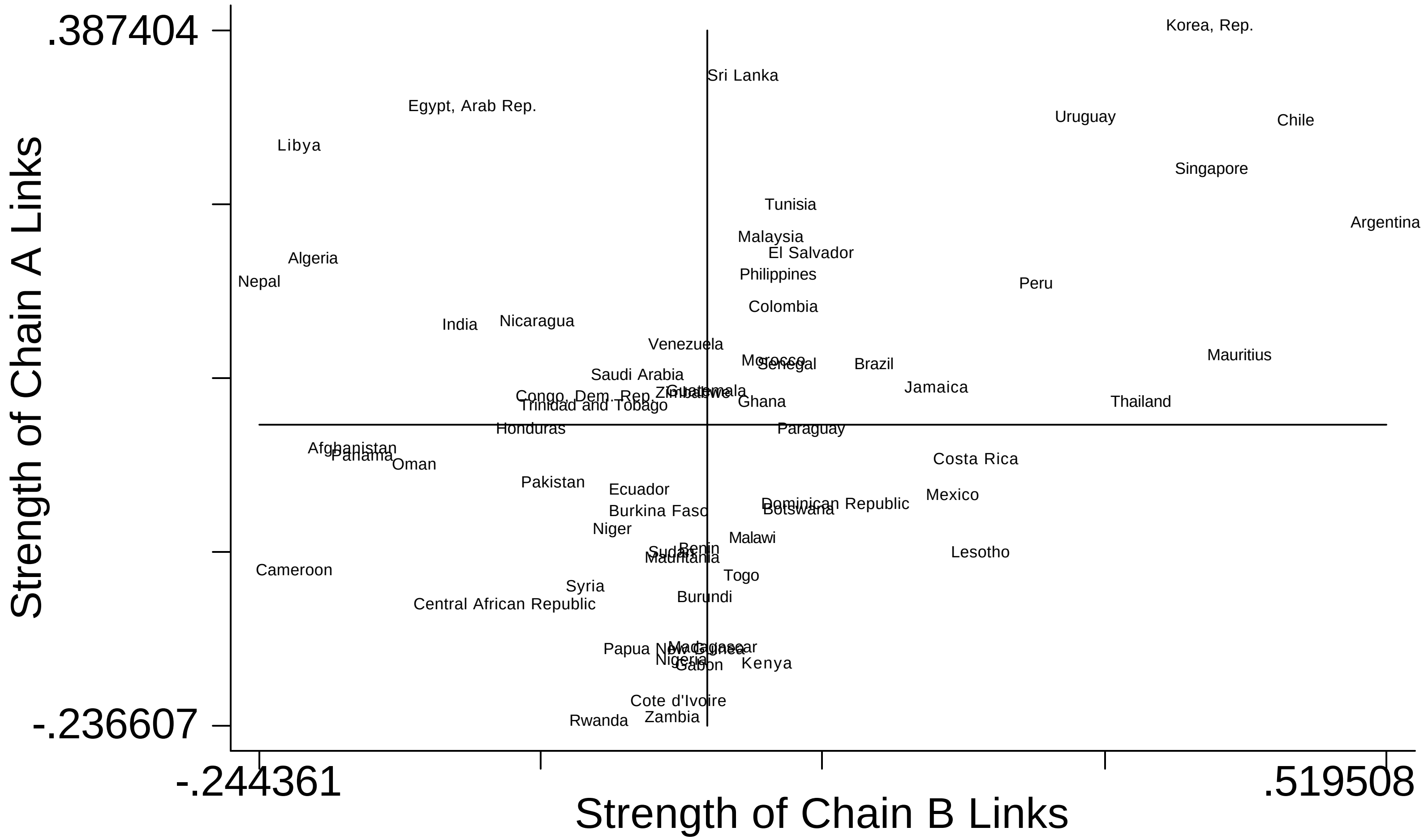

Figure 15: Strength of Chain A and Chain B Links By Region

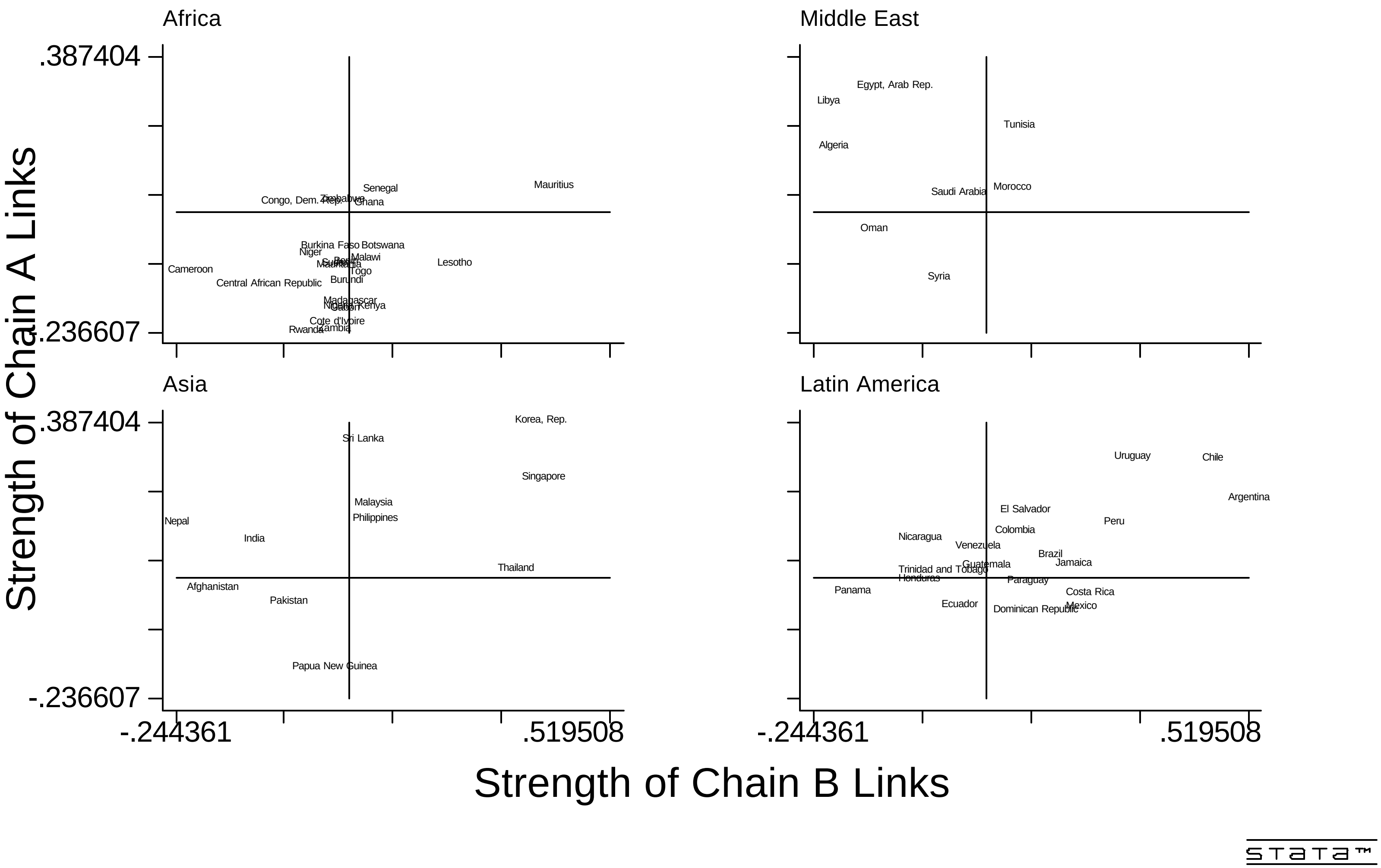

Table 1
Virtuous, Vicious and Lop-Sided Performance, 1960-2000

	1960-1970	1970-1980	1980-1990	1990-2000
Africa				
Benin	Vicious	Vicious	Vicious	Vicious
Botswana	-	Virtuous	Virtuous	HD-lopsided
Burkina Faso	Vicious	Vicious	Vicious	Vicious
Burundi	EG-lopsided	Vicious	Vicious	Vicious
Cameroon	Vicious	EG-lopsided	Vicious	Vicious
Central African Republic	-	Vicious	Vicious	Vicious
Chad	-	Vicious	Vicious	Vicious
Congo, Dem. Rep.	Vicious	Vicious	Vicious	Vicious
Congo, Rep.	Virtuous	Virtuous	Vicious	Vicious
Cote d'Ivoire	EG-lopsided	Vicious	Vicious	Vicious
Eritrea	-	-	-	Vicious
Ethiopia	-	-	Vicious	Vicious
Gambia, The	-	-	Vicious	Vicious
Ghana	HD-lopsided	Vicious	Vicious	Vicious
Guinea-Bissau	-	-	Vicious	Vicious
Kenya	HD-lopsided	Virtuous	HD-lopsided	HD-lopsided
Lesotho	EG-lopsided	EG-lopsided	Vicious	Vicious
Madagascar	Vicious	Vicious	Vicious	Vicious
Malawi	-	EG-lopsided	Vicious	Vicious
Mali	-	Vicious	Vicious	Vicious
Mauritania	-	-	Vicious	Vicious
Mauritius	-	-	Virtuous	HD-lopsided
Mozambique	-	-	Vicious	EG-lopsided
Namibia	-	-	Vicious	Vicious
Niger	-	Vicious	Vicious	Vicious
Nigeria	EG-lopsided	Vicious	Vicious	Vicious
Rwanda	Vicious	Vicious	Vicious	Vicious
Senegal	Vicious	Vicious	Vicious	Vicious

South Africa	Virtuous	-	HD-lopsided	HD-lopsided
Sudan	Vicious	Vicious	Vicious	EG-lopsided
Swaziland	-	EG-lopsided	Vicious	Vicious
Tanzania	-	-	-	Vicious
Togo	EG-lopsided	Vicious	Vicious	Vicious
Uganda	-	-	Vicious	Vicious
Zambia	-	Vicious	Vicious	Vicious
Zimbabwe	Virtuous	HD-lopsided	HD-lopsided	HD-lopsided
Middle East				
Algeria	Vicious	EG-lopsided	Vicious	HD-lopsided
Egypt, Arab Rep.	EG-lopsided	EG-lopsided	Vicious	Vicious
Iran, Islamic Rep.	-	Vicious	Vicious	HD-lopsided
Israel	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Jordan	-	-	HD-lopsided	HD-lopsided
Kuwait	-	HD-lopsided	HD-lopsided	HD-lopsided
Lebanon	-	-	-	Virtuous
Morocco	EG-lopsided	EG-lopsided	Vicious	Vicious
Oman	-	Vicious	Virtuous	HD-lopsided
Saudi Arabia	EG-lopsided	EG-lopsided	HD-lopsided	HD-lopsided
Syrian Arab Republic	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Tunisia	EG-lopsided	EG-lopsided	HD-lopsided	HD-lopsided
United Arab Emirates	-	-	HD-lopsided	HD-lopsided
Yemen, Rep.	-	-	-	Vicious
East Asia				
Cambodia	-	-	-	Vicious
China	HD-lopsided	Virtuous	Virtuous	Virtuous
Hong Kong, China	Virtuous	Virtuous	Virtuous	HD-lopsided
Indonesia	Virtuous	EG-lopsided	EG-lopsided	HD-lopsided
Korea, Rep.	Virtuous	Virtuous	Virtuous	Virtuous
Lao PDR	-	-	Vicious	Vicious
Malaysia	Virtuous	-	HD-lopsided	Virtuous
Mongolia	-	-	Vicious	Vicious
Papua New Guinea	-	Vicious	HD-lopsided	Vicious
Philippines	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Singapore	Virtuous	Virtuous	Virtuous	Virtuous
Thailand	Virtuous	Virtuous	Virtuous	HD-lopsided

Turkey	-	Vicious	Vicious	HD-lopsided
Vietnam	-	-	HD-lopsided	Virtuous
Latin America				
Argentina	Virtuous	HD-lopsided	HD-lopsided	HD-lopsided
Bolivia	Vicious	Vicious	Vicious	Vicious
Brazil	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Chile	Virtuous	HD-lopsided	HD-lopsided	Virtuous
Colombia	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Costa Rica	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Dominican Republic	Virtuous	Virtuous	HD-lopsided	Virtuous
Ecuador	HD-lopsided	Virtuous	HD-lopsided	HD-lopsided
El Salvador	Virtuous	Vicious	Vicious	HD-lopsided
Guatemala	Virtuous	EG-lopsided	Vicious	HD-lopsided
Haiti	Vicious	EG-lopsided	Vicious	Vicious
Honduras	Vicious	Vicious	HD-lopsided	HD-lopsided
Jamaica	Virtuous	HD-lopsided	HD-lopsided	HD-lopsided
Mexico	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Nicaragua	Virtuous	Vicious	Vicious	HD-lopsided
Panama	Virtuous	HD-lopsided	HD-lopsided	HD-lopsided
Paraguay	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Peru	Virtuous	Vicious	Vicious	HD-lopsided
Trinidad and Tobago	Virtuous	Virtuous	HD-lopsided	HD-lopsided
Uruguay	HD-lopsided	Virtuous	HD-lopsided	HD-lopsided
Venezuela, RB	HD-lopsided	HD-lopsided	HD-lopsided	HD-lopsided
South Asia				
Bangladesh	Vicious	Vicious	Vicious	Vicious
India	Vicious	Vicious	EG-lopsided	Vicious
Nepal	Vicious	Vicious	Vicious	Vicious
Pakistan	EG-lopsided	Vicious	Vicious	Vicious
Sri Lanka	Virtuous	Virtuous	HD-lopsided	HD-lopsided

Table 2
Chain A Descriptive Regressions: From EG to the Change in HD
(Measure of ΔHD is IMSR, 1960-2000)

Variable	(1)	(2)	(3)	(4)	(5)	(6)
GDP per Capita Growth Rate, 1960-1970x 10	1.66* (3.14)	2.01* (3.36)	1.67* (2.02)	1.16* (2.36)	1.24** (1.90)	1.30* (2.76)
Gross Primary Enrollment Rate, 1960 x 1000	3.79* (6.27)	-	-	-	-	-
Gross Female Primary Enrollment Rate, 1960 (% of Gross Enrollment) x 10	-	3.16* (3.64)	4.18* (4.00)	2.29* (2.92)	2.41* (2.68)	3.32* (3.40)
Gini Coefficient, average over 1960-2000 x 1000	-	-	-7.14* (2.37)	-	-5.29* (2.13)	-
Public Expenditure on Education (% of GDP), 1980-85 x 1000	-	-	-	-	-	9.30* (2.51)
Public Expenditure on Health (% of GNP), 1960 x 100						6.30* (2.28)
Middle East Dummy	-	-	-	0.31* (5.52)	0.23* (3.48)	0.46* (8.89)
Asia Dummy x 10	-	-	-	0.24* (5.12)	0.26* (5.02)	0.41* (8.01)
Latin America Dummy x 10	-	-	-	0.23* (5.00)	0.26* (5.40)	0.33* (7.46)

Intercept	0.27* (5.49)	0.25* (3.24)	0.52* (3.69)	0.21* (3.38)	0.43* (3.59)	-0.09 (0.75)
Number of Observations	74	73	59	73	59	41
R-squared	0.44	0.27	0.31	0.59	0.62	0.79

Note: Figures in parentheses are absolute t-statistics.
Omitted region is Africa.
* indicates significance at the 5% level, ** at the 10% level and *** at the 15% level.

Table 3
Chain B Descriptive Regressions: From HD to EG
(Measure of EG is GDP per Capita Growth, 1960-2000)

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log GDP per Capita, 1960 x 10	-5.16* (3.35)	-4.87* (3.50)	-6.04* (3.99)	0.17 (0.13)	-1.78 (1.22)	-2.24 (1.38)
Literacy Rate, 1970-1975 x100	-	2.71* (5.12)	1.66* (2.13)	-	1.56* (2.85)	-
Log Life Expectancy, 1960	3.76* (4.70)	-	2.16** (1.80)	-	-	-
Gross Domestic Investment (% of GDP), average over 1960-2000 x 100	-	-	-	9.06* (5.64)	6.80* (3.62)	5.65* (3.04)
Gini coefficient, average over 1960-2000 x 1000	-	-	-	2.00 (0.18)	0.65 (0.06)	1.45 (0.13)
HDI*, 1960	-	-	-	-	-	2.58* (3.21)
Middle East Dummy	0.78* (2.50)	1.38* (4.58)	1.15* (3.56)	0.17 (0.48)	0.42 (1.17)	0.32 (0.94)
Asia Dummy	0.42*** (1.46)	0.48** (1.79)	0.37 (1.35)	0.49* (1.98)	0.25 (0.98)	0.24 (0.92)
Latin America Dummy	0.05 (0.18)	0.12 (0.46)	0.02 (0.08)	0.31 (1.35)	-0.04 (0.17)	-0.10 (0.41)
Intercept	-10.24*	2.69*	-4.45	-0.48	0.41	0.69

	(3.97)	(4.42)	(1.11)	(0.61)	(0.46)	(0.78)
Number of Observations	73	71	71	62	60	52
R-squared	0.43	0.46	0.49	0.55	0.59	0.61

Note: Figures in parentheses are absolute t-statistics.
Omitted region is Africa.
* indicates significance at the 5% level, ** at the 10% level and *** at the 15% level.

Table 4
Explaining the Sustainability of EG Across Countries with HD
(Dependent Variable is the Estimated HLM Coefficient γ)

Variable	(1)	(2)	(3)
Average Infant Mortality (x10, mean = 9.73)	-0.02* (3.63)	-	-
Average Life Expectancy (x10, mean = 5.45)	-	0.16* (4.78)	-
Average Gross Secondary Enrollment Ratio (x10, mean = 3.77)	-	-	0.03* (2.19)
Log Gross Domestic Investment (% of GDP) (mean = 2.93)	0.07 (0.95)	0.03 (0.44)	0.08 (0.96)
Log Export Ratio (% of GDP) (mean = 3.11)	-0.05*** (1.45)	-0.06** (1.66)	-0.02 (0.65)
Middle East Dummy	-0.21* (3.41)	-0.32* (4.82)	-0.22* (3.15)
Asia Dummy	-0.11** (1.96)	-0.18 (0.83)	-0.09*** (1.52)
Latin America Dummy	-0.12* (2.11)	-0.24* (3.56)	-0.06 (1.04)
Intercept	0.34 (1.30)	-0.57* (3.19)	-0.14 (0.65)
Number of Observations	83	83	83
R-squared	0.24	0.31	0.16

Note: Figures in parentheses are absolute t-statistics.