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Going Beyond Functionings to Capabilities: An Econometric Model to Explain and Estimate Capabilities

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Abstract Any attempt to operationalize the capability approach necessitates an adequate framework for the measurement of the abstract unobservable multidimensional concept that the term 'capability' stands for. One such attempt is the latent variable approach, which considers the different dimensions of capability or human development as unobserved variables (factors) manifesting themselves through measurable indicators. In this paper, we propose a structural equation econometric model that accounts for the interdependence among the latent dimensions and other observed endogenous factors and includes causal exogenous variables affecting the latent dimensions and their indicators. We estimate the model using data on a cross-section of countries across the world and use our empirical model to derive capability indicators in different dimensions.

Key words: Human development, Capability approach, Latent variables, Item response, Simultaneous equations

Introduction

According to Nobel Prize Laureate Amartya Sen, the basic purpose of development is to enlarge people's choices so that they can lead the life they want to (Sen, 1985, 1999). He also emphasizes that development is a multidimensional concept enveloping diverse social, economic, cultural and political dimensions, and that economic growth, although necessary, is not sufficient in itself to bring about development in this broad sense.

In Sen's approach, the *choices* that one has are termed 'capabilities' and the actual levels of achievement attained in the various dimensions are called 'functionings'. Thus *human* development is given by the enhancement of the set of choices or capabilities of individuals, whereas functionings are a set of 'beings' and 'doings'; for example, the level of education, the state of health and the extent of participation in the

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political process. The concept of human development proposed by Mahbub ul Haq, in the first *Human Development Report* in 1990 (see United Nations Development Programme [UNDP], 1990a), largely inspired by Sen's various works, represents a major step ahead in the concretization of this extended meaning of development and in the effort to bring people's lives to the centre of thinking and analysis. Since then, human development has been the object of extensive theoretical and empirical research. It has been studied from various angles: conceptual, methodological, operational and policy-making. One such aspect is the measurement issue, which is crucial for a comparative assessment of different situations. As it is not possible to directly observe and measure human development in its broad sense, it is generally constructed as a composite index based on several variables (indicators). The most well known among these multi-dimensional welfare indictors are the Physical Quality of Life Index proposed by Morris (1979) and the Human Development Index (HDI) proposed by the UNDP (1990a).

Income or consumption still remains the most widely used indicator of well-being, but it is also one of the most criticized for not capturing the non-economic dimensions of human life (without denying the importance of the economic aspect; cf. Noorbakhsh, 1998; Osberg and Sharpe, 2003). There are ample examples to show that economic growth, although necessary, is not sufficient to achieve a good quality of life in various spheres such as the political (for instance, regarding the capability to express one's opinion freely), in the area of personal safety/security (being able to move about freely without being assaulted/arrested, having the right to a fair trial) and many others.[1]

A theoretical framework that is appealing in this context is a model that assumes capabilities are unobservable variables observed through a set of indicators. Factor analysis, MIMIC (multiple indicators and multiple causes) and structural equation models (SEM) all fall into this line of reasoning.[2] Another popular method in this context is principal components, which is not a latent variable method but a data reduction technique. This method seeks linear combinations of the observed indicators that reproduce the original variance as closely as possible. However, it lacks an underlying explanatory model which the factor analysis offers. In the factor analysis model the observed values are postulated to be (linear) functions of a certain number (fewer) of latent variables (called factors). Thus, it provides a theoretical framework for explaining the functionings by means of capabilities represented by the latent factors. However, this model does *not* explain the latent variables (or the capabilities) themselves in that it does not say what causes these capabilities to change. We believe it is as important to be able to say something about the capabilities as it is to say how we can enhance them and thus promote human development. It is not enough to be able to measure how much is achieved, but it is also essential to be able to say how things can be improved.

The MIMIC model (cf. Joreskog and Goldberger, 1975) represents a step further in the explanation of the phenomenon under investigation, as it is not only believed that the observed variables are manifestations of a latent concept, but also that there are other exogenous variables that 'cause' and influence the latent factor(s). This structure is highly relevant in our context, as there are several institutional, political and social arrangement factors that definitely influence human development and need to be taken into account. Not only do these factors influence human development, but they are also influenced by it. A simple example is that if access to education is facilitated, leading to an increase in capability in the knowledge dimension and hence in the general well-being of the population, this may in turn motivate people to demand free access to education for all (at least in a democratic setting), forcing the government to implement such a policy. This is because there is some sort of a virtuous cycle that is generated by the process of development. Adequate institutional setups can promote development, but it is also true that development in turn encourages favourable political and social arrangements by making people more and more aware, involved and demanding, and enforces the participatory element of progress. Thus, there is a feedback mechanism by which human development promotes its own 'causal' factors. Unless this feedback mechanism is taken into account we do not have a complete picture of the evolving nature of the whole system. Therefore, one has to go beyond one-way causal links towards SEM. I in fact argue for an extended SEM, including exogenous, latent endogenous and *observed* endogenous variables.

This paper proposes a theoretical framework that encompasses all the relevant features mentioned above in an appropriate manner, and provides the basis for an econometric model that can be fitted using real data enabling a better understanding of how this complex mechanism operates in practice. The empirical model allows us to verify the assumptions about the feedback mechanism mentioned above, and more importantly provides us estimates of capabilities rather than functionings.

The next section puts forward the case for the interdependent nature of capabilities by considering some important components of human welfare such as education, health and social participation. The third section brings in the measurement relations based on the postulate that capabilities are latent and manifest themselves in the form of functionings. Arguments of these two sections combined provide the necessary foundation for formulating the theoretical framework in the fourth section. This in turn leads to the econometric model presented in the subsequent section, where estimation issues are also breifly touched upon. The sixth section presents and discusses the empirical application in detail, and the final section ends the paper with some concluding remarks.

The simultaneous nature of capabilities

We mentioned earlier that 'capabilities' are the choices that one faces in life and 'functionings' are the outcomes. Then it is not difficult to imagine that there could be more than one achievement level for the same capability level. Take education for instance: The 'capability' in this field is given by the freedom to increase one's knowledge through education, in turn facilitated by access to a good school. Thus, existence of a school is an important exogenous factor in enhancing the knowledge capability. However, one person may exercise the choice by actually going to school and getting educated, whereas another may use the same freedom in not going to school due to various reasons. Thus we need a framework in which the same level of capability can give rise to different outcomes depending on external factors (individual, social and environmental) influencing the 'conversion' process (conversion of capability into achievement). Formally, this would mean that some exogenous variables also need to be added in the system of equations linking the observed response (functioning) to the latent capability, be it at the individual or country level.

Let us go further with the same example to get an idea of what these exogenous factors could be. Considering the education of a child in a developing country (especially in rural areas), family perceptions of the return on education compared to the immediate consequence of helping at home or in the field could play a role in deciding whether to send the child to school or not, independent of the availability of a school in the village. While there is the subtle point that the child may not have the choice here, it is beyond the scope of the present paper to go deeper into this issue. Here we take the view that there is a choice, but it is restricted by family compulsions. Another crucial element which comes into play in most developing countries is the gender of the child. Unfortunately it is still not uncommon that only boys are given proper education in certain traditions. Girls are excluded from the process as boys are seen as income-earners who stay with the parents for ever, thus adding to the total household income and ensuring that parents are taken care of in their old age. On the other hand, the family can also give importance to the non-monetary benefits of education (of its children) which will lift its status in society as learned persons always command more respect (wealth is no doubt another important contributor to the social status and here too education helps by providing better job opportunities). Needless to mention, there is also the value added to one's personality, and the self-confidence raised by education. Thus we see that several personal or 'socio-cultural' characteristics enter the process, sometimes acting in opposing directions and influencing the outcome at the individual and national levels.

Next, let us take health. No one can deny the significance of good health as an important constituent of one's well-being. Being healthy is not only an integral part of welfare, but also acts as a means to enhance one's

capacity to work and earn a living. However, all individuals may not react in the same way when faced with a health issue. Even assuming that adequate means and infrastructure exist and are accessible, people may choose different options depending on circumstances. Some may go to a public health centre, some to a private one. Some may not avail themselves of these professional services, but instead may follow a more traditional route of consulting a family/social guide in this matter, a custom still prevalent in many rural areas. In such situations, there is bound to be a difference in the result, given the same choice depending on one's own convictions, social traditions, family practices and on the degree of acceptance of alternative forms of medicine, which are also increasingly sought after in developed countries.

Taking a different angle, one can argue that education brings about a better awareness of health and environmental issues, and enables one to think of options that may otherwise not even have been part of the choice set. This is actually equivalent to saying that it increases the range of choice (i.e the capability set itself). For instance, it is well known that educating a mother has a direct impact on her own and her children's health and well-being (cf. Murthi *et al.*, 1997), meaning that there is a clear interaction between education and health. Thus, improving one capability can affect another in a favourable manner. This implies that capabilities are interdependent and this property should be included in the theoretical model we are trying to develop.[3]

It may be noted here that it is completely legitimate to argue that, given enough time, everything becomes endogenous, including what we considered purely exogenous earlier such as traditions. Thus, it is important to specify the time frame in which one is operating in a given context. However, given that traditions are deep-rooted and may sometimes take several generations to change, they can be generally treated as exogenous in the short/medium term.[4]

The measurement issue

Capabilities, by definition, cannot be directly measured, and hence are specified as latent variables in our model. What can be measured, however, are the functionings; namely, the achievements in each dimension both at the individual (household) and at the national levels. These achievements are generally identified by proper indicators reflecting the performance in the associated dimension. There could either be one indicator, or, as is more often the case, a whole range of indicators available for each capability dimension. In other words, one normally has a vector of functionings rather than a scalar indicator corresponding to each domain. In the case of health, at the aggregate (national) level, one can think of indicators such as life expectancy, infant/child mortality, total fertility, number of doctors per 1000 persons, number of hospital beds per 1000 persons, and so on.

There are several types of indicators available in practice. Some could be continuous — like the aforementioned life expectancy and per-capita number of doctors — whereas some could be of a qualitative nature — for instance, whether or not there is the right to vote, safe water access, a school or a hospital in the neighbourhood, and adequate sanitation facilities. At the individual level one could also have *subjective* assessments, such as whether or not a person considers himself or herself to be poor. The above characteristics are examples of what is called a binary or dichotomous variable (with two possible outcomes: yes and no coded as either 1 and 0 or +1 and −1). There are also other types of qualitative indicators: polychotomous (more than two outcomes; e.g. different levels of education — no formal education, primary, secondary, college, etc.). Note that there is a certain order in the last variable, and hence it is termed as an ordinal variable. There could also be polychotomous variables with no order (e.g. religion — Hindu, Muslim, Buddhist, Christian, etc.). One should bear in mind that the statistical/econometric treatment of these variables differs according to the particular type concerned.

In the psychometric literature, the relationships linking latent 'capabilities' and observable outcomes are called 'measurement equations' and the observed outcomes are 'response variables'.

The general theoretical framework

Let us recall from the foregoing discussion that the following features need to be present in our framework:

(i) Capabilities are *latent*, *unobservable* and interdependent, and are *endogenous* in our structural model.
(ii) Capabilities are influenced by a set of social, political and institutional factors, some of which may in turn be influenced by them. (In addition to capabilities, there are also some *observed endogenous* variables in our model.)
(iii) Capabilities are also influenced by a set of observable external/*exogenous* causes (such as traditions, cultural elements, natural environmental factors and some social, political, institutional ones that are not part of (ii)).
(iv) Achievements/functionings are measurable and are linked to the underlying capabilities (the set of relationships linking the two is the so-called measurement model or the qualitative response model).
(v) The relationships between the latent capabilities and the observed functionings are also affected by *exogenous* elements (for instance, individual characteristics).

We will now introduce some notations that will help us formulate our theoretical framework in precise terms.

We shall denote as follows:

- y^* a $(m \times 1)$ vector of latent capabilities;
- y a $(p \times 1)$ vector of observed indicators representing the functuionings associated with the capability vector; as discussed earlier, some of these y values could be continuous, some qualitative or discrete;
- z a $(n \times 1)$ vector of observed variables that influence the capabilities but are also influenced by them;
- x a $(k \times 1)$ vector of exogenous causes of y^* and z; and
- w a $(s \times 1)$ vector of exogenous factors entering the measurement equations (i.e. the relationships between observed indicators y and latent variables y^*).

For each vector, a typical element will be denoted using a subscript i (e.g. y_i^*, $i=1, \ldots, m$).

Note that we do not have latent exogenous variables, although theoretically it is possible to allow for such a case. The reason for not including them in the above framework is that we do not see their relevance in our empirical context where we would normally directly observe all exogenous factors.

Keeping all the above features in mind we can represent our structure by Figure 1 (which is usually called the path diagram in the social science literature).

The econometric model

The conceptual framework described in the previous section leads us to a general mixed (latent and observed) simultaneous equation model, which we can now write in formal terms as follows:

$$Ay^* + Bz + Cx + u = 0 \tag{1}$$

$$g(y) = b(y^*, w) + v \tag{2}$$

The first set of equations represents the structural model that jointly explains (y^*, z) in terms of x, with A, B, C being the corresponding coefficient matrices of appropriate dimensions. We have used the term

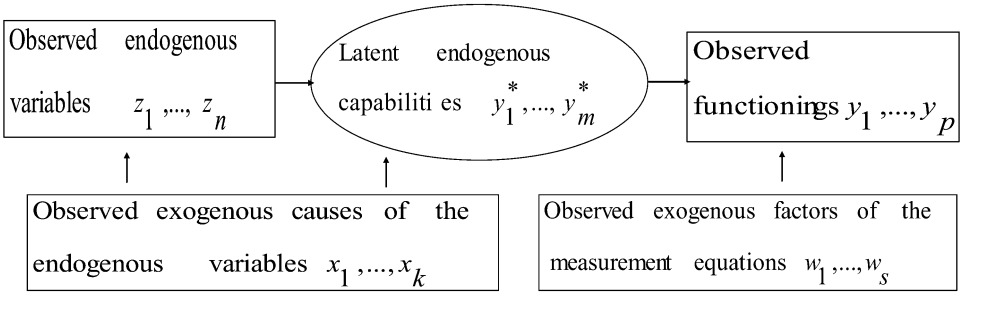

FIGURE 1. Path diagram on our econometric model.

'mixed' to indicate that there are both *latent endogenous* y^* (with qualitative response for some) and *observed endogenous* z (continuous) variables in our structural SEM.[5] The second set of equations forms the measurement model or the qualitative response model, where it is specified how the latent variables are related to the observed responses through functions $g(\cdot)$ and $h(\cdot)$. Note the presence of exogenous variables in both the models.

Vectors u and v are the respective error vectors in the SEM and qualitative response model, with zero expectations, uncorrelated between the two parts but correlated within each. Let us denote:

$$V(u) = \Sigma$$

and

$$V(v) = \Psi.$$

In general Ψ is assumed to be diagonal in the latent variable model literature. Furthermore, depending on the nature of y, the variance of some elements of v will be specified as unity (for proper identification of the coefficients). As far as the SEM part is concerned, certain elements of the coefficient matrices (those appearing in the structural equations explaining the latent variables) can only be estimated up to a proportionality factor under the usual identification conditions.[6]

It is interesting to observe that this general model includes many known models as 'special cases', which are presented in Appendix A. Estimation of the model given by equations (1) and (2) can be carried out by two methods. The first is maximum likelihood estimation applied to the (non-linear) model obtained by substituting equation (1) in equation (2) for y^*. The second method derives structural parameter estimates by (non-linear) generalized method of moments, minimizing the distance between the theoretical expressions of means/thresholds, variances and covariances of observed variables, which are nonlinear functions of model parameters and their sample estimates. The generalized method of moments procedure is made optimal using the variance covariance matrix of the estimators as the weight matrix. All these estimators are consistent and asymptotically normal. One can also obtain 'robust' versions of their standard errors to account for possible heteroscedasticity and serial correlation by applying the Newey–West correction. The reader can refer to Muthen (1983, 1984, 1987, 1989) and Browne and Arminger (1995) for technical details. These methods have been implemented in the MPLUS program (cf. Muthen and Muthen, 2004).

Empirical application

The model

Our empirical application combines three dimensions that can be considered fundamental in any measure of human development; namely,

'knowledge' (denoted as y_1^*), 'health' (y_2^*) and 'political freedom' (y_3^*). Other relevant dimensions could not be included at this stage due to lack of data availability at the global level that we are looking at here. The latent variables associated with these dimensions represent, so to speak, the 'national capability level' in each of them and can be thought of as reflecting the different dimensions of human development at the country level.[7] They are the unobservable endogenous variables of our structural model forming our $(\mathbf{3 \times 1})y^*$ vector. Note that we do not include income or Gross Domestic Product (GDP) per capita as a dimension of human development due to its 'instrumental' role in promoting human development rather than being a component of it. Hence we are not convinced of its place as an intrinsic dimension of human development. The mixing of 'means' and 'ends' in the components of HDI being one of its major drawbacks, we avoid being subject to the same criticism.

The level of achievement in each of these dimensions is measured through a proper set of indicators. As we decided to use the commonly used UNDP and World Bank databases for worldwide data compatibility, our indicators are of the 'conventional' aggregate type. However, the same model can be conveniently implemented for individual or regional level data within a country using more context-specific indicators. Thus, in the field of health, the selected indicators are life expectancy at birth, infant mortality rate and under-five mortality rate, with a high level of health in a country being associated with a high life expectancy and a low mortality rate. In the field of knowledge, the corresponding indicators are adult literacy rate and gross enrollment ratio. A high knowledge level at the macro-economic level can normally be associated with a high level of both indicators. Finally, in the field of political freedom, the selected indicators are political rights, civil liberties, and voice and accountability.[8] The 'political rights' score represents the extent to which all adults participate freely in the political process such as free and fair elections for electing the head of state/government and legislative representatives, free right to form political parties, absence of discrimination of minority groups, and so forth. It is scored on a 0–6 scale, where 0 is the lowest degree of freedom and 6 is the highest. The 'civil liberties' score encompasses the freedom to develop one's own views, create institutions and exercise personal autonomy; it is also scored on a 0–6 scale, where 0 is the lowest degree of freedom and 6 is the highest. 'Voice and accountability' index measures the extent to which citizens of a country are able to participate in the selection of governments, but comes from a different source (World Bank) to the first two (Country Indicators for Foreign Policy). This indicator is scored on a 0–5 scale, where 0 is the lowest degree of participation and 5 is the highest. Thus, all these indicators are scaled in such a way that a higher score corresponds to a higher degree of political freedom.

The aforementioned education, health and political scores form our y vector (i.e. the achievement or functioning vector), and are linked to the latent capabilities through a set of measurement equations:

$$y = \Lambda y^* + Dw + v$$

We assume:

$$E(v) = \mathbf{0} \text{ and } V(v) = \Psi, \textit{ diagonal}$$

Note that all our indicator variables are continuous random variables.

As argued earlier, the level of achievements in these different dimensions are no doubt affected by the availability of a congenial environment allowing for the capability to be realized and accounting for possibly different achievement levels for the same capability level. The following potential exogenous variables (w) were selected to represent the support factors:[9] the 'percentage of population with access to essential drugs', the 'percentage of population using adequate sanitation facilities', the 'percentage of population using improved water sources', the 'number of physicians per 100 000 people' for the health dimension; the 'public expenditure on education' for the education dimension; and the 'control of corruption' and the 'rule of law' for the political dimension. 'Control of corruption' measures the exercise of public power for private gain, including both petty and big corruption, and even state capture, and is scored on a 0–5 scale, where 0 reflects the lack of the control of corruption in a country and 5 the presence of an important control of corruption, and 'rule of law' measures the extent to which agents have confidence in and abide by the rules of society also by means of an integer value lying between 0 and 5, with higher scores corresponding to better outcome. We will see later that some of these exogenous variables were not retained in the final model as their influence was found to be non-significant.

Next we turn to the structural part of the model, the SEM, which explains the system within which the capabilities are determined. The SEM not only models the interactions of our latent dimensions among themselves, but also the influence of exogenous 'causes' (x) representing the social, economic and political context, which is bound to have an impact on the capabilities themselves. Note that these exogenous elements are the ones that directly influence the latent variables, unlike the earlier ones that influence the outcome variables given the same capability.

The SEM is thus written as:

$$Ay^* + Cx + u = \mathbf{0}$$

with $E(u) = \mathbf{0}$; and $V(u) = \Sigma$, positive definite.

Among the exogenous causes (x) of our latent variables, we tested a wide range of political, economic, social, demographic and even technological factors (within the limitations of data availability). The political factors were the earlier ones plus: the 'democracy–autocracy index', which measures the political participation of a country and is on a 21-point scale, ranging from 0 (strongly autocratic) to 20 (strongly democratic); 'government effectiveness', measuring the competence of the

bureaucracy and the quality of public service delivery; 'regulatory quality', measuring the incidence of market-unfriendly policies such as price controls or inadequate bank supervision; 'political stability', which measures perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional and/or violent means; and 'press freedom', which represents the degree to which each country permits free flow of information on a 0–99 scale, where 0–39 is regarded as having a not-free press, 40–69 as having a partly-free press and 70–99 as having a free press. These political scores lie between 0 and 5, with higher scores corresponding to a freer political environment.

Economic factors were represented by 'foreign direct investment', 'gross fixed capital formation' and 'trade', technological factors by 'cellular mobile subscribers', demographic factors by 'population growth rate' and 'urban population growth rate', and commitment to health factors by the 'percentage of population using improved water sources' and the 'number of physicians per 100 000 people'.

Before discussing the results we summarize our list of variables using appropriate notations and classifying them into three groups: the latent endogenous variables, the (observed) achievement indicators, and the (observed) exogenous variables (for both the measurement and structural parts).

Data sources

The first three sources cited in Table 1 are well known and do not require any explanation. The fourth one, Country Indicators for Foreign Policy, perhaps less frequently encountered, is a database with statistical data on several indicators for 196 countries from 1985 to 2000, drawn from a variety of open sources, including the World Bank, the UNDP (1990b), the United Nations High Commission for Refugees, the Stockholm International Peace Research Institute, and the Minorities at Risk and POLITY IV datasets from the University of Maryland.

Variables

See Table 2 for a list of variables.

Table 1. Data sources

UNDP	Human Development Data
World Bank Group	World Development Indicators[a]
World Bank Group	Worldwide Governance Research Indicators[b]
Country Indicators for Foreign Policy	Risk Assessment Indicators[c]

[a]Annual since 1960; see [http://www.worldbank.org/data].
[b]Worldwide Governance Research Indicators Dataset (2004) [http://www.worldbank.org/wbi/governance/data.html].
[c]See [http://www.carleton.ca/cifp/risk.htm].

Table 2. List of variables

Latent endogenous variables	
y_1^*	Knowledge
y_2^*	Health
y_3^*	Political freedom
Achievement indicators	
y_1	Political rights
y_2	Civil liberties
y_3	Voice and accountability
y_5	Life expectancy at birth (years)
y_6	Adult literacy rate (% age 15 and above)
y_7	Combined primary, secondary and tertiary gross enrolment ratio (%)
y_8	Infant mortality rate (per 1000 live births)
y_9	Under-five mortality rate (per 1000 live births)
Possible exogenous variables (observed)	
Structural part	
x_1	Government effectiveness
x_2	Regulatory quality
x_3	Population using improved water sources (%)
x_4	Cellular mobile subscribers (per 1000 people)
x_5	Public expenditure on health (% of GDP)
x_6	Total debt service (% of GDP)
x_7	Density (persons per square km)
x_8	Political stability
x_9	Population growth rate (annual %)
x_{10}	Urban population growth rate (annual %)
x_{11}	Youth bulge (population aged 0–14 as a % of total)
x_{12}	Physicians (per 100 000 people)
x_{13}	Press freedom
x_{14}	Democracy–autocracy index
x_{15}	Total fertility rate (per woman)
x_{16}	Foreign direct investment (US$PPP)
x_{17}	Gross fixed capital formation (US$PPP)
x_{18}	Trade (US$PPP)
Measurement part	
w_1	Control of corruption
w_2	Rule of law
w_3	Population with access to essential drugs (%)
w_4	Population using adequate sanitation facilities (%)
w_5	Public expenditure on education (% of GDP)

Results

Our data relate to a cross-section of middle-income and low-income countries across the world for the year 2000 (or the year closest to it, i.e. 1999 or 1998 for a few variables). Even though we explored many international data sources theoretically covering all countries, the number of countries with no missing values for any of the selected variables was considerably reduced to 56. In fact, it is for this reason that other dimensions could not be added to the model as it would have resulted in a situation with more parameters to be estimated than the number of observations available! In spite of this small number of observations, we

are strongly encouraged in our attempt by the interesting results we obtained that we report here. All estimations are carried out using the 'robust' maximum likelihood method and implemented using the MPLUS software.

Two preliminary remarks: only significant coefficients (or nearly significant considering the small sample) are generally reported; and almost all the coefficients have the expected sign.

Results of the measurement model

The results of the measurement model are presented in Table 3.

The appropriateness of outcome indicators

As expected, our outcome variables, adult literacy rate and combined primary, secondary and tertiary gross enrolment ratio are found to be relevant indicators of the latent dimension 'knowledge'. In other words, they have positive and highly significant coefficients. The situation is similar for life expectancy at birth and infant mortality rate as indicators for health (the second one with a negative coefficient) and the four 'political freedom' indicators. Only one of the two mortality indicators could be retained as including both produced non-significant coefficients, probably due to the high correlation between the two. We therefore conclude that the selected indicators reflect their latent dimension satisfactorily.

The effects of the exogenous factors

The percentage of the population with access to essential drugs has a significant positive impact on life expectancy at birth, whereas it has a negative although not significant effect on the infant mortality rate. Public expenditure on education has a positive and significant effect on the adult literacy rate and the combined primary, secondary and tertiary gross

Table 3. Results of the measurement model

Explanatory variables	Dependent variables						
	y_1	y_2	y_3	y_5	y_6	y_7	y_8
y_1^*	–	–	–	–	1 (0)	0.71 (0.06)	–
y_2^*	–	–	–	1 (0)	–	–	−3.87 (0.34)
y_3^*	1 (0)	0.66 (0.04)	0.40 (0.02)	–	–	–	–
w_3	–	–	–	0.04 (0.03)	–	–	−0.10 (0.09)
w_5	–	–	–	–	1.72 (0.82)	1.58 (0.83)	–
R^2	0.92	0.88	0.95	0.83	0.87	0.80	0.97

Numbers inside parentheses are standard deviations.

enrolment ratio. These results corroborate our *a priori* assumption on the influence of exogenous 'environmental' factors on the level of achievement. None of the exogenous political factors turned out to be significant in the measurement model. However some, of them do have significant coefficients in the structural model as we will see below.

Results of the structural equation model

The results of the structural equation model are presented in Table 4.

The interactions among the latent variables

Let us first look at the interdependence among the latent variables. The positive and significant impact of health (y_2^*) on education (y_1^*) shows that better health is definitely an asset for better performance in education, which is in turn an important factor in achieving political rights as shown by the coefficient of y_1^* on y_3^*. Furthermore, greater political freedom (y_3^*) leads to better health status (y_2^*), thus completing the interactions loop. One can therefore see that y_3^* indirectly affects y_1^* too, because y_3^* affects y_2^* and y_2^* affects y_1^*, and hence all the three dimensions are interdependent.

Table 4. Results of the SEM

Explanatory variable	Dependent variable		
	y_1^*	y_2^*	y_3^*
y_1^*	–	–	0.01
			(0.00)
y_2^*	1.37	–	–
	(0.27)		
y_3^*	–	0.28	–
		(0.31)	
w_1	–	–	0.61
			(0.18)
w_4	–	0.07	–
		(0.02)	
x_7	−0.03	–	–
	(0.01)		
x_{11}	−64.30	–	–
	(30.55)		
x_{12}	–	0.001	–
		(0.01)	
x_{13}	–	–	0.08
			(0.01)
x_{14}	0.58	–	–
	(0.59)		
x_{15}	–	−4.00	–
		(0.48)	
R^2	0.82	0.80	0.89

Numbers inside parentheses are standard deviations.

The effects of the exogenous causes

What are the significant exogenous causes of our latent variables? The democracy–autocracy index has an important positive effect on education (i.e. a more democratic regime seems to favour higher achievement in education). The population growth rate and population density have an important negative effect on education. This can be explained by the increased pressure exerted by a higher growth rate and density of population on existing educational services and government resources, thereby affecting the overall achievement in this field. The percentage of population using improved water sources and number of physicians per 100 000 people have a positive and significant effect on health, whereas fertility has a negative effect as expected. Finally, press freedom and control of corruption have a significant and positive effect on political freedom, the effects of regulatory quality, government effectiveness and political stability not being significant. Lack of corruption definitely implies more freedom — and the more the 'collective voice' in terms of press freedom, the better the political rights atmosphere.

The economic factors chosen were not significant for any of our three dimensions. This does not mean that they are not important as such; they would have been if we had explicitly included the GDP in our model or if our model had a separate dimension corresponding to material welfare.

The R^2 values in both Tables 3 and 4 seem to indicate that a relatively high percentage of the observed variance is explained by the equations of the model, thus implying an adequate fit.

Based on the above model, we estimated the latent variables and normalized them on a **0–1** scale for comparison purposes. Then an aggregate capability index $\hat{H}$ (representing our human development measure) was also computed as a weighted average of the factor scores using the inverse of their variance (in other words, the precision of each latent factor) as weights. Thus, the more statistically reliable a component is, the bigger its weight in the aggregate. The weights of the three factors in our case are 0.124, 0.436 and 0.440, respectively.[10] Health and political freedom therefore receive more weight than education in our measure.

This aggregate score can be interpreted as an index reflecting multiple dimensions (knowledge, health and political freedom in our application) and taking account of various interactive mechanisms operating within the society. Thus, there are two main differences from the HDI: the political freedom element and the derivation of the index and the weights based on the underlying structural model. It should be pointed out here that our latent factors are only ordinal variables and their values have no intrinsic meaning nor any units of measurement.

Ranking our sample countries using $\hat{H}$ and comparing it with that using the HDI (see Tables 5–8), we see that there is a strong correlation between the two measures (0.86 for the ranks and 0.85 for the values). However, if we look at the individual elements of both rank vectors we see there are some big differences for particular countries. For instance, the

Table 5. Explanations of abbreviations used in rank tables

hdi	Human development index
hha	Our aggregate index $\hat{H}$ based on estimated factor scores
Hav	A simple average of the three latent factor scores
newh	A third weighted average with different weights (see Appendix B)
gdp	Normalized GDP per capita
*y**1	'Knowledge' dimension
*y**2	'Health' dimension
*y**3	'Political freedom' dimension
rhdi	Rank according to the HDI
rhhat	Rank according to $\hat{H}$
rhav	Rank according to rhav
rnewh	Rank according to newh
rgdpn	Rank according to (normalized) GDP
*ry*n*	Rank according to y_n^* for $n=1, 2, 3$

Dominican Republic, Guyana, South Africa, Bolivia and Honduras all do much better (with a rank difference greater than or equal to 10) in terms of $\hat{H}$ than of the HDI. Similarly, Mexico, Colombia, Kazakhstan, Uzbekistan and Algeria do better in terms of the HDI than our index.

Looking at the individual components of $\hat{H}$, it is the third one, y_3^* (political freedom), which is the least correlated with the HDI whether it is in terms of ranks or the values themselves. The correlation between the HDI and y_3^* values is only 0.43 and that between their ranks is 0.53. The weak correlation is because they represent entirely different dimensions. However, in spite of this, the overall index $\hat{H}$ (which includes y_3^*) is strongly correlated with the HDI as we saw earlier due to the fact that the other two components (y_1^* and y_2^*) are also present in the HDI and together get more weight than the third component in $\hat{H}$. A striking example of this is China, which is 25th according to the HDI and 38th according to $\hat{H}$, but 52nd (out of 56) in y_3^* (political freedom). The low score in political freedom is compensated by the fact that it performs better in the other two dimensions, leading to a much better position in terms of $\hat{H}$. However, the high level of 'capabilities' in these two dimensions do not fully counter their low level in the third one since our overall index $\hat{H}$ still ranks it lower than the HDI (which has a GDP component). Continuing our attention on the 'political freedom' index, one finds that Costa Rica, Mauritius, Hungary, South Africa, Uruguay, Slovakia, Guyana, Jamaica, Panama and Chile hold the first 10 ranks, and

Table 6. Value and rank correlations

rhdi,rhhat	rhhat,rgdp	rhdi,rgdpn	rhdi, ry*1n	rhdi, ry*2n	rhdi, ry*3n
0.86	0.81	0.89	0.92	0.92	0.53
hdi,hhat	hhat,gdp	hdi,gdpn	hdi,y*1	hdi,ry*2	hdi,ry*3
0.85	0.8	0.89	0.95	0.94	0.43

Table 7. Country rankings

Country	rankhdi	rankhhat	rgdpn	ry*1	ry*2	ry*3
Argentina	1	10	2	3	7	15
Hungary	2	1	1	1	2	3
Slovakia	3	4	3	5	1	6
Chile	4	5	7	6	3	10
Uruguay	5	3	8	2	4	5
Costa Rica	6	2	5	15	5	1
Mexico	7	18	9	17	16	23
Panama	8	7	17	12	11	9
Bulgaria	9	8	13	4	6	11
Romania	10	11	21	7	12	13
Colombia	11	24	11	13	17	34
Mauritius	12	6	6	32	8	2
Venezuela	13	20	20	24	14	27
Thailand	14	15	15	20	18	18
Brazil	15	16	10	16	19	19
Philippines	16	13	27	8	20	16
Kazakhstan	17	36	18	10	37	44
Peru	18	25	23	9	28	28
Jamaica	19	9	29	33	10	8
Turkey	20	29	14	27	30	37
Sri Lanka	21	19	32	14	9	31
Paraguay	22	22	22	22	15	32
Dominican Republic	23	12	12	10	13	14
Uzbekistan	24	43	38	28	32	53
China	25	38	28	19	23	52
Iran (Islamic Republic of)	26	34	18	29	29	45
Jordan	27	26	26	35	25	29
Kyrgyzstan	28	33	36	25	34	38
Guyana	29	14	24	18	33	7
Algeria	30	42	16	37	36	50
South Africa	31	17	4	23	40	4
Syrian Arab Republic	32	41	33	36	21	54
Vietnam	33	40	41	26	22	55
Indonesia	34	27	34	21	27	33
Bolivia	35	23	39	31	41	12
Egypt	36	32	30	30	26	41
Honduras	37	21	35	34	24	22
Guatemala	38	28	25	39	35	26
Morocco	39	31	31	45	31	35
Zimbabwe	40	46	37	38	43	47
Ghana	41	30	40	43	39	24
Cambodia	42	47	46	40	47	39
Kenya	43	45	51	41	42	43
Pakistan	44	51	44	47	46	51
Togo	45	48	47	46	44	42
Bangladesh	46	37	48	50	38	30
Madagascar	47	35	53	44	48	21
Mauritania	48	53	44	54	54	40
Zambia	49	49	55	42	51	36
Senegal	50	44	49	49	45	25
Benin	51	39	52	48	50	17
Guinea	52	55	43	53	52	48

Table 7. Continued

Country	rankhdi	rankhhat	rgdpn	ry*1	ry*2	ry*3
Gambia	53	52	41	51	49	49
Mali	54	50	54	55	55	20
Chad	55	54	50	52	53	46

Table 8. Rank differences

Country	rhdi-rhhat	rgdp-rhhat	rhdi-ry*1	rhdi-ry*2	rhdi-ry*3	rhdi-rgdp
Argentina	−9	−8	−2	−6	−14	−1
Hungary	1	0	1	0	−1	1
Slovakia	−1	−1	−2	2	−3	0
Chile	−1	2	−2	1	−6	−3
Uruguay	2	5	3	1	0	−3
Costa Rica	4	3	−9	1	5	1
Mexico	−11	−9	−10	−9	−16	−2
Panama	1	10	−4	−3	−1	−9
Bulgaria	1	5	5	3	−2	−4
Romania	−1	10	3	−2	−3	−11
Colombia	−13	−13	−2	−6	−23	0
Mauritius	6	0	−20	4	10	6
Venezuela	−7	0	−11	−1	−14	−7
Thailand	−1	0	−6	−4	−4	−1
Brazil	−1	−6	−1	−4	−4	5
Philippines	3	14	8	−4	0	−11
Kazakhstan	−19	−18	7	−20	−27	−1
Peru	−7	−2	9	−10	−10	−5
Jamaica	10	20	−14	9	11	−10
Turkey	−9	−15	−7	−10	−17	6
Sri Lanka	2	13	7	12	−10	−11
Paraguay	0	0	0	7	−10	0
Dominican Republic	11	0	13	10	9	11
Uzbekistan	−19	−5	−4	−8	−29	−14
China	−13	−10	6	2	−27	−3
Iran (Islamic Republic of)	−8	−16	−3	−3	−19	8
Jordan	1	0	−8	2	−2	1
Kyrgyzstan	−5	3	3	−6	−10	−8
Guyana	15	10	11	−4	22	5
Algeria	−12	−26	−7	−6	−20	14
South Africa	14	−13	8	−9	27	27
Syrian Arab Republic	−9	−8	−4	11	−22	−1
Vietnam	−7	1	7	11	−22	−8
Indonesia	7	7	13	7	1	0
Bolivia	12	16	4	−6	23	−4
Egypt	4	−2	6	10	−5	6
Honduras	16	14	3	13	15	2
Guatemala	10	−3	−1	3	12	13
Morocco	8	0	−6	8	4	8
Zimbabwe	−6	−9	2	−3	−7	3
Ghana	11	10	−2	2	17	1
Cambodia	−5	−1	2	−5	3	−4

Table 8. Continued

Country	rhdi-rhhat	rgdp-rhhat	rhdi-ry*1	rhdi-ry*2	rhdi-ry*3	rhdi-rgdp
Kenya	−2	6	2	1	0	−8
Pakistan	−7	−7	−3	−2	−7	0
Togo	−3	−1	−1	1	3	−2
Bangladesh	9	11	−4	8	16	−2
Madagascar	12	18	3	−1	26	−6
Mauritania	−5	−9	−6	−6	8	4
Zambia	0	6	7	−2	13	−6
Senegal	6	5	1	5	25	1
Benin	12	13	3	1	34	−1
Guinea	−3	−12	−1	0	4	9
Gambia	1	−11	2	4	4	12
Mali	4	4	−1	−1	34	0
Chad	1	−4	3	2	9	5

Chad, Zimbabwe, Guinea, Gambia, Algeria, Pakistan, China, Uzbekistan, Syria and Vietnam hold the last 10 ranks.

Turning to the comparison between per-capita GDP (normalized to the 0–1 scale) and $\hat{H}$, the correlation between the two is less than that between the HDI and $\hat{H}$, although it can be still considered to be reasonably high. The correlation between the *values* of $\hat{H}$ and GDP is less than that between the HDI and GDP values. Thus the HDI is 'closer' to GDP than $\hat{H}$.

Conclusions

What are the lessons learnt from our model results and rank comparisons? The most important message is that a better social and political environment not only helps the 'realization' of capabilities, but also augments the level of capabilities themselves as shown by the significant coefficients in the empirical estimations of our measurement and structural models. Thus the State has a positive role to play in terms of better social infrastructure and better governance. In addition, when this support system is provided in an adequate manner we see that not only does it enhance people's capabilities, but also leads the system to a path of 'virtuous' development cycle due to the positive interactions among the different dimensions enabling further progress.

Regarding the rank comparisons, the main point to be emphasized is that one should include as many important dimensions as possible while computing any measure of overall development or welfare, as each new component does contribute significantly to the adequacy of the aggregate measure in representing the complex reality.

Regarding some scope for improvements and extensions: one immediate extension that we can think of is the enlargement of our dataset to include different periods (and more countries) in the analysis,

allowing for different evolutions for different countries in the specification of the model and examining the 'robustness' of our results. Another possible extension is to go a step further in the utilization of our results in terms of deriving multidimensional poverty indices from our individual and aggregate factor scores.

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Notes

1 Throughout this paper we use the terms 'human development', well-being' and 'quality of life' in an inter-changeable manner.
2 The reader can find an excellent coverage of latent variable models with applications in Bollen (1989), Bartholomew and Knott (1999), Muthen (2002) and Skrondal and Rabe-Hesketh (2004). Some applications in the context of human development are given by Nagar and Basu (2001), Lelli (2001), Biswas and Caliendo (2002), Rahman *et al.* (2003), and McGillivray (2005).
3 Note that our concern here is with the interaction among different capabilities of the same individual, and not among capabilities of different people as considered by Iversen (2003) and Qizilbash (2005).
4 In our empirical analysis we use cross-sectional data, and hence the effects we identify can be interpreted as long-term (steady-state) influences.
5 Some authors (Bartholomew and Knott, 1999; Moustaki, 2003) use the same term to denote a mixture of different types of qualitative responses.
6 The reader is referred to Maddala (1983, pp. 22–23) for further explanations.
7 Gaertner and Xu (2006) use a similar notion of human development in their work.
8 Data sources are given later along with the list of variables.
9 Quotes are used to indicate that the variables names are reproduced as such from the data sources used.
10 We also explored other weighting schemes based on different considerations but there was no significant variation in the results among the alternatives. These different schemes and their results are reported in Appendix B.

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Appendix A

In Appendix A we identify some special cases of our model that are of interest in our field of application. Before beginning the particular cases, it is useful to point out that terminologies are sometimes different between the statistical and econometric literature. In general what is termed a structural equation model (SEM) in the latent variable literature does not necessarily have the same meaning in the econometric literature. In classical econometrics, SEM refers to a simultaneous equation model i.e. an interdependent system of equations with as many endogenous variables as the number of equations and enough exogenous variables to identify the structural form. Both the endogenous and exogenous variables are observed in this framework. On the other hand, a system with latent endogenous variables typically comes under qualitative response (discrete choice) or limited dependent variable models.

Case 1

If y is continuous, $g(\cdot)$,$h(\cdot)$ linear and there is no z or w we get the following model:

$$A\boldsymbol{y}^* + C\boldsymbol{x} + \boldsymbol{u} = \boldsymbol{0}$$

with

$$\boldsymbol{y} = D\boldsymbol{y}^* + \boldsymbol{v}; \quad (\boldsymbol{x} = \boldsymbol{x}^*)$$

This is the standard LISREL model (cf. Joreskog (1973)) (except for observed rather than latent exogenous variables, refer to our remark in Section 4 in this respect).

Case 2

With ordinal y and no z,w we have LISREL with ordinal variables (cf. Joreskog (2002), Muthen (1983, 1984)). We omit writing the model as it will involve too many additional notations.

Case 3

If y^* scalar, $A=\mathbf{1}$, no z, no w, y continuous, $g(\cdot)$,$b(\cdot)$ linear, we have the MIMIC model, with appropriate notations (cf. Joreskog and

Goldberger (1975)):

$$y^* = \Psi x + u;$$

$$y = \Phi y^* + v.$$

Case 4

Same as Case 3 with y^* a vector, $A=I$, we have the extended or generalised MIMIC.

Case 5

Same as Case 4 with w and z, we have the MIMIC with covariates (cf. Moustaki (2003)).

Case 6

If y^* is observed (no measurement equation) then we have the classical SEM (cf. e.g. Theil (1979), Hausman(1983)).

Case 7

If y^* is observed, there is no z and $A=I$, then we have the SUR model $y=Bx+u$ (cf. Zellner (1962)).

Case 8

When y^* is scalar (no z) and y is either discrete or limited dependent we have the classical qualitative dependent variable model (see Amemiya (1985).

In the absence of any of these special cases, we have the general mixed simultaneous equation model as defined in Section 5. Thus the model in Section 5 can be viewed as a general structural model encompassing many known latent variable models.

Appendix B

In Appendix B we compare our index $\hat{H}$ with two other indices derived from the same factor score estimates using different weighting schemes. The first one 'hav' is a simple average of the three factor scores. In the second measure 'newh' the weight of a given latent factor is proportional to the R-squared value of the corresponding equation in the structural model indicative of how well the latent dimension is explained by our model. These weights are normalised to sum to unity. As seen from the tables below, there are no significant differences among the alternative schemes.

Table B1. Alternate indices rankings

Country	rankhhat	rankhav	ranknewh
Argentina	10	7	7
Hungary	1	1	1
Slovakia	4	3	3
Chile	5	5	5
Uruguay	3	2	2
Costa Rica	2	4	4
Mexico	18	18	18
Panama	7	8	8
Bulgaria	8	6	6
Romania	11	9	9
Colombia	24	21	22
Mauritius	6	10	10
Venezuela	20	20	20
Thailand	15	16	16
Brazil	16	15	15
Philippines	13	12	12
Kazakhstan	36	30	30
Peru	25	23	21
Jamaica	9	13	13
Turkey	29	27	27
Sri Lanka	19	19	19
Paraguay	22	22	23
Dominican Republic	12	11	11
Uzbekistan	43	37	38
China	38	34	34
Iran (Islamic Republic of)	34	33	33
Jordan	26	28	28
Kyrgyzstan	33	29	29
Guyana	14	14	14
Algeria	42	41	41
South Africa	17	17	17
Syrian Arab Republic	41	39	40
Vietnam	40	36	36
Indonesia	27	26	26
Bolivia	23	25	25
Egypt	32	32	32
Honduras	21	24	24
Guatemala	28	31	31
Morocco	31	38	37
Zimbabwe	46	42	42
Ghana	30	35	35
Cambodia	47	46	46
Kenya	45	44	45
Pakistan	51	51	51
Togo	48	49	49
Bangladesh	37	43	43
Madagascar	35	40	39
Mauritania	53	53	53
Zambia	49	48	48
Senegal	44	47	47
Benin	39	45	44
Guinea	55	55	55

Table B1. Continued

Country	rankhhat	rankhav	ranknewh
Gambia	52	52	52
Mali	50	50	50
Chad	54	54	54

Table B2. Correlations

rhdi,rhhat	rnewh,rhdi	rhav,rhdi	rnewh,rhav	rhav,rhhat
0.86	0.91	0.91	1	0.98
hdi,hhat	newh, hdi	hav,hdi	newh,hav	hav,hhat
0.85	0.91	0.91	1	0.99