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A panel data analysis of social cohesion and human development causality

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Μια ανάλυση δεδομένων πάνελ για τη σχέση μεταξύ κοινωνικής συνοχής και ανθρώπινης ανάπτυξης

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ABSTRACT

The literature on human development is mostly centered on human development core dimensions: health, education and living standard. Studies centered on non-core dimensions such as human rights, participation, and social dimensions are relatively less abundant compared to the formers. With regard to non-core dimensions, few cases consider the relationship between social cohesion and human development. For the few cases considering such aspect, none assesses the bidirectional relationship between the two concepts. This paper uses a panel data approach to investigate the relationship between social cohesion and human development in 61 countries all over the world. Two indices are used for this end: the Human Development Index (HDI) of the Human Development Report Office and an index of social cohesion from the Institute of Development Studies' database for the period 1990 to 2010. The main findings suggest that in the long run there is a positive and significant bidirectional relationship between social cohesion and human development. No relationship is found in the short run. The study recommends investment in social cohesion to build human development.

KEY WORDS: Panel Data Analysis, Social Cohesion, Human Development, Human Development Index (HDI), Institute of Development Studies, 1990-2010.

ΠΕΡΙΛΗΨΗ

Η βιβλιογραφία για την ανθρώπινη ανάπτυξη ασχολείται κυρίως με τις βασικές διαστάσεις της ανθρώπινης ανάπτυξης: την υγεία, την εκπαίδευση και το βιοτικό επίπεδο. Οι μελέτες που επικεντρώνονται σε μη βασικές διαστάσεις όπως τα ανθρώπινα δικαιώματα, η συμμετοχή και οι κοινωνικές διαστάσεις είναι σχετικά λιγότερες σε σύγκριση με τις πρώτες. Όσον αφορά τις μη βασικές διαστάσεις, μόνο ορισμένες μελέτες εξετάζουν τη σχέση μεταξύ κοινωνικής συνοχής και ανθρώπινης ανάπτυξης. Για τις λίγες περιπτώσεις που εξετάζουν μια τέτοια πτυχή, καμία δεν αξιολογεί την αμφίδρομη σχέση μεταξύ των δύο εννοιών. Η παρούσα εργασία χρησιμοποιεί μια προσέγγιση δεδομένων πάνελ για να διερευνήσει τη σχέση μεταξύ κοινωνικής συνοχής και ανθρώπινης ανάπτυξης σε 61 χώρες σε όλο τον κόσμο. Δύο δείκτες χρησιμοποιούνται για τον σκοπό αυτό: ο Δείκτης Ανθρώπινης Ανάπτυξης (HDI) του Γραφείου Αναφορών Ανθρώπινης Ανάπτυξης και ένας δείκτης κοινωνικής συνοχής από τη βάση δεδομένων του Ινστιτούτου Μελετών Ανάπτυξης για την περίοδο 1990 έως 2010. Τα κύρια ευρήματα υποδηλώνουν ότι μόνο μακροπρόθεσμα διαπιστώνεται μια θετική και σημαντική αμφίδρομη σχέση μεταξύ κοινωνικής συνοχής και ανθρώπινη ανάπτυξης. Η μελέτη συνιστά επενδύσεις στην κοινωνική συνοχή για την πρόοδο της ανθρώπινης ανάπτυξης.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: Ανάλυση Δεδομένων Πάνελ, Κοινωνική Συνοχή, Ανθρώπινη Ανάπτυξη, Δείκτης Ανθρώπινης Ανάπτυξης (HDI), Ινστιτούτου Μελετών Ανάπτυξης, 1990-2010.

1. Introduction

UNDP defines human development as the process of enlarging people's choices (UNDP 1990: 10). Human development is multidimensional as revealed by UNDP's different Human Development Reports (1990 to 2022). Other contributions dealing with human development dimensions include: Ranis, Stewart and Samman (2006); Max-Neef (2007); the Sarkozy Commission (2009); Alkire (2002, 2004, 2010, 2016); Nussbaum (1997, 2000a, 2000b, 2003, 2011); Palmer (2020); Jhoner, Mauricio and Sary (2020) to name only them. Human development is commonly measured by the Human Development Index (HDI) which is based on three dimensions: health, education and the living standard. This implicitly means that if opportunities are developed in these dimensions, opportunities will be developed in other remaining (long list) dimensions. We can therefore break down human development dimensions into two main groups: core dimensions and non-core dimensions. Core dimensions include health, education and living standard. Non-core dimensions include several other dimensions of which political, social and economic freedoms and rights, participation and so on.

Several works link core human development dimensions to human development outcomes. In the case of health, Barro (1996a, 1996b), Bloom and Canning (2002), Cole and Neumayer (2006), Saha (2013), Alvi and Alther Maqsoud (2014)) highlight the effect of health on productivity. Behrman and Lavy (1994), Behrman (1996), Alderman and others (1997; 2001), Glewwe, Jacoby, and King (2001), Alderman, Hoddinott and Kinsey (2003), Glewwe and Miguel (2008), the World Bank (2011) and Frankenberg and Duncan (2017) links the determinants of education to human development outcomes through health outcomes. The above-mentioned works underline that quality health positively affects human development through different channels.

With regards to education, it is mentioned that education can affect human development through its effects on earning as in Mincer (1974), Becker (1962), Griliches (1977), Card (1994 and 1999), Krueger and Lindahl (2000), Tamborini, Kim and Sakamoto (2015), Heckman, Humphries and Veramendi (2016). Education also affects human development through its effects on health as in Albert and Davia (2011), Fonseca and Zheng (2011), and Huang (2015) to name only some.

Income is not a direct measure of capabilities. Contrary to health and education, it is only an input into capabilities. In this regard, Sen (1985, 1999), Anand and Sen (2000), Klugman et al. (2011), and Zambrano (2011) can be used as illustrations. At macro level, Ramirez et al. (1998), Ranis et al. (2000), Ranis and Stewart (2001) and Ranis (2004) consider the impact of income on human development through the composition of GDP expenditure or household propension to expend their income. GDP accelerations and decelerations also affect human development as in Ferreira and Schady (2008), Ravallion (2008), Almudena and Lopez- Calva (2009), Conceiçío et al. (2009) to consider only them.

With regards to non-core dimensions, the frequency of human development dimensions used in Human Development Reports between 1990 and 2017 suggests that freedoms and rights are the second most considered dimensions in the evaluation of human development with 52% appearance in these reports[1]. This is also confirmed by the abundant literature dealing with human rights and human development. In this regard, Birdsall (2014), Marks (2022), Rodonaia (2022) and Bayraktar (2022) can serve as illustration among a myriad of contributions. Freedoms and rights are followed by participation (41%) and sustainability (19%). The frequency of appearance of social related dimensions in Human Development Reports only represents 10% between 1990 and 2017. This relative negligence of social related dimensions is also observed in the literature which records mere works on the relationships between social related dimensions and human development as in Razmi, Salimatar and Bazzazan (2013) and Rauf and Chaudhary (undated). Last, but not the least, the literature suggests that only one way relationship has so far been considered in the analysis of human development: the movement from human development dimensions to human development outcomes. By considering the two-way relationship between social cohesion and human development, this study aims to cover this gap.

The main objective of this paper is to investigate the bidirectional relationship between social cohesion and human development. To achieve this objective, section two is a brief literature review on the relationship between the two concepts. Section three presents the theoretical specification of the model and data used. The empirical specification of the model and the main findings are discussed in section four. In section five, the last section, we discuss policy recommendations.

2. Brief Literature Review of the Effect of Social Cohesion on Human Development

Though it is recognised that social cohesion is a multidimensional concept, there is significant confusion regarding its definition and measurement. Jenson (1998), Bernard (1999), Duhaime et al. (2004), Chan et al. (2006), Berger-Schmitt (2002), Noll (2002), Rajulton et al. (2007), Whelan and Maître (2005), Dickes et al. (2010) can serve as illustrations. The concept is often used as synonimus to social capital. This paper does not intend to define and measure social coehion. It considers that social cohesion is concerned with higher level of interpersonal trust, that social cohesion deals with trust in institutions and legitimacy of the government institutions. In this regard, social cohesion is an important basis to define national development goals and tackle development challenges. By doing so, social cohesion is a good instrument to human development. Few authors have studied the relationship between social cohesion and huuman development. The available burgeon literature is rooted in Bottoni (2018 and 2024), Seyoum (2020), Diori HI and NaRanong (2022), Lengfelder (2023).

The main aim of Bottoni (2024) is to empirically assess the direct effect of social cohesion on quality of life controlling for country's wealth, economic inequality and other factors considered country-level capabilities. Measure social cohesion using Bottoni's model (2018). The method estimates a multilevel regression model in multiple steps Findings suggest that cohesion exerts a positive effect on subjective wellbeing. Meaning that higher levels of social cohesion enhance quality of life. In this regard, cohesive countries tend to create positive aggregate conditions as underlined in (Bottoni, 2018). These conditions in turn positively affect individuals' quality of life. Cohesion can therefore be regarded as an aggregate country-level capability (Nussbaum, 2011; Sen, 1985) that helps individuals to turn available resources into well-being. Bottoni (2018) provide a theoretical approach of social cohesion which takes into account the multidimensionality and the multilevel structure of the concept. He provides an operational definition of social cohesion and empirically testes that the social cohesion is a multidimensional concept that involves seven sub-dimensions: interpersonal trust, density of social relations, social support, the willingness to accept people from different countries (openness), civic engagement (participation), legitimacy of institutions and institutional trust.

The impact of social cohesion on human development is one of the main purposes of Seyoum (2020). This analysis shows that social cohesion has both direct and indirect effects on human development. The indirect effect is captured trough state legitimacy. This study uses the state fragility index as social cohesion indicator. The fragility index assesses the vulnerability of states to collapse.

Diori HI and NaRanong (2022) use a panel data analysis of 35 countries between 1995 to 2019 to determine the effect of multiparty democracy, social cohesion, and their interaction on human development The study is based on fixed-effects and system generalized methods of moments. Results suggest that multiparty democracy, social cohesion, and their interaction positively affect human development in the long-term.

Lengfelder (2023) analyses data on social cohesion and mental disorders throughout the Asian region. She concludes that social cohesion is a good predictor of mental health. Strengthening social cohesion is an opportunity to improve mental health and promote human development in Bhutan and even beyond.

3. Theoretical Model and Data

3.1 Theoretical Model

If social cohesion is considered as an investment in human development, an increase in social cohesion must ultimately lead to higher human development achievements. In the other way, if human development is considered as an investment in social cohesion, an increase in human development would lead to higher social cohesion outcomes.

Let us adopt a two variable model which hypothesises that human development is a function of social cohesion.

$$HDI_{it} = f(SCI_{it}) \quad (1)$$

where HDI_{it} is the Human Development Index of country i at period t and SCI_{it} is the social cohesion index of country i at period t.

The linear specification of the model takes the following form:

$$HDI_{it} = a_i + \beta_{it} SCI_{it} + \varepsilon_{it} \quad (2)$$

Where a_i is the individual effect of cross-section i (the cross-section specific fixed effect), and β_{it} is the regression coefficient of i at period t. ε_{it} is the term error of cross-section i at t.

HDI data are from the Human Development Report Office. These data are available on an annual basis. SCIs are still to be widely developed. However, spare initiatives exist. This is the case of the Indices of Social Development (ISD)[2] which produces data on civic activism, intergroup cohesion (social cohesion), clubs and associations, interpersonal safety and trust, gender equality and minority inclusion. The sixth dimension, is ignored because fewer countries present data on this dimension.

3.2 Data

ISD produced data on social cohesion components over the period from 1990 to 2015. However, only data from 1990 to 2010 are comparable because of methodological change. These data are on a five-year basis. We are therefore forced to use five-year data to run our analysis with a smaller time-series observation (T = 5). Our sample includes 14 Sub-Saharan Africa countries, 5 Middle East and Nord Africa (MENA) countries, 12 Asia Pacific countries, 17 countries from the Americas and 13 European countries. Descriptive statistics are summarized in table 2.

Table 2: Summary statistics

	countries	Indices	1990	1995	2000	2005	2010
Africa	14	SCI	0.61	0.62	0.53	0.58	0.67
		HDI	0.43	0.43	0.44	0.47	0.51
MENA	5	SCI	0.57	0.54	0.47	0.53	0.64
		HDI	0.65	0.69	0.72	0.75	0.78
Europe	13	SCI	0.65	0.65	0.55	0.61	0.72
		HDI	0.74	0.77	0.79	0.82	0.85
Asia Pacific	12	SCI	0.59	0.62	0.54	0.56	0.67
		HDI	0.61	0.64	0.68	0.71	0.74
Americas	17	SCI	0.58	0.61	0.52	0.58	0.69
		HDI	0.62	0.65	0.68	0.70	0.73

Sources: computed using data from ISD and HDRO (UNDP) 2018.

A smaller time-series observation is not appropriate for cointegration analysis. However, though a large number of time series observations improves the quality of the analysis, it is argued that the length of the sample time span is more important than the number of observations within a fixed time span (Shiller and Perron 1985; Hakkiko and Rush 1991). In our case, the time span is 20 years, which can be used to capture long term causality. Before using our data in the model, we need to run specific tests. One of these tests, the unit root tests, prevents from running spurious regressions.

4. Empirical Model and Findings

4.1 Preliminary Tests

4.1.1 Panel Unit Root Tests

If one runs regression with two non-stationary variables, he may have a spurious or non-sense regression. In a long run estimation analysis, stationary variables are important in order to avoid spurious regression. For this reason, we test the two variables for unit root using a 5% significance level.

i) Social Cohesion

We first graph SCI variable for all 61 cross-sections (annex 1). The graphical observation underlines that in all cross-sections, data is not around zero, meaning that there is an intercept. Also, several cross-sections present a trend in their data though this trend is not very clear for all cross-sections. For these reasons, we make estimation at level assuming individual intercepts and trend. Eviews provides results for several tests: Levin, Lin & Chu (LL), Breitung t-statistic (BT), Im, Pesaran and Shin W-statistic (Im and PP), Augmented Dickey Fuller - Fisher Chi-square (ADF), and PP - Fisher Chi-square test (PP). All these tests (annex 2) suggest a unit root. We therefore conclude that SCI series has unit root. At first differences, all tests reject a unit root if one assumes no individual effects and no trend (annex 3). Because of limited number of time series, we could not assume individual intercept and trend. Also, after first differenced, data are around zero, meaning that there is no intercept. We can conclude that SCI is stationary at first differenced, rather SCI is I(1).

ii) Human Development

We also start by graphing the HDI variable for all cross-sections (annex 4). The graphic outlines the existence of a trend in HDI. Also, all values are far from zero. For this reason, we assume individual intercept and trend in unit root test at level. At this step, we have mixed results. BT and ADF cannot reject unit root while LL and C, Im, and PP reject unit root (annex 5). We therefore run the Hadri test (annex 6) which rejects stationarity, meaning that there is unit root. From the analysis above, because three tests out of five suggest unit root, we can accept that HDI has unit root. At first differences, all test results suggest no unit root (annex 7), meaning that HDI is I(1).

Summing up, both SCI (hereby proxied by the social cohesion index) and HDI are integrated of the same order. More specifically both SCI and HDI are I(1), meaning that we can run a cointegration test.

4.1.2 Cointegration Test

We run cointegration test to check whether SCI and HDI are cointegrated. Eviews proposes several methods. The Pedroni residual cointegration test suggests that there is cointegration (annex 8). In fact, 8 of the 11 statistics suggest cointegration while three suggest no cointegration. The Kao test (annex 9) also suggests cointegration. We therefore conclude that SCI and HDI are cointegrated, meaning that we can run a panel Vector Error Correction Model (VECM).

4.2 Panel VECM

Because we found cointegration, we assess causality based on the Engle-Granger (1987) causality method. We use a panel vector error correction model (VECM) which consists of two main steps. In the first step, we specify the cointegration relationship to assess the long term bidirectional movement between SCI and HDI. We regress this relationship using the following equation.

$$HDI_{i,t} = a_i + \delta_{it} + \beta_1 SCI_{it} + \varepsilon_{it} \qquad (3)$$

In equation (3.7), a_i is the country specific intercept, δ_{it} is the country specific time trend, β_1 is the regression coefficient (the influence of SCI on HDI). ε_{it} is the error term.

In the second step, we estimate the residuals of equation (3.7).

$$\varepsilon_{it} = HDI_{i,t} - (a_i + \delta_{it} + \beta_1 SCI_{it}) \qquad (4)$$

These residuals are used as lagged regressors (the error correction terms) in the final panel VECMs. To test for causality between SCI and HDI, we need to estimate a model with growth in HDI as the dependent variable and a model with growth in SCI as the dependent variable. Estimation models are:

Model A: model with growth in HDI

$$\Delta HDI_{it} = a_{ait} + \gamma_{ait} ECT_{i,t-1} + \sum_p \lambda_{ai} \Delta HDI_{i,t-p} + \sum_p \beta_{ai} \Delta SCI_{i,t-p} + u_{it} \qquad (5)$$

Model B: model with growth in SCI

$$\Delta SCI_{it} = a_{bit} + \gamma_{bi} ECT_{i,t-1} + \sum_p \lambda_{bi} \Delta SCI_{i,t-p} + \sum_p \beta_{bi} \Delta HDI_{i,t-p} + u_{it} \qquad (6)$$

Where the operator Δ refers to first differences. Subscribes a and b respectively refer to model A and model B. Subscribe p denotes the lag length, λ_i is the auto regression coefficient, β_i is the regression coefficient. ***ECT*** refers to error correction term.

For the empirical specification of the model, we need to indicate the optimal number of lags before proceeding to model estimation.

4.3 Lag Length Selection

The empirical VECM necessitates to determine the optimum number of lags. The optimum lags length (p) ensures that the residuals empirically follow a white noise process. The adequate lag length can be determined using e-views five criterion: the sequential modified LR test statistics (LR), the Final Predictor Error test (FPE), the Akaike Information Criterion (AIC) statistics, the Schwarz Bayesian Information Criterion (SBC), and the Hannan-Quinn (HQ) Information Criterion. For these criteria, the guidance principle is: the lower the value, the better the model. In our model, because of limited time series, we include a maximum lag length of 2 lags. According to results (annex 10) LR, FPE, AIC and HQ suggest an optimal number of 2 lags. We can choose two lags because most of the tests accept two lags. More importantly, Khim and Liew (2004) found that AIC and FPE are superior than other criteria under study in case of small sample (60 observations and below) as they minimize the chance of under estimation while maximizing the chance of recovering the true lag length. Our sample is made of 61 cross- sections, not far different from 60. We therefore confirm the optimal number of 2 lags because both FPE and AIC suggest it.

4.4 Empirical Specification of the Model and Findings

We finally run the two models below: Model A'

$$\Delta HDI_t = c_{1a}(HDI_{t-1} - \beta_{1a} SCI_{t-1} - \varepsilon_t) + c_{2a}(HDI_{t-1}) + c_{3a}(HDI_{t-2}) + c_{4a}(SCI_{t-1}) + c_{5a}(SCI_{t-2}) + c_{6a} + \mu_t \qquad (7)$$

Model B'

$$\Delta SCI_t = c_{1b}(SCI_{t-1}-\beta_1 HDI_{t-1}-\varepsilon_t) + c_{2b}(SCI_{t-1}) + c_{3b}(SCI_{t-2}) + c_{4b}(HDI_{t-1}) + c_{5b}(HDI_{t-2}) + c_{6b} + u_t \qquad (8)$$

Where c_{1a} and c_{1b} are error correction coefficients of model A' and B' respectively.c_{2a} and c_{2b} are lag1 autoregressive coefficients of HDI and SCI respectively.c_{3a} and c_{3b} are lag2 autoregressive coefficients of HDI and SCI respectively.$c_{4a}$and c_{5a} are regression coefficients of lagged SCI. c_{5a} and c_{5b} are regression coefficients of lagged HDI. $\mu_t$and u_t are error terms.

Using HDI as dependent variable, results suggest that the error correction coefficient (-0.037) is negative and significant at 1% (annex 11), meaning that there is a long term causality running from SCI (proxied by social cohesion) to HDI. Analysis suggests that there would be a speed of adjustment of 3.7% every five years to long term equilibrium. The speed of adjustment is low.

We also test short run causality using the Wald test (annex 12). This model tests whether c(4a) and c(5a) are zero (null hypothesis) or not. As P value is larger than 5%, we cannot reject the null hypothesis, meaning that c(4a) and c(5a) are both zero, rather there is no short run causality running from SCI to HDI.

Using SCI as independent variable, findings (annex 13) suggest that the error correction coefficient (-0.030) is negative and significant at 5%, meaning that there is a long run causality running from HDI to SCI. There would be a speed of adjustment of 3% every five years to long run equilibrium. This speed is also low. We also test short run causality using the Wald test. The model tests whether c(4b) and c(5b) are zero (null hypothesis) or not. As P value is larger than 5% (annex 3.14), we cannot reject the null hypothesis, meaning that C(4b) and c(5b) are both zero, rather there is no short run causality running from SCI to HDI.

The diagnostic checking of the model underlines an R2 = 0.42, which is low. Low R2 are generally found in cross-section analyses. The statistic and the P-value are significant at 5% (annex 13). Residual/serial correlation check suggests that the Jacque-Berra Statistic probability is greater than 5% (annex 15), meaning that there is no serial correlation with residuals, which is good for the model. Summing up, the model suffers from low R2 which is common to cross- section analyses. Also, more importantly, data availability forces us to limits the sample to very limited number of observations within the time span from 1990 to 2010. This is the weakness of the study.

To conclude, panel VECM results suggest that there is bidirectional long run causality between social cohesion proxied by the social cohesion index and human development proxied by HDI. As a consequence, investment in social cohesion is good for human development improvement. The long run causality between the two variables can be understood in that social cohesion can be seen as an instrument of capabilities. For this reason, it takes time to translate to people real capabilities and functionings. This explains why no short run causality between the two variables is found.

6. Conclusion

The analysis is an investigation of the relationships between social cohesion and human development. Based on a panel of 61 countries for the period between 1990 to 2010, the study reveals a positive and significant bidirectional long term relationship between the two concepts. In fact, panel data analysis suggests that both social cohesion and human development positively affect each other in the long run. No effect is found in the short run. For this reason, social cohesion should be considered as a core human development dimension beside health, education and income.

As a consequence of our findings, laying emphasis on social cohesion in policies aiming at improving human development would lead to better development outcomes. Improving the health status of populations should no longer be limited to concentrating on individuals and ignoring individuals' interrelationships. Improving individuals' educational attainment should not ignore the quality of people interrelationships (parents and children, parents and teachers, teachers among themselves, parents among themselves and so on). Policies oriented towards improvement of individuals and households' incomes should no more be limited to natural capital, physical capital and human capital. They should be expanded to social cohesion, a key component of social capital. For this reason, important investments in building social cohesion are necessary in order to support sustained wellbeing as it has been the case for natural capital, physical capital, and human capital.

Notes

1. The frequency of apparition of core dimensions in Human Development Reports is 100%.
2. (URL: http://www.IndSocDev.org/)

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Biographical Note

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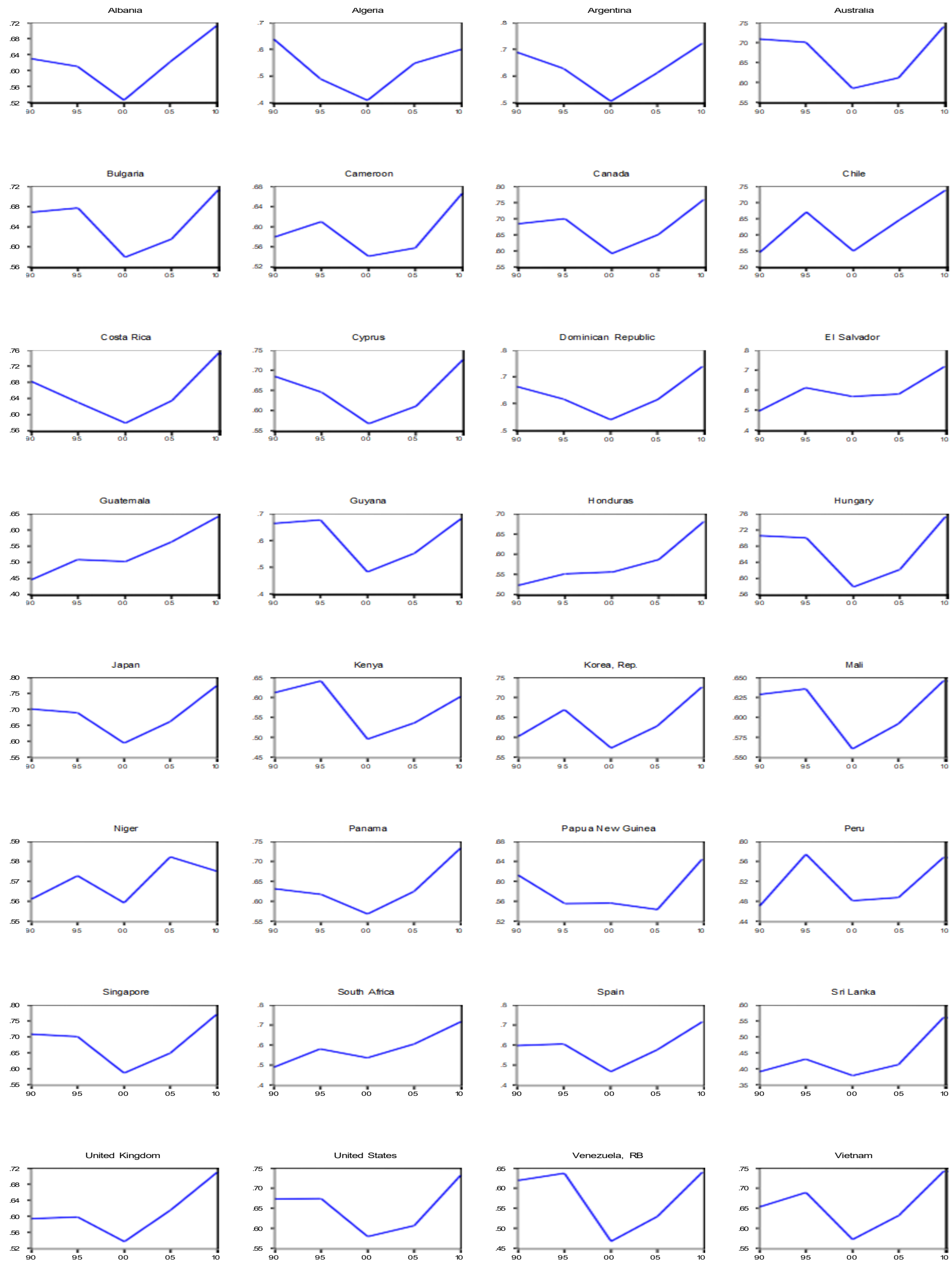
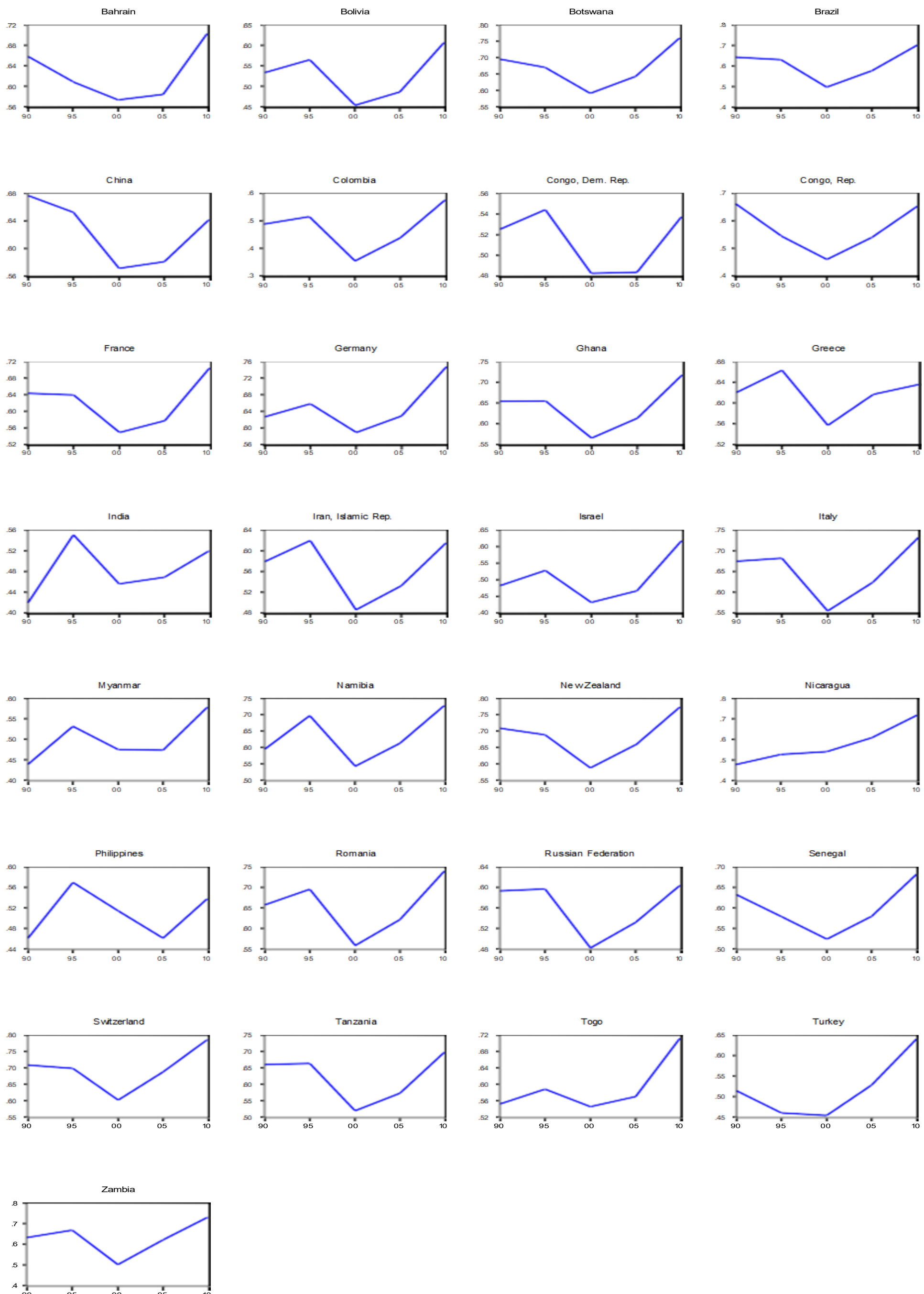
Annexes

Annex.1: Trends in Social Cohesion in Selected Countries





Source: ISD database

Annex.2: Panel unit root test: Summary: SCI

Panel unit root test: Summary				
Series: SCI				
Date: 04/09/23 Time: 09:23				
Sample: 1990 2010				
Exogenous variables: Individual effects, individual linear trends				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	7.08193	1.0000	61	244
Breitung t-stat	6.77265	1.0000	61	183
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.46261	0.9997	61	244
ADF - Fisher Chi-square	26.1246	1.0000	61	244
PP - Fisher Chi-square	27.0099	1.0000	61	244

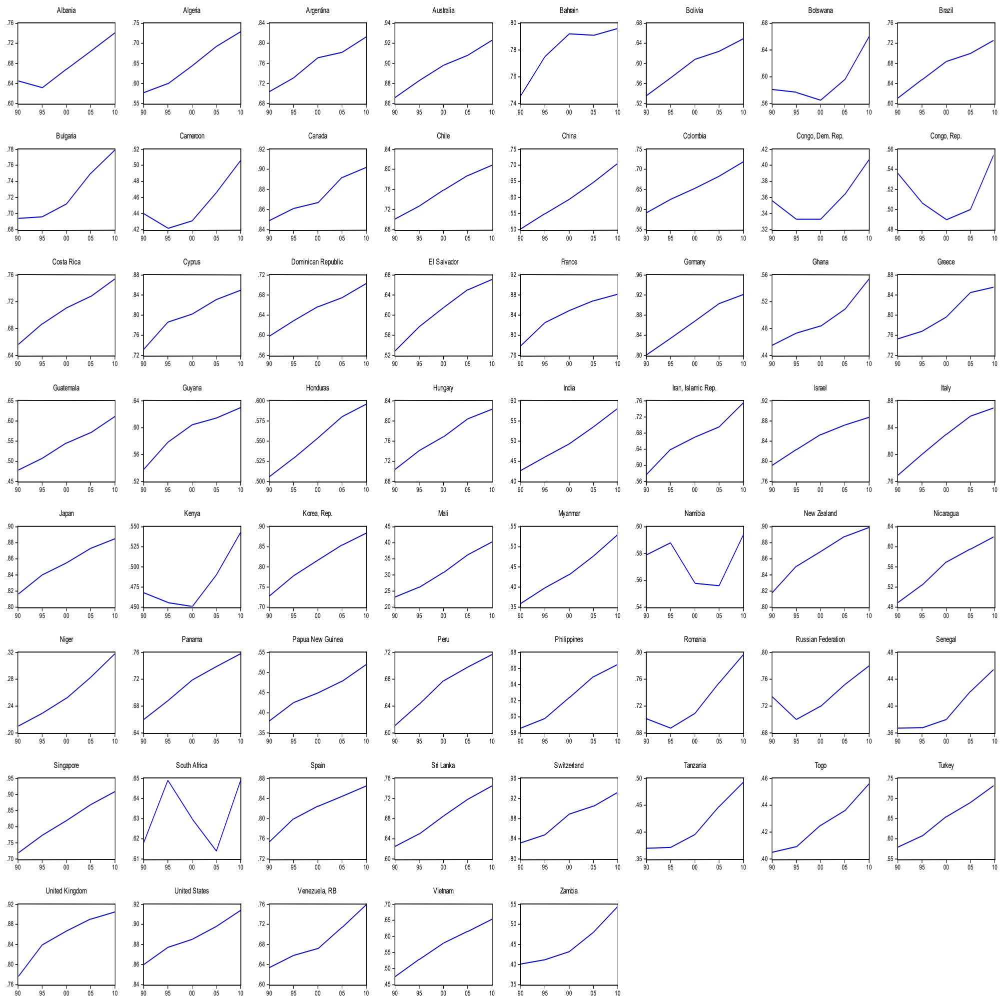
** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Annex 3: Panel unit root test: Summary D(SCI)

Panel unit root test: Summary				
Series: D(SCI)				
Date: 04/09/23 Time: 09:25				
Sample: 1990 2010				
Exogenous variables: None				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross- sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-11.6980	0.0000	61	183
Null: Unit root (assumes individual unit root process)				
ADF - Fisher Chi-square	219.575	0.0000	61	183
PP - Fisher Chi-square	222.994	0.0000	61	183

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Annex 4: Trends in Human Development in Selected Countries



Source: HDRO database

Annex 5: Panel unit root test: Summary: HDI

Panel unit root test: Summary				
Series: HDI				
Date: 04/09/23 Time: 09:27				
Sample: 1990 2010				
Exogenous variables: Individual effects, individual linear trends				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-23.6319	0.0000	61	244
Breitung t-stat	6.46075	1.0000	61	183
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.86690	0.0310	61	244
ADF - Fisher Chi-square	120.628	0.5181	61	244
PP - Fisher Chi-square	199.411	0.0000	61	244

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality

Annex 6: HDI Hadri stationarity test

Null Hypothesis: Stationarity				
Series: HDI				
Date: 04/09/23 Time: 10:53				
Sample: 1990 2010				
Exogenous variables: Individual effects, individual linear trends				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total (balanced) observations: 305				
Cross-sections included: 61				
Method			Statistic	Prob.**
Hadri Z-stat			79.4252	0.0000
Heteroscedastic Consistent Z-stat		76.4797	0.0000	
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on HDI				
Cross- section	LM	Variance HAC	Bandwidth	Obs
Albania	0.5000	4.58E-05	4.0	5
Algeria	0.5000	7.44E-06	4.0	5

Argentina	0.5000	5.28E-06	4.0	5
Australia	0.5000	5.81E-07	4.0	5
Bahrain	0.5000	1.98E-05	4.0	5
Bolivia	0.5000	8.64E-06	4.0	5
Botswana	0.5000	0.000141	4.0	5
Brazil	0.5000	8.46E-06	4.0	5
Bulgaria	0.5000	2.67E-05	4.0	5
Cameroon	0.5000	8.49E-05	4.0	5
Canada	0.5000	2.60E-06	4.0	5
Chile	0.5000	1.66E-06	4.0	5
China	0.5000	4.49E-06	4.0	5
Colombia	0.5000	6.59E-07	4.0	5
Congo, Dem. Rep.	0.5000	0.000111	4.0	5
Congo, Rep.	0.5000	0.000165	4.0	5
Costa Rica	0.5000	2.17E-06	4.0	5
Cyprus	0.5000	1.62E-05	4.0	5
Dominican Republic	0.5000	1.96E-06	4.0	5
El Salvador	0.5000	1.36E-05	4.0	5
France	0.5000	2.04E-05	4.0	5
Germany	0.5000	4.40E-06	4.0	5
Ghana	0.5000	2.16E-05	4.0	5
Greece	0.5000	1.08E-05	4.0	5
Guatemala	0.2419	2.31E-06	2.0	5
Guyana	0.5000	1.87E-05	4.0	5
Honduras	0.5000	1.14E-06	4.0	5
Hungary	0.2048	9.07E-06	2.0	5
India	0.5000	5.28E-06	4.0	5
Iran, Islamic Rep.	0.5000	1.54E-05	4.0	5
Israel	0.5000	7.91E-06	4.0	5
Italy	0.5000	6.66E-06	4.0	5
Japan	0.4000	2.29E-06	3.0	5
Kenya	0.5000	0.000129	4.0	5
Korea, Rep.	0.5000	7.41E-06	4.0	5
Mali	0.5000	6.12E-06	4.0	5
Myanmar	0.5000	7.94E-06	4.0	5
Namibia	0.5000	5.27E-05	4.0	5
New Zealand	0.5000	7.56E-06	4.0	5
Nicaragua	0.5000	8.46E-06	4.0	5
Niger	0.5000	6.66E-06	4.0	5

Panama	0.5000	3.90E-06	4.0	5
Papua New Guinea	0.5000	3.44E-06	4.0	5
Peru	0.5000	7.68E-06	4.0	5
Philippines	0.5000	2.14E-06	4.0	5
Romania	0.5000	8.14E-05	4.0	5
Russian Federation	0.5000	8.53E-05	4.0	5
Senegal	0.5000	4.16E-05	4.0	5
Singapore	0.4000	3.17E-06	3.0	5
South Africa	0.5000	3.32E-05	4.0	5
Spain	0.5000	1.44E-05	4.0	5
Sri Lanka	0.5000	8.51E-07	4.0	5
Switzerland	0.5000	3.16E-06	4.0	5
Tanzania	0.5000	6.12E-05	4.0	5
Togo	0.2022	7.53E-06	2.0	5
Turkey	0.0773	1.62E-05	0.0	5
United Kingdom	0.5000	4.55E-05	4.0	5
United States	0.5000	5.97E-07	4.0	5
Venezuela, RB	0.5000	2.33E-05	4.0	5
Vietnam	0.5000	8.86E-06	4.0	5
Zambia	0.5000	7.51E-05	4.0	5

Annex 7: Panel unit root test: D(HDI) Summary

Panel unit root test: Summary				
Series: D(HDI)				
Date: 04/09/29 Time: 09:28				
Sample: 1990 2010				
Exogenous variables: None				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross- sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.60232	0.0000	61	183
Null: Unit root (assumes individual unit root process)				
ADF - Fisher Chi-square	162.795	0.0080	61	183
PP - Fisher Chi-square	201.861	0.0000	61	183

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Annex 8: Pedroni Residual Cointegration Test

Pedroni Residual Cointegration Test					
Series: HDI SCI					
Date: 04/09/23 Time: 09:36					
Sample (adjusted): 1990 2010					
Included observations: 305 after adjustments					
Cross-sections included: 61					
Null Hypothesis: No cointegration					
Trend assumption: No deterministic intercept or trend					
Automatic lag length selection based on SIC with a max lag of 0					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		-3.445335	0.9997	-4.257520	1.0000
Panel rho-Statistic		-2.652559	0.0040	-3.167330	0.0008
Panel PP-Statistic		-5.563042	0.0000	-5.982316	0.0000
Panel ADF-Statistic		-5.536369	0.0000	-5.978455	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		3.444271	0.9997		
Group PP-Statistic		-4.341213	0.0000		
Group ADF-Statistic		-4.323369	0.0000		
Cross section specific results					
Phillips-Peron results (non-parametric)					
Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
Albania	-0.005	0.003111	0.003111	0.00	4
Algeria	0.129	0.007007	0.009846	1.00	4
Argentina	0.136	0.008645	0.008645	0.00	4
Australia	0.111	0.007562	0.007562	0.00	4
Bahrain	0.037	0.004469	0.004469	0.00	4
Bolivia	0.132	0.005267	0.005267	0.00	4
Botswana	0.168	0.000744	0.000744	0.00	4
Brazil	0.146	0.006848	0.006848	0.00	4
Bulgaria	0.175	0.002987	0.002987	0.00	4
Cameroon	-0.022	0.000955	0.000955	0.00	4
Canada	-0.058	0.005564	0.005564	0.00	4
Chile	-0.539	0.004021	0.004021	0.00	4
China	0.545	0.003538	0.005864	1.00	4

Colombia	0.064	0.012006	0.012006	0.00	4
Congo, Dem. Rep.	0.466	0.000812	0.000812	0.00	4
Congo, Rep.	0.129	0.001864	0.001864	0.00	4
Costa Rica	0.123	0.003317	0.003317	0.00	4
Cyprus	0.176	0.004632	0.004632	0.00	4
Dominican Republic	0.140	0.004251	0.004251	0.00	4
El Salvador	-0.542	0.002198	0.001809	1.00	4
France	0.126	0.006746	0.006746	0.00	4
Germany	-0.073	0.004824	0.004824	0.00	4
Ghana	0.255	0.001090	0.001090	0.00	4
Greece	0.146	0.004175	0.003342	1.00	4
Guatemala	-0.265	0.000725	0.000725	0.00	4
Guyana	0.187	0.008077	0.008077	0.00	4
Honduras	-0.316	0.001002	0.001002	0.00	4
Hungary	0.205	0.006347	0.006347	0.00	4
India	0.109	0.004149	0.004149	0.00	4
Iran, Islamic Rep.	0.297	0.005299	0.005299	0.00	4
Israel	-0.173	0.012751	0.012751	0.00	4
Italy	0.106	0.007265	0.007265	0.00	4
Japan	0.066	0.005682	0.005682	0.00	4
Kenya	0.347	0.002540	0.002540	0.00	4
Korea, Rep.	-0.040	0.004608	0.004608	0.00	4
Mali	0.620	0.001801	0.002831	1.00	4
Myanmar	0.308	0.002038	0.002038	0.00	4
Namibia	-0.496	0.001997	0.001997	0.00	4
New Zealand	0.103	0.006696	0.006696	0.00	4
Nicaragua	0.288	0.001947	0.001947	0.00	4
Niger	0.749	0.000679	0.001015	1.00	4
Panama	0.085	0.003167	0.003167	0.00	4
Papua New Guinea	0.219	0.000978	0.001473	1.00	4
Peru	-0.186	0.004368	0.004368	0.00	4
Philippines	-0.097	0.004253	0.004253	0.00	4
Romania	-0.041	0.005089	0.005089	0.00	4
Russian Federation	0.040	0.004493	0.003832	1.00	4
Senegal	0.307	0.000570	0.000782	1.00	4
Singapore	0.261	0.006254	0.006254	0.00	4
South Africa	0.436	0.003847	0.003847	0.00	4
Spain	0.054	0.013515	0.013515	0.00	4

Sri Lanka	-0.240	0.008055	0.008055	0.00	4
Switzerland	0.037	0.005957	0.005957	0.00	4
Tanzania	0.407	0.002586	0.002586	0.00	4
Togo	-0.386	0.001219	0.001219	0.00	4
Turkey	0.125	0.003573	0.003573	0.00	4
United Kingdom	0.094	0.005658	0.005658	0.00	4
United States	0.029	0.005948	0.005948	0.00	4
Venezuela, RB	0.228	0.007647	0.007647	0.00	4
Vietnam	0.287	0.003706	0.003706	0.00	4
Zambia	0.142	0.002804	0.002249	1.00	4
Augmented Dickey-Fuller results (parametric)					
Cross ID	AR(1)	Variance	Lag	Max lag	Obs
Albania	-0.005	0.003111	0	0	4
Algeria	0.129	0.007007	0	0	4
Argentina	0.136	0.008645	0	0	4
Australia	0.111	0.007562	0	0	4
Bahrain	0.037	0.004469	0	0	4
Bolivia	0.132	0.005267	0	0	4
Botswana	0.168	0.000744	0	0	4
Brazil	0.146	0.006848	0	0	4
Bulgaria	0.175	0.002987	0	0	4
Cameroon	-0.022	0.000955	0	0	4
Canada	-0.058	0.005564	0	0	4
Chile	-0.539	0.004021	0	0	4
China	0.545	0.003538	0	0	4
Colombia	0.064	0.012006	0	0	4
Congo, Dem. Rep.	0.466	0.000812	0	0	4
Congo, Rep.	0.129	0.001864	0	0	4
Costa Rica	0.123	0.003317	0	0	4
Cyprus	0.176	0.004632	0	0	4
Dominican Republic	0.140	0.004251	0	0	4
El Salvador	-0.542	0.002198	0	0	4
France	0.126	0.006746	0	0	4
Germany	-0.073	0.004824	0	0	4
Ghana	0.255	0.001090	0	0	4
Greece	0.146	0.004175	0	0	4
Guatemala	-0.265	0.000725	0	0	4
Guyana	0.187	0.008077	0	0	4

Honduras	-0.316	0.001002	0	0	4
Hungary	0.205	0.006347	0	0	4
India	0.109	0.004149	0	0	4
Iran, Islamic Rep.	0.297	0.005299	0	0	4
Israel	-0.173	0.012751	0	0	4
Italy	0.106	0.007265	0	0	4
Japan	0.066	0.005682	0	0	4
Kenya	0.347	0.002540	0	0	4
Korea, Rep.	-0.040	0.004608	0	0	4
Mali	0.620	0.001801	0	0	4
Myanmar	0.308	0.002038	0	0	4
Namibia	-0.496	0.001997	0	0	4
New Zealand	0.103	0.006696	0	0	4
Nicaragua	0.288	0.001947	0	0	4
Niger	0.749	0.000679	0	0	4
Panama	0.085	0.003167	0	0	4
Papua New Guinea	0.219	0.000978	0	0	4
Peru	-0.186	0.004368	0	0	4
Philippines	-0.097	0.004253	0	0	4
Romania	-0.041	0.005089	0	0	4
Russian Federation	0.040	0.004493	0	0	4
Senegal	0.307	0.000570	0	0	4
Singapore	0.261	0.006254	0	0	4
South Africa	0.436	0.003847	0	0	4
Spain	0.054	0.013515	0	0	4
Sri Lanka	-0.240	0.008055	0	0	4
Switzerland	0.037	0.005957	0	0	4
Tanzania	0.407	0.002586	0	0	4
Togo	-0.386	0.001219	0	0	4
Turkey	0.125	0.003573	0	0	4
United Kingdom	0.094	0.005658	0	0	4
United States	0.029	0.005948	0	0	4
Venezuela, RB	0.228	0.007647	0	0	4
Vietnam	0.287	0.003706	0	0	4
Zambia	0.142	0.002804	0	0	4

Annex 9: Kao Cointegration test

Kao Residual Cointegration Test				
Series: HDI SCI				
Date: 04/09/23 Time: 09:33				
Sample (adjusted): 1990 2010				
Included observations: 305 after adjustments				
Null Hypothesis: No cointegration				
Trend assumption: No deterministic trend				
Automatic lag length selection based on SIC with a max lag of 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
		t-Statistic		Prob.
ADF		-1.949323		0.0256
Residual variance		0.000930		
HAC variance		0.001072		
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RESID)				
Method: Least Squares				
Date: 04/09/23 Time: 09:33				
Sample (adjusted): 1995 2010				
Included observations: 244 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.461756	0.044679	-10.33494	0.0000
R-squared	-0.354823	Mean dependent var	0.022244	
Adjusted R-squared	-0.354823	S.D. dependent var	0.022864	
S.E. of regression	0.026613	Akaike info criterion	-4.410716	
Sum squared resid	0.172110	Schwarz criterion		-4.396383
Log likelihood	539.1073	Hannan-Quinn criter.	-4.404943	
Durbin-Watson stat	0.876421			

Annex 10: Lag length selection

VAR Lag Order Selection Criteria						
Endogenous variables: HDI SCI						
Exogenous variables: C						
Date: 04/09/23 Time: 09:43						
Sample: 1990 2010						
Included observations: 183						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	267.3700	NA	0.000189	-2.900219	-2.865142	-2.886000
1	715.4889	881.5454	1.47e-06	-7.753977	-7.648748	-7.711323
2	747.8169	62.88935*	1.08e-06*	-8.063573*	-7.888191*	-7.992482*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Annex 11: Vector Error Correction Estimates

System: Equation estimates				
Estimation Method: Least Squares				
Date: 04/09/23 Time: 09:46				
Sample: 2005 2010				
Included observations: 122				
Total system (balanced) observations 244				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.037133	0.007204	-5.154553	0.0000
C(2)	0.498278	0.077735	6.409943	0.0000
C(3)	-0.160320	0.066404	-2.414292	0.0165
C(4)	-0.017854	0.018315	-0.974857	0.3306
C(5)	-0.027193	0.021057	-1.291383	0.1979
C(6)	0.018817	0.002422	7.769192	0.0000
C(7)	0.054075	0.020356	2.656419	0.0084
C(8)	-0.257173	0.219658	-1.170789	0.2429
C(9)	0.009472	0.187640	0.050477	0.9598
C(10)	0.106848	0.051752	2.064614	0.0401
C(11)	-0.275452	0.059502	-4.629308	0.0000
C(12)	0.076423	0.006844	11.16670	0.0000

Determinant residual covariance	1.21E-07		
Equation: D(HDI) = C(1)*(HDI(-1) - 0.570863232838*SCI(-1) -0.349455591039) + C(2)*D(HDI(-1)) + C(3)*D(HDI(-2)) + C(4)*D(SCI(-1)) + C(5)*D(SCI(-2)) + C(6)			
Observations: 122			
R-squared	0.422902	Mean dependent var	0.029311
Adjusted R-squared	0.398027	S.D. dependent var	0.014664
S.E. of regression	0.011378	Sum squared resid	0.015016
Durbin-Watson stat	2.195397		
Equation: D(SCI) = C(7)*(HDI(-1) - 0.570863232838*SCI(-1) -0.349455591039) + C(8)*D(HDI(-1)) + C(9)*D(HDI(-2)) + C(10)*D(SCI(-1)) + C(11)*D(SCI(-2)) + C(12)			
Observations: 122			
R-squared	0.441848	Mean dependent var	0.078298
Adjusted R-squared	0.417790	S.D. dependent var	0.042135
S.E. of regression	0.032150	Sum squared resid	0.119900
Durbin-Watson stat	2.522228		

Annex 12: Wald Coefficient Diagnostic test

Wald Test:			
Equation: HDI=f(SCI)			
Test Statistic	Value	df	Probability
F-statistic	0.837974	(2, 116)	0.4352
Chi-square	1.675948	2	0.4326
Null Hypothesis: C(4)=C(5)=0 Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		-0.017854	0.018315
C(5)		-0.027193	0.021057
Restrictions are linear in coefficients.			

Annex 13: Vector Error Correction Estimates

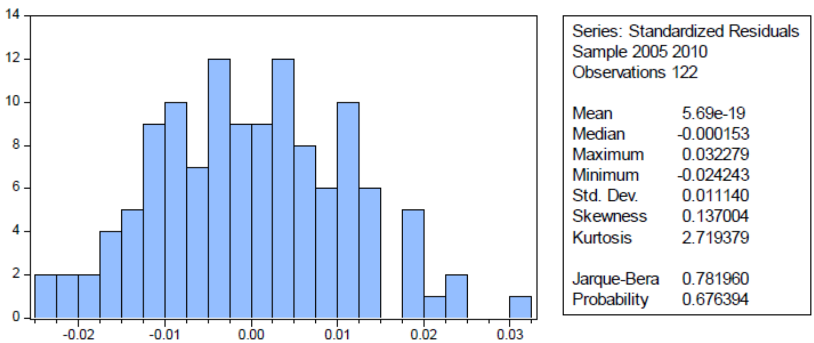
System: Equation estimates				
Estimation Method: Least Squares				
Date: 04/09/23 Time: 09:50				
Sample: 2005 2010				
Included observations: 122				
Total system (balanced) observations 244				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.030869	0.011621	-2.656419	0.0084
C(2)	0.106848	0.051752	2.064614	0.0401
C(3)	-0.275452	0.059502	-4.629308	0.0000
C(4)	-0.257173	0.219658	-1.170789	0.2429
C(5)	0.009472	0.187640	0.050477	0.9598
C(6)	0.076423	0.006844	11.16670	0.0000
C(7)	0.021198	0.004112	5.154553	0.0000
C(8)	-0.017854	0.018315	-0.974857	0.3306
C(9)	-0.027193	0.021057	-1.291383	0.1979
C(10)	0.498278	0.077735	6.409943	0.0000
C(11)	-0.160320	0.066404	-2.414292	0.0165
C(12)	0.018817	0.002422	7.769192	0.0000
Determinant residual covariance		1.21E-07		
Equation: D(SCI) = C(1)*(SCI(-1) - 1.75173306403*HDI(-1) +0.612152913232) + C(2)*D(SCI(-1)) + C(3)*D(SCI(-2)) + C(4)*D(HDI(-1)) + C(5)*D(HDI(-2)) + C(6)				
Observations: 122				
R-squared	0.441848	Mean dependent var		0.078298
Adjusted R-squared	0.417790	S.D. dependent var		0.042135
S.E. of regression	0.032150	Sum squared resid		0.119900
Durbin-Watson stat	2.522228			
Equation: D(HDI) = C(7)*(SCI(-1) - 1.75173306403*HDI(-1) +0.612152913232) + C(8)*D(SCI(-1)) + C(9)*D(SCI(-2)) + C(10)*D(HDI(-1)) + C(11)*D(HDI(-2)) + C(12)				
Observations: 122				
R-squared	0.422902	Mean dependent var		0.029311
Adjusted R-squared	0.398027	S.D. dependent var		0.014664
S.E. of regression	0.011378	Sum squared resid		0.015016
Durbin-Watson stat	2.195397			

Annex 14: Wald Coefficient Test

Wald Test:			
Equation: SCI=f(HDI)			
Test Statistic	Value	df	Probability
F-statistic	0.837974	(2, 116)	0.4352
Chi-square	1.675948	2	0.4326
Null Hypothesis: C(4)=C(5)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		-0.017854	0.018315
C(5)		-0.027193	0.021057
Restrictions are linear in coefficients.			

Annex 15: Residuals Check

Residuals check: HDI = f(SCI)



SCI = f(HDI)