

# Comparing Human Development Patterns Across Countries: Is it Possible to Reconcile Multidimensional Measures and Intuitive Appeal?

Mario Biggeri

Vincenzo Mauro

Dept. of Economics, University of Florence

Dept. of Economics, University of Florence

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## Abstract

The aims of this paper are two. The first is to present a framework that facilitates the identification and analysis of human development patterns in terms of outcomes performance from a cross and time perspective. The second is to find a method that is effective in summarizing different dimensions that concerns human development progress. We consider human development progress as enhanced throughout virtuous synergies among positive human development outcomes and between these and ‘positive’ economic outcomes.

The methodology aims to take into consideration these synergies, while the theoretical framework captures different patterns of human development progress through the distinction between the social dimensions (SD) and the economic dimensions (ED) as ‘command over resources’. Although this framework is not a sufficient guide for policy, the research findings are an explicit recognition of the need to analyse and to integrate economic and social policies. Furthermore, the explorative empirical results highlight different human development patterns between countries and their connection to the different policies adopted by each country (e.g. by transition economies) and by the impact of different type of crises.

**Keywords:** Human Development, HDI, Multidimensional Index

# 1 Introduction<sup>1</sup>

Human development<sup>2</sup> (HD) can be defined as a process of promotion and expansion of valuable capabilities (Sen, 1999), indeed, for several countries and UN development agencies, HD is considered as a policy objective, an aspiration. Besides to the understanding of policies towards HD, as academics and policy makers, “we are interested in identifying countries which, for one reason or another, seem to do particularly well on one dimension and less well on others, or particularly badly on one dimension and better on others, as well as managing to do well on all, or failing to do well on any” (Ranis et al., 2007, p. 120). In other words, if HD<sup>3</sup> is a central objective it becomes relevant to identify categories of development patterns of countries according to their success or failure with respect to different dimensions of HD.

An analysis of HD requires to move beyond the Human Development Index (HDI) (Gasper, 2002)<sup>4</sup>. The HDI - although is recognized to hold a relevant role in political terms in the development arena<sup>5</sup> versus the GDP primacy - can be considered just the tip of the iceberg of HD paradigm<sup>6</sup>.

In our research to go beyond the HDI we tried to answer the following questions: is it possible to reconcile an aggregative measure of HD and, at

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<sup>2</sup>The HD definition draws on elements from Basic Needs and from the Capability Approach, and it puts people at the centre of its concerns (see for instance Comim et al., 2008 and Deneulin, 2009).

<sup>3</sup>With HD we also mean Sustainable Human Development.

<sup>4</sup>This is particularly true if we include the concepts of the capability approach such as agency and interaction among different capabilities and among persons (Biggeri et al., 2010; Bellanca et al., 2010).

<sup>5</sup>HDI is intended as a broader approach for looking at the conditions of all people in the society i.e. “conglomerative perspective” vs “deprivation perspective” that is concentrating specifically on the living conditions of the poor (Anand and Sen, 1997, p. 1). These perspectives can complement each other. The construction of the HDI was driven to a great extent by the cross-country data available in 1990, as well as the need to generate a simple compelling policy message i.e. it does not include all capabilities that might be of interest (Fukuda-Parr, 2000).

<sup>6</sup>For instance, among many attempts, Ranis et al. (2006) extended the measurement of HD to 11 important categories of life and proposed plausible indicators within each category.

the same time, to give the opportunity to analyse different country patterns? If the answer to the previous question is yes, can this analysis go further in detail while maintaining the intuitive appeal of the HDI?

The aim of this paper thus is twofold. On one side the intention is to find a method that is effective in summarizing different dimensions of that concerns HD. On the other side the purpose is to build-up a framework that, without significant loss of information, facilitates the identification and analysis of HD patterns in terms of outcomes performance from a cross and time perspective.

In order to maintain the balance between intuitive appeal and explanatory power, the interpretative framework proposed is build up on HD theoretical concepts and rooted on the idea of HD as a process to expand human valuable capabilities using the income as an instrument (Sen, 1999; Anand and Sen, 2000). The framework we are going to present is based also on some intuitions of different researchers which understood the relevance of the synergies between economic progress and human development (Mehrotra and Jolly, 1997; Ranis et al. 2000, 2006; Mehrotra and Delamonica, 2007 and Mehrotra and Biggeri, 2007). In particular, the framework individuates two sub-indices related respectively to the social-political-civil aspects and to the economic instrumental aspect ('command over resources'). Considering that we limit our research to data availability we have no pretention to propose this framework as a sufficient guide for policies.

In the second section we develop an interpretative framework that facilitates the analysis of HD patterns in terms of outcomes performance. In the third section we present a statistical procedure to aggregate different dimensions of human development into a uni-dimensional index. In the fourth section a few explorative examples of different HD patterns are reported, while in the conclusions the main findings are summarised.

## **2 An interpretative framework for the analysis of human development outcomes**

If HD is a process to expand the capabilities - abilities and opportunities - of people to lead the kind of life they have reason to value, "The view of human beings as the 'primary ends' of the process of development calls for emphasis to be placed on what people get from development, not only what they put into it." (Anand and Sen, 2000, p. 84). In other words this implies that we are interested in the different opportunities that a human being may face in different countries.

In this section, according to these premises, we develop an interpretative framework for the analysis of the evolution of HD outcomes. Among the basic ideas of HD process we emphasize the fact that between the HD outcomes and the instruments there are relevant synergies. In particular, these synergies are among the outcomes that characterise HD - for instance, the capability to be educated has an intrinsic value but also a relevant instrumental value that enhance other capabilities and vice versa<sup>7</sup>. The other synergy is between HD outcomes and the means intended as ‘economic progress’. Thus HD outcomes enhance the economic progress and this, as ‘command over resources’<sup>8</sup>, can improve HD outcomes.

According to the literature, a first relevant element to support our framework is the existence of a strong two-way connections between Economic Growth (EG) and HD (e.g. Ranis et al, 2000; 2006; Ranis and Stewart, 2006; UNDP, 1996; 2003). On the one hand, EG can provide the resources to permit sustained improvements in HD and this, on the other hand, can influence with feedback loops EG. In particular, Ranis et al (2000, 2006) introduce the existence of two chains linking HD and EG. This indicates that an economy may be on a mutually reinforcing upward spiral, with high levels of HD leading to high growth which in turn further promotes HD. Conversely, weak HD may result in low growth and consequently poor progress toward HD improvement.<sup>9</sup> The strength of the links in the two chains influences the extent of mutual reinforcement between HD and EG, in either direction.<sup>10</sup>

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<sup>7</sup>This recalls Sen’s broader distinction between 1) the primary end and 2) the principal means of development. When development is seen as a process of expanding the real freedom that people enjoy, “The intrinsic importance of human freedom as the preeminent objective of development has to be distinguished from the instrumental effectiveness of freedom of different kinds to promote human freedom”. (Sen, 1999, p. 37). “..., the instrumental freedoms link with each other and with the ends of enhancement of human freedom in general” (Sen, 1999, p. 10).

<sup>8</sup>i.e. including the entitlement concept.

<sup>9</sup>According to Ranis et al (2000) a country performance can be usefully classified into four categories, virtuous, vicious and two types of lop-sidedness, i.e. lopsided with strong HD/weak growth (called HD-lopsided); and lopsided with weak HD/ strong growth (EG-lopsided). In the virtuous cycle case, good HD enhances growth, which in turn promotes HD, and so on. In the vicious cycle case, poor performance on HD tends to lead to poor growth performance which in turn depresses HD achievements (Ranis et al 2000). Because of the mutual causation between HD and EG, countries tend to fall into virtuous or vicious cycle categories (Ranis and Stewart 2006). Furthermore, Ranis et al (2000 and 2006) - as Mehrotra and Biggeri (2007) for the local systems - underline how countries rarely persist in a lop-sided category because the weak side acts as a brake bringing the country back into a vicious cycle unless there is some policy change which strengthens the lagging dimension, allowing the country (or the local system) to move into a virtuous cycle (two synergy strategy in Mehrotra and Biggeri, 2007).

<sup>10</sup>This is supported theoretically and empirically not only by Ranis et al (2006), but

A second element is the recognition of the existence of this synergies also in policy implementation between social and economic interventions (Mehrotra and Delamonica, 2007; Mehrotra and Biggeri, 2007). Pursuing the synergies between the two sets of interventions can significantly enhance human capabilities and promote positive economic outcomes (Taylor et al, 1997).<sup>11</sup> These have important policy implications at local,<sup>12</sup> national and international level as well as for aid policies (Mehrotra and Delamonica, 2007).

To sum up, HD progress (i.e. human flourishing) springs throughout virtuous synergies among positive HD outcomes and between these and ‘positive’ economic outcomes. These synergies can be found at different levels: at the individual and household level (micro), at the local system of development level (meso) at the country level (macro) and at international level.

Going back to the framework, among the characteristics we are looking for, it should be understandable and easy to describe. It should be flexible, so it can be used in different purposes and contexts, technically robust, operationally viable given existing data and easily replicable by analysts in different countries (Alkire and Santos, 2009, p. 143).

Following these procedural concerns and according to our previous analysis, we divide the informational space for the interpretative framework into two macro aspects: the social-political-civil dimensions (SD), and the economic-inequality-environmental dimensions (ED). This *modus operandi* gives the possibility to individuate two sub-indices that increase the explanatory power of the framework while maintaining a theoretical and intuitive

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also by other empirical micro and macro studies (Ranis and Stewart, 2006).

<sup>11</sup>The first type of synergies is between interventions within basic social services (BSS) - basic education, basic health, water and sanitation, and nutrition which result in better achieved functionings). Interventions in health, nutrition, water and sanitation, fertility control and education complement each other. This increases the impact of any one from investments in any other (Mehrotra and Biggeri, 2007). The second type of synergies is between income increase, its better dispersal, and health and education outcomes. For instance, after a certain threshold, a continuous improvement in health and education indicators may be unachievable in the absence of income growth, just as sustained growth would be impossible without at least a minimally educated and healthy workforce. At the same time, at the macro-economic level it is critical to promote economic growth of the kind that improves the income distribution in favour of the poorest. This is the essence of the second synergy - the interaction among income-poverty reduction, the quality of human functionings at the aggregate societal level, and economic growth. In reality, the first set of synergies in being a goal per se can be set in motion without necessarily the second set of synergies actually being in place. However, in the long run, there is a strong risk of the first set of synergies ‘running out of steam’ in the absence of the second set of synergies (Mehrotra and Biggeri, 2007).

<sup>12</sup>Mehrotra and Biggeri, for instance, identify different types of strategies for HD progress in the case of local system of development through clusters of small and medium enterprises (2007, chap 11) (see also note 10).

appeal.

In order to build up the interpretative framework, we need to pass throughout some other relevant operationalisation steps.

First of all, according to the Aristotelian thought, we should focus on domains/dimension of ‘functionings’ that people need in order to ‘flourish’ as human beings. Considering the fact that we need a multi-dimensional information space, the first step is to identify the dimensions<sup>13</sup> to be used in the analysis of the HD process in terms of SD and ED.<sup>14</sup> This is a general and central issue which may not need to reach a common solution. Sen’s capability approach, indeed, does not prescribe one list of capabilities or sets of functionings that should be considered a priori and, apart from the indication of basic capabilities, much is left to public scrutiny and debate validation (Sen, 2005). According to Sen the problem does not lie in listing important capabilities in themselves, but in endorsing one predetermined list of capabilities (Sen, 2004). Indeed, especially for the analysis of local systems it is better if the choice of dimensions and, subsequently, of indicators is more flexible.<sup>15</sup> Besides, it is important to notice that within the capability approach there are important exceptions as the well-known list of ten central

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<sup>13</sup>According to the Aristotelian thought, we should focus on domains/dimension of ‘functionings’ that people need in order to ‘flourish’ as human beings.

<sup>14</sup>In general this is the problem faced by researchers when they decide to enlarge the HDI components in the informational capability space.

<sup>15</sup>Furthermore, there are different methods that can be used, even combined, to choose domains (Alkire, 2007, Alkire 2008 and Biggeri and Mehrotra, 2010) and also specific procedures to conceptualise capability dimensions (see for instance Robeyns, 2003, and Biggeri et al, 2006 or Biggeri and Libanora, 2010).

capabilities proposed<sup>16</sup> by Martha Nussbaum (2000; 2003) among others.<sup>1718</sup>

Although 'lists' can vary (see for instance Alkire, 2002, Camfield, 2006; Ranis et al., 2006), a number of main and common domains/dimensions can be identified from the literature as requirements for human flourishing such as "Life and physical health", "Body integrity and safety", "Mental well-being", "Social relations", "Participation", "Political freedom", "Education and knowledge", "Work", "Leisure", "Environment", "Respect".

Ranis et al., on the other side, present a 'pragmatic' list for evaluating HD based on the analysis of the literature review that takes into account also the ED aspects (Ranis et al, 2006, p. 326)<sup>19</sup>. Indeed, the main difference with the other lists (see notes 13-15) is that, in Ranis et al (2006), the dimensions related to the economic aspects of life - or better "command over

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<sup>16</sup>The Nussbaum Central Human Capabilities are the following: 1. Life; 2. Body Health; 3. Body Integrity; 4. Sense, Imagination and Thought; 5. Emotions; 6. Practical Reasons; 7. Affiliation; 8. Other species, 9. Play; 10. Control Over One's Environment. (Nussbaum 2003, p. 41-42).

<sup>17</sup>For instance, Robeyns (2003) presented the following list regarding gender issues: 1. Life and physical health: being able to be physically healthy and enjoy a life of normal length. 2. Mental well-being: being able to be mentally healthy. 3. Bodily Integrity and safety: being able to be protected from violence of any sort. 4. Social relations: being able to be part of social networks and to give and receive social support. 5. Political empowerment: being able to participate in and have a fair share of influence on political decision-making. 6. Education and knowledge: being able to be educated and to use and produce knowledge. 7. Domestic work and nonmarket care: being able to raise children and to take care of others. 8. Paid work and other projects: being able to work in the labour market or to undertake projects, including artistic ones. 9. Shelter and environment: being able to be sheltered and to live in a safe and pleasant environment. 10. Mobility: being able to be mobile. 11. Leisure activities: being able to engage in leisure activities. 12. Time-autonomy: being able to exercise autonomy in allocating one's time. 13. Respect: being able to be respected and treated with dignity. 14. Religion: being able to choose to live or not to live according to a religion.

<sup>18</sup>According to Alkire the selected missing dimensions of well-being are: employment: particularly informal employment and safety at work; empowerment or agency: the ability to advance goals one values and has reason to value; physical safety: focusing on security from violence to property and person, and perceived violence; the ability to go about without shame: to emphasize the importance of dignity, respect and freedom from humiliation, and psychological and subjective well-being: to emphasize meaning, its determinants, and satisfaction (Alkire, 2008) and love and care in the case of children (Biggeri et al 2006).

<sup>19</sup>According to Ranis, Stewart and Samman, the dimensions are the following: 1. The HDI itself. This broadly covers bodily well-being, material well-being and mental development. Of course, it itself is a multidimensional indicator. We include it as a single indicator because it is the generally accepted measure of achievement on HD. 2. Mental well-being. 3. Empowerment. 4. Political freedom. 5. Social relations. 6. Community well-being. 7. Inequalities. 8. Work conditions. 9. Leisure conditions. 10. Political security. 11. Economic security. 12. Environmental conditions. (Ranis et al, 2006, p. 328-9).

resources” (1, 7 and 11) - are included in the analysis which moves from capabilities dimensions which characterize HD to HD as a process. Therefore, while all the dimensions recalled in the other lists are valuable as aspects of a good life, and also valued as constituents of the capability to do other things (instrumental), “resource availability” is only an instrument for other ends - indeed, income is just one way of seeing this command” (Anand and Sen, 2000, p. 84).<sup>20</sup> For instance, the purpose of including GDP per capita in the HDI was that there are many important capabilities which are critically dependent on one’s economic circumstances (Anand and Sen, 2000, p. 84). However, it is also clear that after a certain level more income does not determine an increase of HD especially at the aggregate level if there are not policies towards HD. Furthermore, the resource availability needs to take into account not only the income level but also social and environmental sustainability by future generations (UNDP, 1996). In line with Mahbub ul Haq - who identified four essential pillars: equality, sustainability, productivity and empowerment (UNDP 1996) - the ‘command over resources’ denotes that it is important how these resources are divided among persons, the employment opportunities generated as well as the environmental dimension. This last point implies that the quality of economic growth matters, as underlined by UNDP<sup>21</sup> there are different kinds of growth: ‘jobless growth’ (that does not expand the opportunities for employment), ‘ruthless growth’ (the fruits of growth mostly benefit the rich), ‘futureless growth’ (where present generations squander resources needed), as well as those types of ‘peace-less growth’ that feeds conflicts. In other words, this has a political implication: any development process that increases the severity of poverty, the severity of unemployment or create an environmental damage or fuels conflicts needs to be accounted negatively in a HD process perspective.

The second step is to select the variables or indicators within each dimension. Unfortunately, although Sen has argued that for many evaluative purposes, the appropriate ‘space’ is that of substantive freedoms and capa-

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<sup>20</sup>Furthermore, GDP per capita signals deprivation of economic provisions including public basic social services and private opportunities as pointed out by Anand and Sen (1997, p. 8). Moreover, the ability to command resources with which a person can lead a positively free life in a number of fields gives us an indirect account of many significant aspects of HD (Anand and Sen, 2000, p. 99).

<sup>21</sup>Indeed, as the HDR 1996 emphasises, the quality of growth matters, or policy failures may occur (UNDP, 1996): (i) jobless growth - that does not expand the opportunities for employment, (ii) ruthless growth - the fruits of growth mostly benefit the rich, (iii) voiceless growth - growth has not been accompanied by expansion of democracy, empowerment, (iv) rootless growth - causes people’s cultural identity to wither, and (v) futureless growth - where present generations squander resources needed by future generations (UNDP, 1996; Ranis, 2007).



bilities (1999), we can only observe achievements rather than the full range of achievable functionings (i.e. capability set). Note that, conceptually, “there is no difference as far as the space is concerned between focusing on functionings or on capabilities. A functioning combination is a point in such a space, whereas capability is a set of such points” (Sen, 1992, p. 50). Indeed, “The actual set of achievements on any variable, of course, indicates that it is a one of the set of possible choices, but the range of choices presumably goes much beyond actual performance, as options not chosen are not included.” (Ranis et al 2006, p. 324). Hence, from the point of view of our analysis we can compare the individual achieved functionings to the ‘best’ and the ‘worst’ achieved functioning (realised). In other words, the HD outcomes in terms of achieved functionings can give an idea of the potential functionings for the individual unit in a given context. Outcomes reached on different dimensions give a proxy of the opportunity open to a person in a certain context.

The third step is to aggregate the indices of different dimensions into the two macro components or sub-indices. Therefore, if we select more than one indicator per each of the two macro aspects, we must also decide how to combine them into a sub-dimensional index. This step is, thus, to decide which method could be used to aggregate those dimensions i.e. to create two sub-indices depending on the level of analysis and data availability. It is possible to aggregate first across people and then across dimensions, while different methods can be used from simple averages, geometric, harmonic, or throughout principal component analysis<sup>22</sup>.

The interpretative framework with the two macro aspects and related sub-indices can represent the countries HD outcomes and economic outcomes during time. In other words, we can represent, as in figure 1, the different patterns in term of HD progress during time based on the two macro dimensions: the social-political-civil outcomes dimensions (SD) and the economic-inequality-environmental outcomes dimensions (ED). Throughout this interpretative framework it is possible to identify three different levels and three different routes of HD progress.

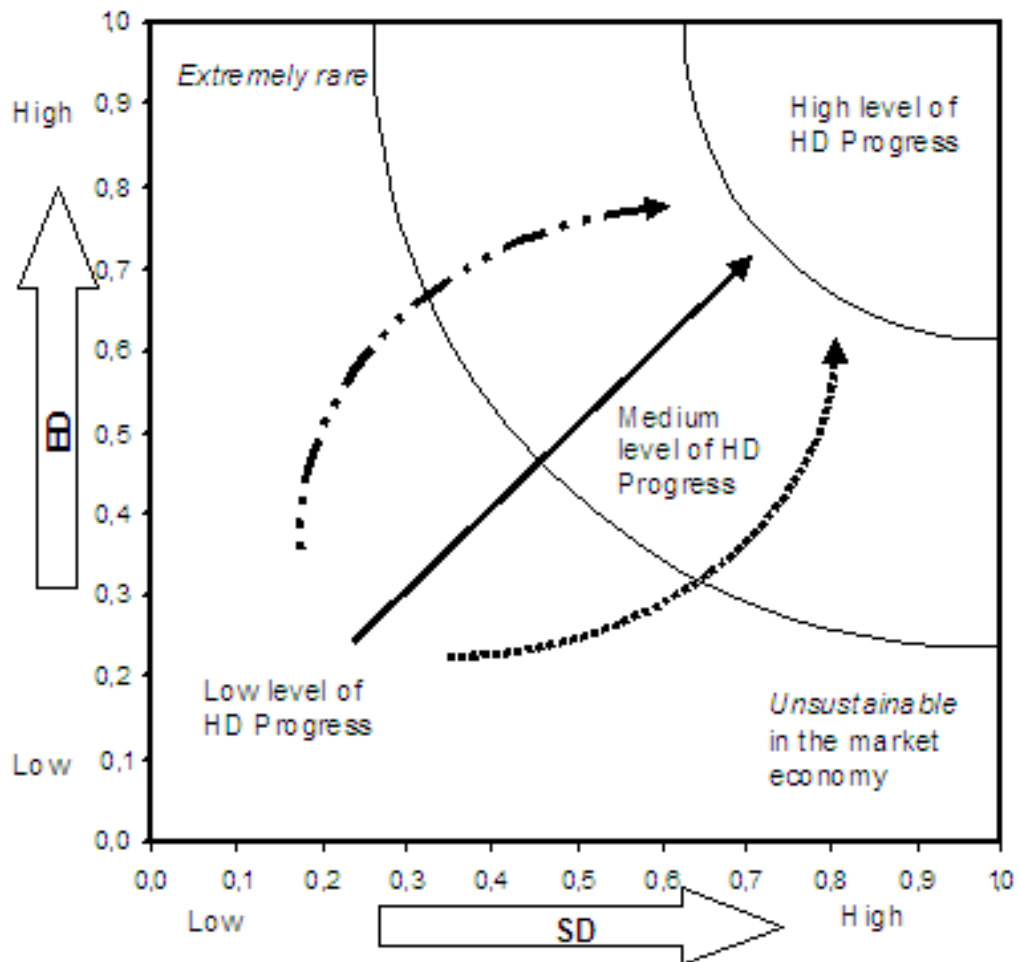
The highest synergies among social-political-civil outcomes and economic-inequality-environmental outcomes are in the synergic strategic route.


The SD strategic route privileges HD at the expense of ED (i.e. SD lop sided), and vice-versa. Although the frame is simple, it gives important information on the actual situation of each country during time.

Under the hypothesis that the HD progress is enhanced throughout the

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<sup>22</sup>The Principal component analysis is more suitable for the analysis at the local systems of development and rather than for international comparison.



Synergies strategic route 

SD strategic route 

ED strategic route 

Notes: SD= Social-political-civil Dimension; ED=Economic Dimension

Figure 1: Patterns of HD progress

synergic path introduced above, we need a quantitative tool to measure it. In the next section we propose an index that takes into account the synergies as a function of the homogeneity between the outcomes considered. In section (4) we presents some explorative examples using data on a group of 23 countries and four instants in time.

### 3 Statistical methodology

To analyse the synergies of the units, we first divide into two groups (SD versus ED) the variables available as outcomes.

Let  $n$  be the total number of units (countries) and  $k$  and  $h$  the number of variables selected for each group. We can define two matrices  $S_{n \times k}$  and  $E_{n \times h}$ . The generic entry of S,  $s_{ij}$ , represents the value of variable  $j$  measured on unit  $i$ . Matrix E is defined analogously.

Our aim is to represents each unit  $i$  in a two-way plot to observe its social and economic dimensions and to analyse the interaction between them. In order to reduce the dimensionality of the data, we need to summarize each row of the matrix into a unidimensional value. This issue could be addressed straightforwardly by first normalizing the variables<sup>23</sup> and then using an arithmetic mean to reduce the dimensionality. This method is widely used because of its simplicity, but it does not take into account the (possible) heterogeneity between the components that are aggregated into a unidimensional index. This can be a tough drawback for an index aiming to measure synergies.

Foster et al. (2005) propose a distribution-sensitive parametric class of indices (that include the arithmetic mean as a particular case) in order to account for the inequality with which the benefits are distributed among the population<sup>24</sup>. This work essentially uses the class of general means given by  $\mu_\alpha(x) = (\sum_{i=1}^n x_i^\alpha / n)^{\frac{1}{\alpha}}$  and suggests to utilize a value  $\alpha < 1$  to emphasize the (implicit) weight of the variables with lower (i.e. more deprived) values. The inequality in the distribution is here considered because the general mean (with  $\alpha < 1$ ) tends to score lower values if calculated over heterogeneous values.

In this paper we propose an index that is a generic mean  $\mu_\alpha(d) = (\sum_{i=1}^n d_i^\alpha / n)^{\frac{1}{\alpha}}$  that is calculated over  $d_i$ , i.e. the difference between the value of  $x_i$  and its maximum possible value. We then choose  $\alpha = 2$ . The reasons for this specific

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<sup>23</sup>We here assume for simplicity that all variables have the same logical direction, see section (4.1) for further details.

<sup>24</sup>For earlier works that aim to account for distribution-sensitive measures, see Anand and Sen (1993, 1997), Hicks (1995).

choice are explained in the next section.

### 3.1 The index proposed

The index must be a function  $f : R^k \rightarrow R$ . It is applied to each row of the matrices of the data  $S_{n \times k}$  and  $E_{n \times h}$  introduced above to finally obtain, for each unit, a single value for the social components and a single value for the economic components.

We first normalize each column (variable) of each matrix with the common formula, obtaining a new matrix<sup>25</sup>  $\tilde{S}$  with generic entry

$$\tilde{s}_{ij} = \frac{s_{ij} - a_j}{b_j - a_j}$$

The values of  $a_j$  and  $b_j$  (with  $a_j \leq \min(j)$  and  $b_j \geq \max(j)$ ) are chosen for each variable, according to the distribution of the variable, considering in particular the best and the worst performances a country can achieve<sup>26</sup>.

If  $a_j = \min(j)$  and  $b_j = \max(j)$  then a common normalization is obtained<sup>27</sup>, with the worst unit set as 0 and the best unit set as 1.

For each row of the matrix we then calculate our unidimensional index  $\delta$  as

$$\delta(i) = 1 - \sqrt{\sum_{j=1}^k (1 - \tilde{s}_{ij})^2 / k} \quad (1)$$

The  $\delta$  index is 1 minus the quadratic mean of the differences between the the value of each component of the unit and its maximum possible value. Since the  $j$  variables are normalized, the maximum value is 1 for each column. At a first sight, this index may seem easy to compute but hard to interpret. The interpretation of the index is easier if we re-write formula (1) as:

$$\delta(i) = 1 - \frac{\sqrt{\sum_{j=1}^k (1 - \tilde{s}_{ij})^2}}{\sqrt{k}} \quad (2)$$

and we notice that, for the generic row  $i$ , the numerator of the second term in equation (2) is the euclidean distance between the unit and the best

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<sup>25</sup>For simplicity, only one matrix is represented.

<sup>26</sup>The choice of  $a_j$  and  $b_j$  is subjective. See section (4.1) for the criteria used for the variables selected in this specific work

<sup>27</sup>In the rest of the paper, we will indicate as “normalized” a variable that is constrained to assume values between 0 and 1, but not necessarily reaching these values.

possible units (i.e. the unit having  $s_{ij} = 1 \forall j$ ), a distance that is bounded<sup>28</sup> between 0 and  $\sqrt{k}$ :

$$0 \leq \sqrt{\sum_{j=1}^k (1 - \tilde{s}_{ij})^2} \leq \sqrt{k}$$

The denominator of the second term ( $\sqrt{k}$ ) represents the upper bound of the numerator, and the  $\delta(i)$  is then bounded between 0 and 1.

Since the  $k$  columns (variables) in matrix are normalized, defining  $\bar{s}_i = \sum_{j=1}^k s_{ij}$  as the arithmetic mean of each row of matrix  $S$ , the  $\delta$  index satisfies an important property:

$$\begin{aligned} \delta(i) = s_{ij} = \bar{s}_i &\iff s_{ij} = s_{ik} \quad \forall j, k \\ \delta(i) < \bar{s}_i &\quad \text{otherwise} \end{aligned} \tag{3}$$

In other words, the value assumed by the index for a unit  $i$  equals the arithmetic mean  $\bar{s}_i$  of the row if and only if all the elements of the row are the same (i.e. if the variance of  $s_{i1} \dots s_{ik}$  is zero). As the variance of the elements of the row increases, the index tends to assume lower values with respect to  $\bar{s}_i$ . More specifically, it can be demonstrated that if two units  $i, j$  have the same arithmetic mean (i.e.  $\bar{s}_i = \bar{s}_j$ ) then:

$$\delta(i) > \delta(j) \iff \sigma^2(i) < \sigma^2(j)$$

$$\text{with } \sigma^2(i) = \sum_{j=1}^k (s_{ij} - \bar{s}_i)^2 / k.$$

### 3.2 Geometrical Interpretation

The  $\delta$  index has an appealing geometrical interpretation. We illustrate it in a simple example, using a  $\tilde{S}_{2 \times 2}$  matrix of data of 2 units and 2 variables.

| Unit | $v_1$ | $v_2$ |
|------|-------|-------|
| a    | 0.2   | 0.8   |
| b    | 0.4   | 0.4   |

Since we have to deal with two variables only, data can be represented in a two-way plot as in figure 2a. The columns of the matrix are normalized, so that all the points in the graph are contained in a unitary square. The

<sup>28</sup>Since the variables are normalized, if the distance reaches its minimum (maximum), then the unit is a  $k$ -dimensional vector with elements equal to 1 (0).

top-right point (labeled B as “Best”) can be interpreted as the unit that potentially has the maximum value of all variables, with the bottom-left point (labeled W as “Worst”) representing the unit that has potentially the minimum value of all variables considered<sup>29</sup>. For each unit we can compute the distance between the unit and point B. Recalling equation (2) we can now provide an intuitive geometrical interpretation of the index  $\delta$ .

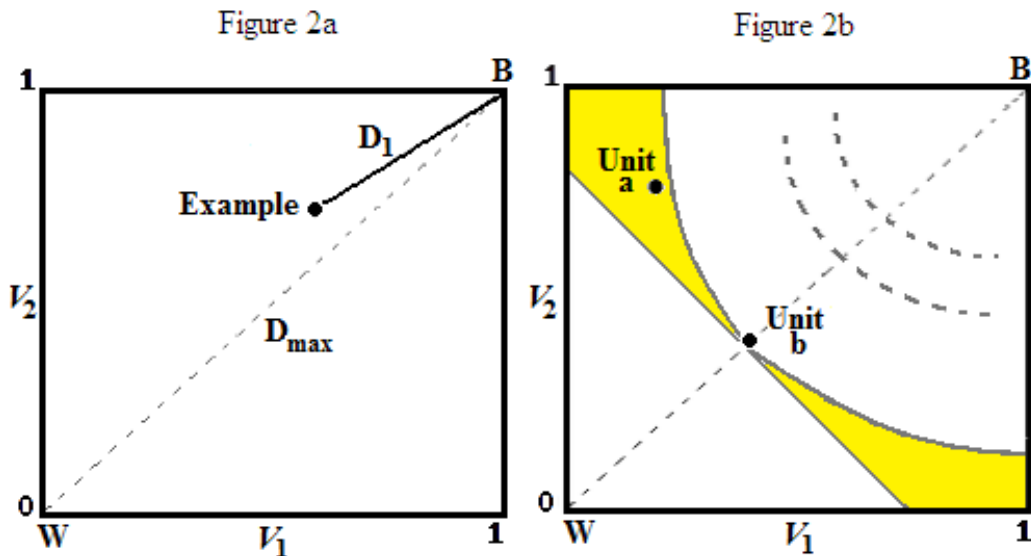


Figure 2: Geometrical interpretation of index  $\delta$

In figure 2a is represented the distance for a single unit (labeled as “Example”). The distance between the unit and the point B is the numerator of the second term in equation (2), while the denominator is represented by the diagonal of the square, (i.e. the distance between the best and the worst unit). So, recalling equation (1), the quadratic mean of the distance between each point and the maximum possible values can now be represented geometrically by the ratio between segments  $D_1$  and  $D_{max}$  in figure 2a. This ratio is bounded between 0 and 1, but it is small for units close to B and it increases as the unit moves towards W. To deal with this counterintuitive issue, we subtract 1 to finally obtain equation (1). The example is easily generalizable to the case of  $k > 2$  dimensions.

It is now possible to illustrate what happens to the value of the index as the unit changes its position in the plot. In figure 2b are represented various curves obtained considering the points of the graph with the same value of

<sup>29</sup>The worst and the best unit are respectively represented by the vectors  $(a(1), \dots, a(k))$   $(b(1), \dots, b(k))$

the index. It is interesting to notice that these curves have the same basic properties of the well-known *indifference curves* in economics<sup>30</sup>. All points on a single curve share the same value of the  $\delta$  index, and are ranked either more or less than every other point not on the same curve<sup>31</sup>. It is now easy to notice (using data in table 1) how the index automatically takes into account the inequality in the distribution of  $v_1$  and  $v_2$ . If we compare units  $a$  and  $b$  in figure 2b, we can see that unit  $b$  lies on a curve that is associated to a higher value of  $\delta$ . But if the index calculated on the same units  $a$  and  $b$  is an arithmetic mean with equal weights, the situation is opposite, with the point  $a$  obtaining a higher mean (index) than  $b$ . This happens because a simple mean does not take into account the heterogeneity between the two variables, that are implicitly considered as perfect substitutes in any situation. If a unit (country) has a normalized value of  $v_1$  and  $v_2$  that is, for instance,  $(0.2 ; 0.8)$ , the simple mean does not consider the possibility that the country is deprived in the first variable, and consider it at the same level of a country scoring  $(0.5 ; 0.5)$ . The indifference curve<sup>32</sup> for a simple mean for unit  $b$  lies below unit  $a$ , reflecting the lower value of the mean. The shadowed area in figure 2b represents the points for which the simple mean is higher than unit  $b$  and the  $\delta$  index is lower. For points lying in this area, the choice of not taking into consideration the heterogeneity within the variables can lead to possible biases. To sum up, a ranking based on a simple mean (e.g. the HDI) can be misleading if the units considered present a high variance between the values of variables that compose the index.

### 3.3 Implicit weighting

Another possible interpretation of the index  $\delta$  takes into account a weakness of the HDI and, more generally, of every arithmetic mean-based index: the subjectivity associated to the system of weights.

We keep using units  $a$  and  $b$  as an example to compare the arithmetic mean and the  $\delta$  index. In table 1 are reported the values of the variables  $v_1$  and  $v_2$ , as well as the values of variance, arithmetic mean with equal weights, and  $\delta$  index. The aim is to show how the index proposed can be seen as an arithmetic mean of the starting variables with higher weights assigned to variables with low<sup>33</sup> values.

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<sup>30</sup>In particular, they are 1.Negatively sloped, 2.Convex, 3.Complete and 4.Transitive

<sup>31</sup>Geometrically, this means that the curves do not intersect.

<sup>32</sup>In this case, since the mean is a linear operator, the curve is a straight line with negative slope, as represented in figure 2b.

<sup>33</sup>More specifically, if we consider as “low” a value of a variable  $v_{ij}$  that is lower than the arithmetic mean.

Table 1: Example on implicit weighting

| Unit | $v_1$ | $v_2$ | variance | mean | $\delta(i)$ | $w_1$ | $w_2$ |
|------|-------|-------|----------|------|-------------|-------|-------|
| a    | 0.2   | 0.8   | 0.09     | 0.5  | 0.42        | 0.63  | 0.37  |
| b    | 0.4   | 0.4   | 0        | 0.4  | 0.4         | 0.5   | 0.5   |

The question is: if we want to obtain the same results of the  $\delta$  index using a weighted arithmetic mean, what system of weights do we have to use? In the last two columns of table 1 are reported the weights  $w_1$  and  $w_2$  that produce the value of  $\delta$  using a simple weighted mean. For unit  $b$ , that has no variance (i.e. no inequality) between variables, the value of the simple mean and the  $\delta$  are coincident, so that the implicit weights  $w_1$  and  $w_2$  are equal. For unit  $a$ , that presents an higher variance, the weights are different, and the higher weight is associated to the variable ( $v_1$ ) more deprived.

This example based on the system of weights is hard to generalize in  $k$  dimensions because the degrees of freedom in the system of weights increases as the number of variables grows up, with the consequences that the linear combination is not unique (i.e. there are infinite solutions for the vector with elements  $w_i$ ). But the basic property (3) introduced before holds for any fixed  $k$ , reflecting the fact that units with high inequality between indicators, results more penalized by the value of  $\delta$ .

## 4 Empirical examples

### 4.1 Data

In this section we present an explorative analysis to show how the results can be presented and interpreted. In this example, the dimensions examined are six, three pertaining to the SD and three pertaining to the ED.

Although the ranking (that depends on the levels) between countries is biased by the omission of some relevant dimensions<sup>34</sup>, the analysis can be used as a device for understanding different patterns of HD progress.

For this reason, we focused on the different type of patterns<sup>35</sup> rather than

<sup>34</sup>According to our list in section 2, the missing dimensions are “Body integrity and safety”, “Mental well-being”, “Social relations”, “Participation”, “Leisure”.

<sup>35</sup>The bias is lower for the patterns since we assume that the heterogeneity of these omitted dimensions is higher between countries than between different years of a single country.



on the country levels (see figure 3).<sup>36</sup>

Three indicators used are the components of HDI - Life expectancy index, Education index, GDP index - for these variables the source is the Human Development Report (on line database on trends, UNDP, 2009).

The other data used (from the WDI, World Bank) are the following:

- Carbon dioxide ( $CO_2$ ) emissions. These emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.<sup>37</sup>

- Unemployment. This variable refers to the share of the labor force that is without work but available for and seeking employment. Definitions of labor force and unemployment differ by country.<sup>38</sup>

- Freedom index. The index is calculated by a combination of the political rights and civil liberties ratings, indicating the general state of freedom in a country or territory. The data on political rights and civil liberties categories are taken from the Freedom House and they contain numerical ratings between 0 and 12 for each country or territory, with 12 representing the most free and 0 the least free.<sup>39</sup>

All the six variables introduced are measured in four instant in time: 1990, 1995, 2000 and 2005. In table 2 are reported the maximum and minimum

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<sup>36</sup>Furthermore, the analysis is explorative for three other reasons: 1) the variable chosen are, as usual, the available proxies of dimensions, 2) the selection of the countries are based on data availability, 3) the countries represented in the six figures are selected in order to describe different patterns of HD progress. The initial 50 countries with available data are: Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Belize, Bolivia, Botswana, Brazil, Chile, China, Colombia, Costa Rica, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Finland, France, Honduras, Iceland, India, Indonesia, Israel, Italy, Japan, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Peru, Philippines, Poland, Romania, Russian Federation, South Africa, Sri Lanka, Thailand, United Arab Emirates, United States, Uruguay, Venezuela, Zambia. Please note that 12 missing data on unemployment were interpolated.

<sup>37</sup>Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.

<sup>38</sup>Source: International Labour Organization, Key Indicators of the Labour Market database.

<sup>39</sup>The data are obtained from a survey measuring freedom (the opportunity to act spontaneously in a variety of fields outside the control of the government and other centers of potential domination) according to two broad categories: political rights and civil liberties. Political rights enable people to participate freely in the political process, including the right to vote freely for distinct alternatives in legitimate elections, compete for public office, join political parties and organizations, and elect representatives who have a decisive impact on public policies and are accountable to the electorate. Civil liberties allow for the freedoms of expression and belief, associational and organizational rights, rule of law, and personal autonomy without interference from the state.

values for each variable for year 2005, as well as the bounds ( $a$  and  $b$ ) chosen to perform the normalization of the data. The original data are first redirected towards a common positive direction, and then normalized.

Table 2: Variables considered

| Variable                       | Min-Max 1990/2005 |       | a   | b    |
|--------------------------------|-------------------|-------|-----|------|
| Freedom Index                  | 0                 | 12    | -4  | 16   |
| Employment                     | 68.4%             | 99.4% | 60% | 100% |
| $CO_2$ Emissions <sup>40</sup> | -1.63             | -0.05 | -3  | 0    |

Table 3: HDI components and new variables normalized,  $\delta_{SD}$ ,  $\delta_{ED}$ , year 2005

Source: Our elaboration on WDI (World Bank 2010) and HDI Trends (UNDP 2010)

| Country (code)             | GDP  | Emp | Co2 | Edu | LE  | Free | $\delta_{SD}$ | $\delta_{ED}$ |
|----------------------------|------|-----|-----|-----|-----|------|---------------|---------------|
| Algeria (DZA)              | .72  | .62 | .76 | .74 | .78 | .35  | .58           | .69           |
| Argentina (ARG)            | .79  | .73 | .77 | .95 | .83 | .70  | .80           | .76           |
| Bangladesh (BGD)           | .41  | .90 | .97 | .52 | .66 | .50  | .55           | .65           |
| Brazil (BRA)               | .75  | .85 | .85 | .89 | .78 | .70  | .78           | .81           |
| China (CHN)                | .63  | .90 | .76 | .85 | .79 | .25  | .54           | .74           |
| Colombia (COL)             | .72  | .71 | .88 | .87 | .79 | .60  | .73           | .76           |
| Costa Rica (CRI)           | .76  | .84 | .86 | .88 | .89 | .80  | .85           | .81           |
| Denmark (DNK)              | .98  | .88 | .67 | .99 | .88 | .80  | .87           | .80           |
| Egypt (EGY)                | .65  | .72 | .83 | .70 | .74 | .35  | .56           | .72           |
| Estonia (EST)              | .86  | .80 | .61 | .97 | .79 | .80  | .83           | .74           |
| Finland (FIN)              | .96  | .79 | .65 | .99 | .90 | .80  | .87           | .76           |
| Honduras (HND)             | .59  | .90 | .89 | .81 | .78 | .60  | .71           | .75           |
| India (IND)                | .53  | .89 | .88 | .63 | .63 | .65  | .64           | .71           |
| Morocco (MAR)              | .61  | .73 | .86 | .55 | .76 | .45  | .57           | .71           |
| Peru (PER)                 | .71  | .78 | .88 | .88 | .79 | .65  | .75           | .78           |
| Russia (RUS)               | .81  | .82 | .65 | .93 | .67 | .35  | .58           | .75           |
| South Africa (ZAF)         | .75  | .33 | .67 | .84 | .45 | .75  | .64           | .55           |
| Sri Lanka (LKA)            | .61  | .82 | .94 | .84 | .81 | .60  | .73           | .75           |
| Thailand (THA)             | .72  | .97 | .76 | .89 | .72 | .60  | .71           | .79           |
| United Arab Emirates (ARE) | 1.00 | .92 | .50 | .82 | .87 | .30  | .58           | .71           |
| United States (USA)        | 1.00 | .87 | .56 | .97 | .90 | .80  | .87           | .74           |
| Venezuela (VEN)            | .78  | .67 | .73 | .89 | .80 | .50  | .68           | .72           |
| Zambia (ZMB)               | .42  | .68 | .97 | .68 | .30 | .50  | .47           | .62           |

The values of parameters  $a$  and  $b$  introduced in section (3.1) are very important, representing an implicit weighting of every index that is then

computed on the values of the normalized matrix obtained in function of these parameters. In table 2 are reported the values of  $a$  and  $b$  chosen for each variable, as well as the minimum and maximum values assumed in our dataset in each year considered.

The value of  $a$  and  $b$  for variables “GDP”, “Life expectancy” and “Literature” are those of the HDI trends, while the values for variables “Freedom Index”, “Unemployment” and “ $CO_2$  Emissions” are chosen taking into account the distribution of each variable.

For variable “Freedom” an arbitrary value of  $a = -4$  was chosen because some countries (e.g. China) scored 0 in this variable in 1990 and 1995. The choice of a negative value tries to take into account the fact that the Chinese level of freedom cannot be considered the worst possible situation. For analogous reasons, the best possible score was set at 16.

For variable “Employment” the bottom value was set at a rate of 60% of employment, while the best possible value is 100%.

The variable “ $CO_2$  Emissions” has been previously transformed using a logarithmic scale to account for the huge differences between countries. The logarithmic values were then normalized using  $a = -3$  and  $b = 0$ .

In table 3 are reported the values of the normalized variables for year 2005 as well as the values of the index  $\delta_{SD}$  and  $\delta_{ED}$  for each country.

## 4.2 Patterns of HD progress

The aim of this section is to identify typologies of HD progress patterns according to the interpretative theoretical framework and the aggregation method presented. Considering this purpose the countries selected have been clustered and analysed in different figures. The Cartesian coordinates SD and ED facilitates the identification and analysis of HD patterns in terms of outcomes performance from a cross and time perspective (i.e. 20 years a point every five years: 1990, 1995, 2000, 2005).

Analysing the empirical results allows us to examine the different HD patterns of countries and try to relate the results to the different policies adopted or to the occurrence of a specific crisis. Specific results are not definitive and should be treated cautiously (as already mentioned in the previous section, relevant variables concerning equalities and social inclusion and immaterial aspects of well-being are missing). This is an additional reason to privilege the discussion on typologies patterns rather than going into a detailed country analysis.

The first pattern, represented in figure 4a (Costa Rica, Denmark, Estonia, Sri Lanka), is related to the synergic HD progress. Three of these countries are considered as high HD achievers “developing” countries: Costa Rica, Sri

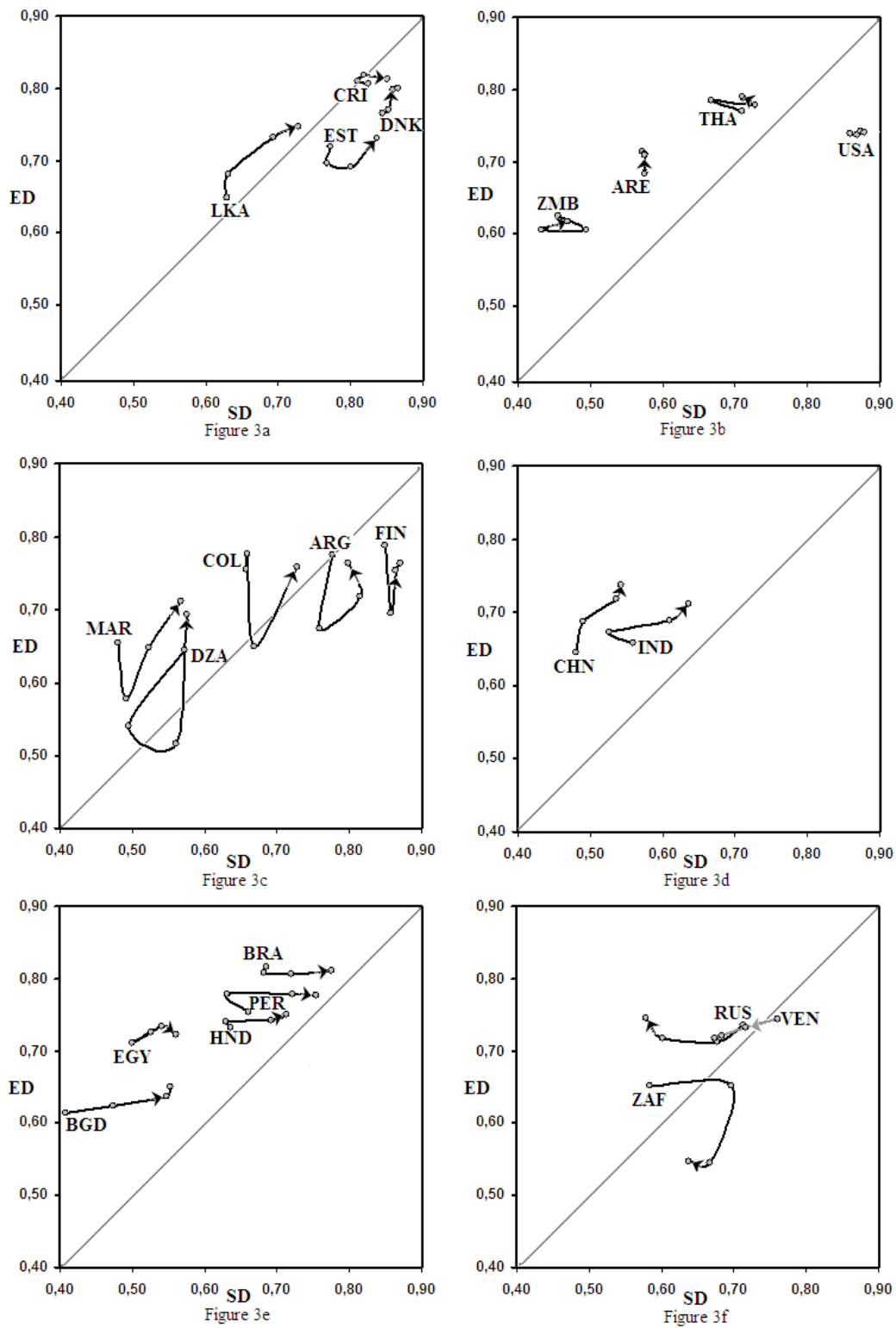


Figure 3: Patterns of HD progress - 23 countries (1990, 1995, 2000, 2005)

Note: a) Synergistic strategic route (Costa Rica, Denmark, Estonia, Sri Lanka), b) different levels of HD progress (Thailand, Zambia, United Arab Emirates and USA); c) Impact of ED crises and recovery Algeria, Argentina, Colombia, Finland, Morocco, d) ED route of emerging powers India and China, e) From ED to the synergistic route Bangladesh, Brazil, Egypt, Hungary and Peru, f) negative patterns Russia, South Africa and Venezuela.

Lanka (Mehrotra and Jolly, 1997) and Denmark. We decided to add Estonia because after a negative period (due to the transition from a planned to a market economy), the country recovered initially through SD outcomes and then in the synergy route.

In figure 4b (Thailand, Zambia, United Arab Emirates and USA) are represented different levels of HD progress<sup>41</sup> which all see a ED outcome to prevail to SD except for USA where SD are higher than ED (this is mainly due to the high level of environmental pollution).

The countries reported in figure 4c (Algeria, Argentina, Colombia, Finland and Morocco) show ED crisis but with different SD outcome patterns. For Finland, Colombia and Morocco the growth in SD does not seem to be affected by the crisis, while for Argentina and Algeria reduction in the SD are observed during the crisis and the following recovery.

ED routes of emerging powers India and China, in figure 4d, are clear. Liberalization policies after 1990 in India reduced the well-being SD but then several reforms increased the SD outcomes. China 1992 passage from a command to a socialist market economy produced strong ED but, at the same time, the SD suffered from a lack of freedom. Although the economic growth is remarkable, the high level of pollution reduces the overall HD progress.

In figure 4e are reported the examples of different countries that are moving from the ED side to the synergic route (Bangladesh, Brazil, Egypt, Hungary and Peru) thanks to government policies and collective action.

The patterns of the three countries (Russia South Africa and Venezuela) reported in figure 4f shows possible negative paths (vicious patterns). After the initial transition from a command to a market economy, Russia faced a strong reduction both in ED and SD due to financial crises, and then a slow recovery in terms of ED associated to a dramatic decrease in SD (Ellman, 2003). After the success of 1995 in terms of SD due to the end of apartheid (political and civil freedom), South Africa registered a deep economic crisis: the ED reduction determined a negative feedback in SD. Venezuela instability reduced both SD and ED till 2000 when HD progress showed more stability.

Finally, we can observe that it is possible to examine cross country and time comparison as well. Transition economies considered (e.g. Estonia, Russia and China) show very different patterns, and for this reason are reported in different figures. The Chinese gradual reforms with a “Chinese style” produced very good results in terms of ED, while the SD progress seems much slower (Biggeri, 2007). Russia inconsistent ‘shock therapy’ (Ellman, 2003) appears dramatically loose in terms of both dimensions just recovered in ED

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<sup>41</sup>Thailand economic crisis is not captured fully since it is exactly in the middle between 1995 and 2000. Yearly data would have been able to capture the Asian crisis event.

after 20 years. Estonia after a reduction of ED progress regained both in terms of ED and SD.

Before concluding this section it is relevant to point out that there are some important dimensions missing e.g. equality (vertical inequality too many data missing also from wider database) and social inclusion as well as regarding important immaterial aspects of well-being (i.e. subjective indicators could be added).

## 5 Conclusions

According to Sen “Human development’ accounting involves a systematic examination of a wealth of information about how human beings in each society live... . It brings an inescapably pluralist conception of progress to the exercise of development evaluation” (Sen, 2000, p. 18).

In this paper we present a framework that allows the identification and the analysis of HD patterns in terms of outcomes performance from a cross and time perspective. In particular, we focus on the synergies between positive HD outcomes and between these and positive economic outcomes.

We introduce an index to measure this synergies that are supposed to enhance the HD progress. The index aggregates the indicators under the implicit hypothesis of convex preferences because of its quadratic structure. The convex preferences refer to a property of the ordering of various outcomes which corresponds to the idea that “averages are better than the extremes”<sup>42</sup>. Utilizing the  $\delta$  index allows us to assign higher scores to countries with homogeneous levels of the outcomes (i.e. more synergic).<sup>43</sup>

The theoretical framework allows us to depict the different patterns of HD progress through the distinction the social-political-civil outcomes dimensions (SD) and the economic-inequality-environmental outcomes dimensions (ED)

The empirical examples highlight the different HD patterns of countries as a results of different policies adopted. The transition economies Russia, China and Estonia are a good example as well as the countries affected by different type of crises such as Argentina.

As already underlined, the application proposed must be considered an example: the missing dimensions mentioned in section (4.1) do not allow a full analysis of the patterns and, above all, of the levels. Furthermore, it is

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<sup>42</sup>A concept closely related to the law of diminishing returns.

<sup>43</sup>The widely-used aggregation method obtained through simple arithmetic averages can be seen as a particular case of the  $\delta$  index proposed under the hypothesis of perfect substitutibility of the outcome variables.

important to notice that, if sufficient data are available, the analysis can be conducted at different level of aggregation (e.g. local areas).

Another extension of the work include the possibility of considering different synergies at different level of growth of a country. Mauro and Biggeri (forthcoming), propose a framework to measure the synergy between single dimension as a function of the level of the development achieved.<sup>44</sup>

To conclude, although this framework cannot be considered a sufficient guide for policies, the research findings are an explicit recognition of the need to analyse and to integrate economic and social policy. In this direction, if “the separation of the ‘economic’ from the ‘social’ discourse is inherent in the leader-follower hierarchy model of the orthodox policy recommendations. ... In such circumstances, Social Funds and education and health ministries are left to take care of the consequences of macroeconomic policy mistakes - essentially, to pick up the pieces.” (Mehrotra and Delamonica, 2007, p. 14).

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<sup>44</sup>Under the assumption that the less is the level of development, the more is the need for synergy between dimensions.

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