A Panel Data Analysis of the Impact of Trade on Human Development

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Arguments for a positive link between trade and per-capita income are often met with the counterargument that "there is more to life than income" – the implication being that trade improves income, but degrades "quality of life." In this paper, we attempt to address this counterargument by examining the impact of trade on countries' social developments as measured by the Human Development Index (HDI) – a composite measure of education, literacy, and income published by the United Nations Development Programme. Utilizing a generalized method of moments (GMM) procedure in a panel data framework, we find that increases in trade are positively associated with future increases in social welfare.

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1. Introduction: "More to Life than Income"

Over two-hundred years of theoretical and empirical research, offered by both liberal and conservative economists, provides overwhelming evidence that free trade offers a significantly better life and substantially more socio-economic opportunities to individuals in both developing and developed countries.[2] The principal argument advanced, in virtually all introductory economics and international trade texts, is that free trade among countries channels resources to relatively more efficient industries. As a consequence, world output is augmented, the gains from trade are shared to varying degrees among countries, world per-capita income rises, and invariably both domestic and world welfare improve.[3]

Those who challenge the juggernaut of pro-free-trade evidence believe that trade is either a zero-sum game where "the rich grow richer and the poor become poorer," or trade at best "lifts all boats," but in a very inequitable fashion that heavily favors the rich.[4] These challengers also believe that trade has adverse non-income effects: trade is a major source of environmental degradation especially in developing countries; trade negatively impacts indigenous cultures; and, to the extent that it involves multinational national agreements or foreign direct investment, trade undermines national sovereignty.

Seminal research by Grossman (2003) debunks the environmental-degradation story. Grossman (2003) offers strong empirical evidence that trade-inspired growth raises

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[2] The birth of a pure theory of trade may be marked with the theory of Comparative Advantage as delineated by both Ralph Torrens in 1808 and 1815 and by David Ricardo in 1821—see Chacholiades (1978), chapter 1, Griswold (2003), Coughlin (2002), Krugman (1997), McCulloch (1997), Mussa (1997), and Kenen (1994).

[3] Excluding of course non-observed but theoretically possible cases of Jagdish Bhagwati's "immizerizing growth" where conditions of free trade and capital/technological growth lead to a dominating adverse change in the terms of trade. For example, assuming a non-functioning OPEC cartel, a technological innovation in oil drilling could depress the price of oil to the point that oil-export-dependent countries are made worse off.

[4] Cf., Bhagwati and Daly (1993), and Lash (1997).

the per-capita income of developing countries. As per-capita income passes various thresholds, developing countries utilize the additional income to improve their environment. Furthermore, in a free market setting, competition guarantees that profit-seeking industries will utilize the newest resource-saving technologies to reduce their costs of production. China's cities provide an enlightening example: In the 1980s, cities like Jinan, Tianjin, Xian, Beijing, and Shanghai were so soot-laden from coal dust, during the winter months, that cars had to drive with their headlights on during daytime. Trade, privatization, and foreign direct investment caused China's growth rates and per-capita income to surge. The increase in income allowed the major cities to convert to coal gas in the early 90s and then to natural gas in the mid-90s. By the late 90s, taxis were required to have catalytic converters. Although pollution is still a major challenge in China, as of 2004, the air and water quality has improved dramatically in most cities.

The impact of international trade on national sovereignty and indigenous cultures has been adequately addressed in the literature—especially by the Assistant Secretary of Commerce for Market Assess and Compliance, William H. Lash III.[5] Lash (1996) states that trade does not diminish national sovereignty, and that elements of culture deemed to be important by the domestic population are remarkably resilient.[6]

Studies which focus on income inequality and development may be highly misleading because countries may have identical income distributions but significantly different social welfare levels due to differences in economic and social mobility.[7] Admittedly, income equality is important, but a preferred avenue of research lies in

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[5] Cf., Quinlivan (2000), Bhagwati and Panagariya (1997), Weidenbaum (1999), Sweeney (1998), and Lash (1996).
[6] Cf., Lash (1996), and Quinlivan (2000).
[7] Cf., Birdsall and Graham (2000).

analyzing the impact of trade on factors that lead to improved economic and social mobility, e.g., improved educational opportunities, that promote human development.[8] Thus, the rational for our paper follows this path and we proceed to incorporate a broader measure of human development than per-capita income.

In the next section, we present an overview of the differential impact of trade on longevity and education across developed and developing countries. In section 3, we develop a panel data distributed lag model aimed at measuring the impact of trade on the Human Development Index. In section 4, we offer some concluding remarks on our results and suggestions for future research.

2. Expanding the Debate

Pro-trade arguments frequently focus on a positive link between openness and per-capita income. As stated above, we suggest expanding the debate by focusing on the impact of trade on broader social development. We use the United Nations Development Programme's (UNDP) Human Development Index (HDI) as our measure of social development.[9] The UNDP claims that the HDI is superior to per-capita GDP for measuring social well-being because: (1) per-capita GDP measures only income whereas the HDI is also weighted for longevity and education, and (2) per-capita GDP only reflects average income whereas HDI is influenced by the type of goods that constitute

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[8] Ibid. Almost all the authors point out that education is the principal reason for the increase in mobility over the last century.

[9] In addition to the HDI, the UNDP also publishes the Human Poverty Index for Developing Countries (HPI-1), the Human Poverty Index for Select OECD Countries (HPI-2), the Gender-Related Development Index (GDI), and the Gender Empowerment Measure (GEM). The HPI-1 and HPI-2 indices are composite measures of poverty indicators. The GDI is a comparison of longevity, education, and per-capita income across genders. The GEM measures cross-gender disparities in political and economic power.

GDP.[10] For example, "…a country with a very high GDP per-capita such as Kuwait has a lower HDI rank because of a relatively lower level of educational attainment. Uruguay has roughly half the GDP per-capita of Kuwait but has a higher HDI rank."[11]

To construct the HDI, the UNDP looks at various social outcome measures for each country and establishes a "dimension index" for each country and outcome.[12] Dimension indices that feed into the HDI are: GDP index,[13] life expectancy index, adult literacy index, and gross educational enrollment index.[14] Because the index calculations can change from one publication to the next, the UNDP recalculates the HDI for all countries from 1975 to the current year using the current year's index calculations.[15] As a result, HDI figures published in different years cannot be directly compared. Further, because the indices are functions of maximum and minimum values across countries, an absolute, but not relative, improvement in a one of the measures can result in a decrease in the country's index.

The standard argument for a positive relationship between trade and human development is that more trade begets a greater standard of living which, in turn, begets more education, better health care, better social services, etc. The standard argument rests

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[10] Cf., Wallace (2004). Wallace's interview with Amartya Sen, a major contributor to the development of the HDI, reveals the following: (1) to develop a measure of the standard of living for a particular country that is broader in scope than "… GNP [per-capita] and take account of the different influences on human well-being and opportunity"; (2) the purpose of the index is to reflect "observed features of living conditions"; (3) that HDI is "…the most widely accepted measure of comparative international welfare."

[11] http://www.undp.org/hdr2001/faqs.html

[12] The dimension index is calculated as (actual – minimum) / (maximum – minimum) where the maximum and minimum values are set as "goal posts" by the researchers. For example, setting the maximum and minimum literacy rates to 100 and 0, respectively, a country with a literacy rate of 85% would receive a literacy dimension index of $(85 - 0) / (100 - 0) = 0.85$.

[13] Unlike the other indices, the GDP dimension index is calculated as $(\ln(\text{actual}) - \ln(\text{minimum})) / (\ln(\text{maximum}) - \ln(\text{minimum}))$.

[14] The indices are combined such that HDI = (1/3)(life expectancy index) + (2/9)(adult literacy index) + (1/9)(gross educational enrollment index) + (1/3)(GDP index).

[15] For example, in 2003, the "maximum" and "minimum" life expectancies were set at 85 and 25, respectively. The "maximum" and "minimum" GDP's were set at 40,000 and 100.

on the premise that trade's influence on *income* is direct, while trade's influence on non-income measures is *indirect* and transmitted via income. A broader or "globalist" argument is that trade impacts non-income human development measures <u>both</u> indirectly via income and directly via cross-cultural fertilization and an increased variety of goods available. Trade promotes education because communication, cross-cultural understanding, and global awareness are necessary for conducting business across countries. Trade results not merely in an increase in the quantity of goods consumed, but an increase in the variety of goods consumed. To a developing nation, the new types of goods flowing into the country will include medicines, health related equipment, and medical training – all of which improves the health, nutrition, and longevity of the country's people. Even if trade had no impact on income, we would expect the cross-cultural fertilization that accompanies trade to foster improved human development simply by broadening people's outlooks and exposing the people to new products.

We argue that the relationship between per-capita trade and human development will follow a distributed lag pattern. Following our "indirect effect" argument above, improvements in trade will result in some immediate income gains. The immediate income gains will, in turn, result in future increases in literacy and health as people's standards of living rise and the opportunities for returns to education increase. Direct gains in human development result from exposure to foreign goods (particularly medical and health related products). As with new products in developed countries, "early adopters" provide an example and testament to novel goods and practices such that the impact of the new products is felt over time as adoption spreads. Given this line of argument, we can imagine cases in which the link between trade and human development

might be mitigated such as totalitarianism (wherein consumption of foreign goods is restricted), socialism (wherein trade is conducted by the government, not the private sector), and extreme industry concentration (wherein the bulk of trade is conducted by a small group within the population). In each of these instances, we might expect the impact of trade on human development to be lessened because the exposure to the benefits to trade is restricted to a select few.[16]

In an attempt to capture the impact of trade on human development, we model the change in the HDI index as a function of per-capita trade. Studies involving trade usually look at trade as a share of GDP. Given our focus on human development, we are concerned with trade as it impacts the people and so use the metric *trade per-capita* rather than *trade per-GDP*. For example, suppose a country's economy grows 3% while its trade grows 2% and its population remains constant. The trade per-GDP metric would show a decline in trade when, in fact, relative to the people impacted by the trade, more trade is occurring.

3. Measuring the Impact of Trade on Human Development

Because the Human Development Index is integrated, we use the change in the HDI over adjacent years as the dependent variable

$$y_{it} = \text{HDI}_{it} - \text{HDI}_{i,t-1} \qquad (1.1)$$

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[16] We offer this argument for the purpose of explication. The construction and testing of formal hypotheses along these lines is beyond the scope of this paper.

where y_{it} is the growth in the HDI for country i (out of N countries) in year t (out of T years).[17]

To measure the impact of trade on countries' HDI growths, we model the growth in the HDI as a distributed-lag function of current and past changes in the country's per-capita trade, where we define "trade" as the sum of FOB exports and imports:

$$x_{it} = \ln\left(\frac{\text{Exports}_{it} + \text{Imports}_{it}}{\text{Population}_{it}}\right) - \ln\left(\frac{\text{Exports}_{i,t-1} + \text{Imports}_{i,t-1}}{\text{Population}_{i,t-1}}\right) \qquad (1.2)$$

where $i = [1, 154]$, and $t = [1, 28]$. The panel contains annual data on 154 countries over the period 1975 through 2002. Of the possible 4,312 HDI observations, 750 are missing. Of the 3,562 present HDI observations, 1,193 come from "high development" countries, 1,689 from "medium development" countries, and 680 from "low development" countries.[18] After accounting for the impact of lags and missing data in the independent variables, we are left with 2,237 matched observations of which 36% come from high development countries, 44% come from medium development countries, and 20% come from low development countries. The distribution among levels of development represented in the final data set approximately matches the distribution of levels of development among the 154 countries (33%, 48%, and 19%, respectively). The distributions of countries according to the HDI and the components of the HDI (life index, education index, and GDP index) are shown in Figure 1.

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[17] Because HDI figures published in different years are not comparable, for each publication, the UNDP goes back and recalculates historical HDI figures utilizing the current year's calculation methods. The historical HDI figures used in this paper come from a single Human Development Report and so are comparable.

[18] Some of the countries may have moved between income classifications over the span of the data set. The income classifications shown here are for the countries as of the 2002 HDI. The Human Development Report defines high development countries as those with HDI's of 0.8 or higher, and medium development countries as those with HDI's of 0.5 or higher but less than 0.8. Those remaining are classified as low development countries.

[insert Figure 1 here]

Data on the HDI are available in five-year increments (with the exception of the most current year) for the period 1975 through 2002. As data on per-capita trade is available on an annual basis, we interpolate the HDI for intervening years by assuming a straight-line annual progression from one measurement to the next.[19] Although this results in more than 70% of the observations of the HDI being estimated, we argue that the changes in the HDI over a single five-year interval are small enough that the interpolation is reasonable. For example, the median and third-quartile changes in HDI over all five-year periods and for all countries are 3% and 5%, respectively.

Let us suppose that the growth rate in a country's HDI (y_{it}) is a distributed-lag function of the current and past log changes in the country's per-capita trade (x_{it}, $x_{i,t-1}$, …). We have:

$$y_{it} = \alpha + \beta \left(x_{i,t} + \lambda x_{i,t-1} + \lambda^2 x_{i,t-2} + ... + \lambda^t x_{i,0} \right) + u_{it} = \alpha + \beta \sum_{k=0}^{t} \lambda^k x_{i,t-k} + u_{it} \qquad (1.3)$$

Following the standard procedure for modeling geometric lags, we have:

$$y_{it} - \lambda y_{i,t-1} = \alpha(1-\lambda) + \beta x_{it} + u_{it} - \lambda u_{i,t-1} \qquad (1.4)$$

or

$$y_{it} = \alpha(1-\lambda) + \beta x_{it} + \lambda y_{i,t-1} + u_{it} - \lambda u_{i,t-1} \qquad (1.5)$$

Because $y_{i,t-1}$ contains a random component (both by virtue of its status as the dependent variable and because of the interpolations we introduced), and because the error term in (1.5) exhibits serial correlation, OLS and GLS procedures will yield biased and inconsistent parameter estimates. Following the general techniques laid out in Davies

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[19] Population and trade data come from the International Monetary Fund's International Financial Statistics (September 2004).

and Lahiri (1995), and Davies and Lahiri (1999), we construct an error covariance matrix and employ generalized method of moments (GMM) to estimate the model. We use values of x_{it} lagged from one to four years, and changes in the population growth rate from year t-1 to year t (g_{it}) as instruments.

Let us assume that the disturbances are homoskedastic within countries and over time, (possibly) heteroskedastic across countries, and otherwise well behaved. That is:

$$\text{cov}(u_{it}, u_{js}) = \begin{cases} \sigma_i^2 & \forall\ i = j,\ t = s \\ 0 & \text{otherwise} \end{cases} \tag{1.6}$$

Rewriting the disturbance in (1.5), we have

$$y_{it} = \alpha(1 - \lambda) + \beta x_{it} + \lambda y_{i,t-1} + v_{it} \tag{1.7}$$

where

$$\text{cov}(v_{it}, v_{js}) = \begin{cases} \sigma_i^2(1+\lambda^2) & \forall\ i = j,\ t = s \\ -\lambda\sigma_i^2 & \forall\ i = j,\ |t-s| = 1 \\ 0 & \text{otherwise} \end{cases} \tag{1.8}$$

Constructing the NT x NT error covariance matrix, $\boldsymbol{\Omega}$, represented by (1.8), we have:

$$\boldsymbol{\Omega} = \begin{bmatrix} \sigma_1^2 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \sigma_N^2 \end{bmatrix}_{NxN} \otimes \begin{bmatrix} 1+\lambda^2 & -\lambda & 0 & \cdots & 0 \\ -\lambda & 1+\lambda^2 & -\lambda & & \vdots \\ 0 & -\lambda & 1+\lambda^2 & \ddots & 0 \\ \vdots & & \ddots & \ddots & -\lambda \\ 0 & \cdots & 0 & -\lambda & 1+\lambda^2 \end{bmatrix}_{TxT} \tag{1.9}$$

The GMM parameter estimates are

$$\hat{\boldsymbol{\beta}}_{GMM} = \left(\mathbf{X'Z}(\mathbf{Z'\Omega Z})^{-1}\mathbf{Z'X}\right)^{-1}\mathbf{X'Z}(\mathbf{Z'\Omega Z})^{-1}\mathbf{Z'Y} \tag{1.10}$$

where $\mathbf{Z}$ is the matrix of instrumental variables, the tth row of $\mathbf{X}$ is $[1 \; x_{it} \; y_{i,t-1}]$, and the tth row of $\mathbf{Z}$ is $[1 \; x_{it} \; x_{i,t-1} \; x_{i,t-2} \; x_{i,t-3} \; x_{i,t-4} \; g_{it}]$. The variances of the parameter estimates are given by

$$\text{var}\left(\hat{\boldsymbol{\beta}}_{GMM}\right) = \left[\mathbf{X'Z}\left(\mathbf{Z'\Omega Z}\right)^{-1}\mathbf{Z'X}\right]^{-1} \tag{1.11}$$

After constructing (1.9), but before computing (1.10) and (1.11), we adjust the data set for missing observations. For each row, j, of $\Psi = \begin{bmatrix} \mathbf{X} \; \mathbf{Y} \; \mathbf{Z} \end{bmatrix}$ for which at least one column entry contains a missing observation, we delete the jth rows of $\mathbf{X}$, $\mathbf{Y}$, and $\mathbf{Z}$, and delete both the jth row and j^{th} column of Ω.[20]

We first perform instrumental variable estimation on (1.7) assuming spherical disturbances. The parameter estimates achieved are inefficient, but unbiased and consistent. Using the consistent estimate for λ, we construct the estimated error covariance matrix $\widehat{\boldsymbol{\Omega}}$ according to (1.9). Using the consistent estimate $\widehat{\boldsymbol{\Omega}}$, we perform the GMM estimation in (1.10).

We obtain the following GMM estimates (where numbers in parentheses are standard errors). The estimates for β and λ are significant at the 1% level:

$$\alpha = 0.0003 \;\; (0.0001)$$
$$\beta = 0.0017 \;\; (0.0003)$$
$$\lambda = 0.8795 \;\; (0.0273)$$

Note that GMM estimates are efficient among the class of instrumental variable estimators, but not among the class of linear estimators. Thus, our rejections of the null hypotheses $\beta = 0$ and $\lambda = 0$ can be considered at least as significant as what we would

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[20] This procedure follows that described in Davies and Lahiri (1995).

obtain from best linear unbiased estimators (were such estimates achievable given this

data). From our estimate for λ, we can compute the median and mean geometric lags as:

$$\text{Median lag} = \frac{\ln 0.5}{\ln \lambda} = 5.4$$

$$\text{Mean lag} = \frac{\lambda}{1-\lambda} = 7.3$$

(1.12)

Given these results we conclude that: (1) an increase in per-capita trade is

associated with a subsequent series of increases in the growth of the Human

Development Index, and (2) the series of increases in the growth of the HDI occur such

that, after approximately five years, one-half of the full change in HDI has been realized.

For example, consider the country with the lowest HDI for 2002 (Sierra Leone at 0.27),

and the country with the greatest mean annual per-capita trade growth (China at 14.0%

for the period 1981 through 2002). According to our estimated model, if a country with

the HDI of Sierra Leone were to maintain a per-capita trade growth equal to that of

China, the country would improve its HDI from 0.27 to 0.32 over the course of a single

generation.[21] The significance of the change is more apparent when one converts the

change in the HDI into the implied changes in the HDI components. For example, a

country with an HDI of 0.27 might have the following component measures: per-capita

GDP = $500, life expectancy = 41 years, adult literacy rate = 27%, and educational

enrollment = 27%. An increase in the HDI to 0.32 is the same as either (1) a 160%

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[21] The criticism that a country like Sierra Leone could not maintain the trade growth of a country like China is refuted by the data. For example, Maldives and Myanmar had per-capita trade levels less than that of Sierra Leone in 1977 (the first year for which data is reported for Sierra Leone), yet exhibited average annual per-capita trade growth similar to that of China (12.8% and 12.3%, respectively).

increase in per-capita GDP to $1,300, or (2) a 10-year increase in life expectancy to 51 years, or (3) a 50% increase in adult literacy and education attainment rates to 43%.[22]

4. Conclusions

This paper offers evidence, within the context of a multi-country, multi-year panel data analysis, which suggests a significantly positive relationship between improvements in social welfare and increased trade. In a related study, Hoskins and Eiras (2002), find that economic freedom and real per-capita GDP are positively related in an accelerating fashion, and that the relationship can be explained by the protection of property rights. Similarly, a study by Flanders et al. (2001) show that, among developing countries, those with significantly more open economies also had the highest per-capita incomes while those with closed economies were the poorest. The authors also found that the freer nations attracted more foreign direct investment—the poorest ten countries attracted only 0.43 percent of the total FDI obtained by the 54 developing countries in their sample.

While this study begins to scratch the surface of the impact of trade on social welfare, the results point to some areas that beg further study. For example: The UN Development Programme constructs additional measures of social welfare such as the Human Poverty Index (HPI), the Gender-Related Development Index (GDI), and the Gender Empowerment Measure (GEM). Similar analyses of these measures may point to differences in the impact of trade on alternate social welfare measures, and/or a common "propagation path" in which improvements in trade encourage a similar sequence of improvements across countries—for example, improved trade is followed by improved

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[22] For illustrative purposes, we treat each component change independently. In reality, the increase in the HDI would be driven by smaller, but coincident, increases in more than one of the components.

per-capita income, which is followed by improved literacy, which is followed by improved longevity, etc. In addition, by employing techniques in spatial analysis, and subject to data availability, further research may be able to illuminate the manner in which improvements in social welfare propagate across trading partners as trade increases.

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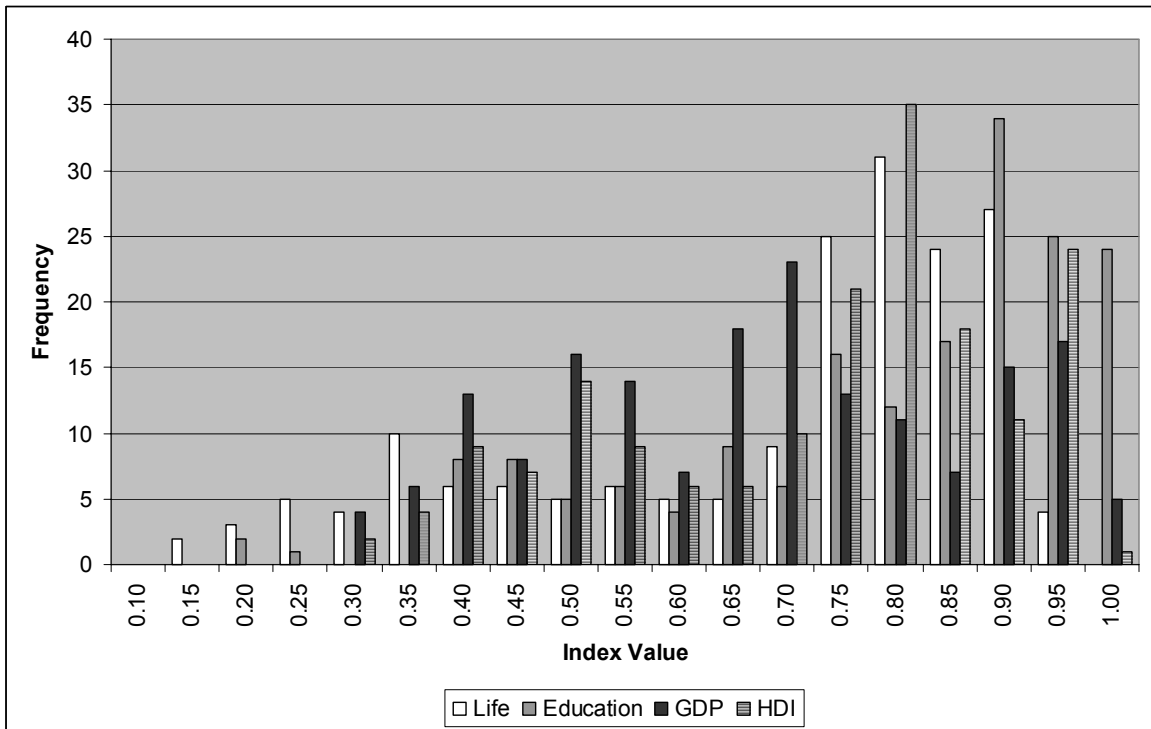Monetary Fund, IMF Publication Services, Washington DC, 2001.

Figure 1. Distributions of Countries by Indices