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Going beyond functionings to capabilities: an econometric model to explain and estimate capabilities

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Going beyond functionings to capabilities: an econometric model to explain and estimate capabilities

by

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Abstract

Any attempt to operationalise 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 including principal components, factor analysis and MIMIC models. The first two models provide estimates of the latent variables but are silent on the factors influencing these variables (capabilities in our context). MIMIC models represent a step further in this direction as they include exogenous "causal" variables for the latent factors but the effects go only in one direction i.e. from the "causes" to the latent variables. We argue that some of these causal factors not only influence human development but they are also influenced by it and that unless this feedback mechanism is taken into account we do not have a complete picture of this complex phenomenon. In this paper we present a theoretical framework incorporating the above aspects into a coherent system of causes, effects and interactions, leading to an econometric model which represents a generalisation of existing latent variable models. Estimating the model will enable us to explain the level of capabilities, derive appropriate estimators, say how they can be improved and test our theoretical hypotheses.

Keywords: human development, capability approach, latent variables, item response, simultaneous equations.

JEL Classification codes : C3, I31, O10

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1 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, though necessary, is not sufficient in itself to bring about development in this large 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 political process. The concept of human development proposed by Mahbub ul Haq, in the first Human Development Report in 1990 (see UNDP(1990)), largely inspired from Sen's various works (e.g. Sen (1985,1999)), represents a major step ahead in the concretization of this extended meaning of development and in the effort to bring people's lives into the center of thinking and analysis. Since then, human development has been the object of extensive theoretical and empirical researches. 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 large sense, it is generally constructed as a composite index based on several variables (indicators).

The most well-known of these are the Physical Quality of Life Index (PQLI) proposed by Morris (1979) and the Human Development Index (HDI) proposed by the UNDP (1990). The former takes into account life expectancy at age one, infant mortality and adult literacy and the latter the following: life expectancy at birth, an education index (a composite index combining adult literacy rate and school enrolment ratio with a weight of 2/3 and 1/3 respectively) and the real GDP par capita. These indices are given equal weights in the construction of the HDI. Over the recent years other indices came to be proposed which are derived from an underlying theoretical model, that offer some explanation of the variables composing the index as well as a better justification for the choice and values of the weights in the construction of the index.

Income or consumption still remains the most widely used indicator of well-being but it is also one of the most criticised for not capturing the non-economic dimensions of human life (without denying the importance of the

economic aspect, cf. Noorbakhsh (1998) and Osberg and Sharpe (2003)). There are ample examples to show that economic growth though necessary is not sufficient to achieve a good quality of life[2] in various spheres such as the political one (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. In Sen's capability approach (Sen (1999)), the freedom that one enjoys in being able to choose the life one wants is multi-dimensional in nature and economic welfare is only one of the many dimensions it comprises.

A theoretical framework that is appealing in this context is a model which assumes that the capabilities are unobservable latent variables observed through a set of indicators. Principal components, factor analysis and MIMIC (multiple indicators and multiple causes) models all fall into this line of reasoning (cf. Nagar and Basu (2001), Lelli (2001), Biswas and Caliendo (2002), Rahman *et al.* (2003), McGillivray (2003)). Latent variable models are common in psychology and the reader can find an excellent coverage of most of these models with applications in Bartholomew and Knott (1999) and Skrondal and Rabe-Hesketh (2004). The principal components estimate the latent variables as linear combinations of the observed indicators chosen in such a way as to reproduce the original data as closely as possible. But this method lacks an underlying 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 unobserved 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 important 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 an underlying unobserved 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 which definitely influence human development and need to be taken into account. Not only do these factors influence human

[2]Throughout this paper we will use the terms 'human development', 'well-being' and 'quality of life' in an interchangeable manner.

development but they are also influenced by it. A simple example is that if access to education is facilitated, i.e. knowledge capability is increased, development occurs and this may in turn incite 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.

There are other models in the psychometric literature such as LISREL with ordinal variables (cf. Muthen (1983, 1984) and Arminger and Küsters (1988), Joreskog (2002)) and MIMIC with exogenous variables (cf. Moustaki (2003)) that represent useful extensions for our context (though not yet applied in this field to our knowledge). However, as we argue in the following sections none of them seem to incorporate all the features that we believe are essential for adequate modelling of the capability approach. For instance MIMIC has exogenous causes of latent variables but lacks structural interdependence; LISREL and its generalisations account for simultaneity but lack exogenous elements in measurement modules.

In this paper we propose a theoretical framework that takes all the relevant aspects into account in an appropriate way. Then we transform it into an econometric model which can be fitted using real data enabling a better understanding of how this complex mechanism works in practice. It would also allow us to verify our assumptions about the feedback mechanism mentioned above. Finally it would give us estimates of the actual capabilities rather than just the functionings.

The next section puts forward the case for the interdependent nature of capabilities by taking some of the most important components of human welfare such as education, health and social participation. In Section 3 we bring in the measurement relations based on our postulate that capabilities are latent and manifest themselves in the form of functionings. Arguments of Sections 2 and 3 combined will provide us with the necessary foundation for formulating our theoretical framework in Section 4. This will in turn lead to the econometric model presented in Section 5 where we also briefly touch upon estimation issues. Section 6 presents and discusses the empirical application and Section 7 ends the paper with some concluding remarks.

2 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 which is 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. 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. Though 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 and 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 the society as learned persons always command more respect (wealth is no doubt another important contributor to the social status and education helps here too by providing better job opportunities). Needless to mention the value added to one's personality and the self-confidence procured by knowledge acquired through 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. None 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 an instrument in enhancing one's capacity to work and earn a living. However all individuals may not react 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 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 more and more sought after in developed countries too.

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 not have even been part of the choice set otherwise. 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, Guio and Drèze (1997) e.g.) meaning that there is a clear interaction between education and health. Thus improving one capability can affect another in a favourable manner implying that capabilities are interdependent and this property should be included in the theoretical model we are trying to develop.

Let us remain in the health domain and consider yet another aspect. We mentioned earlier that health is valuable not only in itself but also in enabling a person to be usefully occupied (whether it be for earning a livelihood for oneself and one's family or for helping others). Also, the healthier one is, the more active one can be in participating in local community affairs on the political, social or environmental fronts. Once again this will positively influence the choice-set on the whole. Imagine a poor area in a developing country where there is lack of safe drinking water supply. An active involvement of local citizens is sometimes the only way to alert the otherwise indifferent and/or corrupt political authorities. For this to happen, the citizens must have the necessary knowledge, exposure and health to be able to organise themselves and exercise their political and social rights. One can of course argue that certain institutions need to be in place for action to be pursued in this regard. Well, if they do not exist then the local citizens may even end up taking the initiative to create them. This only goes to show that many 'exogenous' factors affecting capabilities (the institutional setup in this example) can in turn be affected by them i.e they are not exogenous at all! This is the feedback mechanism that we mentioned in the introduction and one

cannot ignore this simultaneous nature of our variables. At the same time it is also true that there are some purely exogenous factors like the traditions that we talked about in our previous paragraphs on education and health or in the water supply example it could be the existence of a river or a lake nearby and/or rain water storage facilities etc.

One can go on and on with many other arguments to support the case for the interdependent nature of capabilities but we believe there is no further need to elaborate on this. Not only do capabilities interact among themselves but also with other elements representing the socio-political setup. For some elements belonging to latter group, there are feedback effects (thus making them jointly dependent) whereas for others the causal link only operates in one direction (making them purely exogenous).

3 The Measurement Issue

Capabilities by definition cannot be directly measured. Hence they need to be specified as latent unobservable 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 for 1000 persons, number of hospital beds for 1000 persons and so on. Sometimes one may need to combine all of these to give a single measure. However combining raises additional issues like common units, weights etc. and we do not intend to go deeper into these problems in this paper. At this stage we will limit ourselves to admitting our preference for using vectors so that these problems can be avoided. However we do not exclude the possibility of being forced to aggregate during the practical implementation or estimation of our model due to size limitations that come up while running the program. Examination of this issue is therefore left for the future.

There are several types of indicators available in practice. Some of them could be continuous like the above-mentioned life expectancy, per capita number of doctors whereas some could be of a qualitative nature for instance the existence of the right to vote or not, existence of safe water access or not, a school or a hospital in the neighbourhood or not, existence of adequate sanitation facilities or not. At the individual level one could also have *subjective*

assessments such as whether a person considers herself to be poor or not. 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...). 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 for example religion - Hindu, Muslim, Buddhist, Christian etc. Some other indicators could be truncated or censored - truncated when not observed for a particular range of values, censored when observed only if greater than a threshold value. One should bear in mind that the statistical/econometric treatment of these variables differs according to the particular type concerned.

Having established the interdependent nature of the underlying latent capabilities and the observable nature of the outcomes or functionings, it is fundamental that we maintain both sets of variables in our model and link the two through a set of relationships. In the psychometric literature, these relationships are called 'measurement equations' and the observed outcomes 'response variables'. These will complete our theoretical setting while paying heed to our concern for differentiating between capabilities and functionings.

4 The General Theoretical Framework

Let us recall from the foregoing discussion that the following features need to be present in our framework which should above all *explain* the capabilities:

(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 which 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).

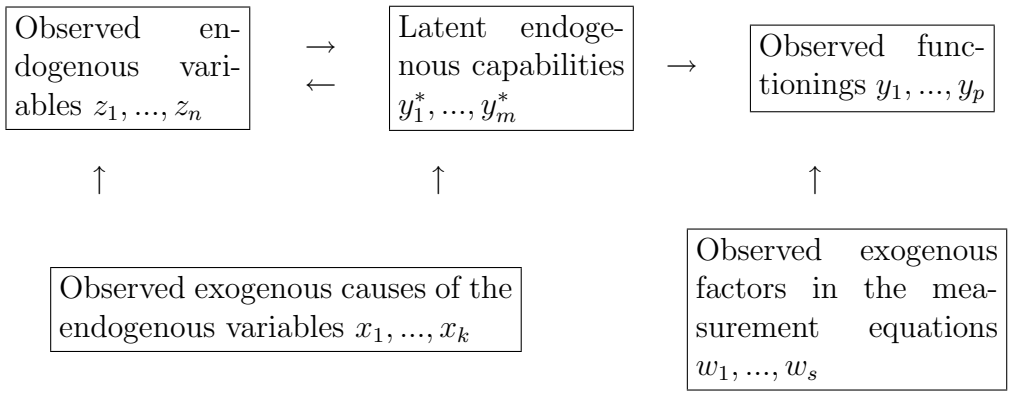
Let us now introduce some notations which will help us formulate our theoretical framework in precise terms. We shall denote by

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

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

Note that we do not have latent exogenous variables though theoretically it is perfectly 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 practical context where we would normally directly observe all exogenous factors.

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



5 The Econometric Model

The conceptual framework arrived at in Section 4 leads us to a general mixed (latent and observed) simultaneous equation model which we can now write down in formal terms as follows.

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

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

The first set of equations represents the structural model which 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 'mixed' to indicate that there are both *latent endogenous* y^* (with qualitative response for some) and *observed endogenous* z (continuous) variables in our structural simultaneous equation model (SEM)[3]. The second set of equations forms the measurement model or the qualitative response model (QRM) 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 QRM, 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. Further, depending on the nature of y 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. The reader is referred to Maddala (1983) for further explanations.

It is interesting to observe that this general model includes many known models as "special cases" which we will come to shortly. Before that, we also note that there are some other cases where both y^* and y appear in the SEM part that fall outside this framework (cf. Maddala (1983)). In

[3]Some authors (Bartholomew and Knott (1999), Moustaki (2003)) use the same term to denote a mixture of different types of qualitative responses.

such cases one has to pay attention to the additional problem of logical consistency or coherence of the whole system. This problem does not arise in our model in so far as the SEM part only contains the latent variables without their observed counterparts. Though we can also theoretically extend our framework to such situations, we are not sure of their practical relevance in our context where it would mean that capabilities lead to functionings but functionings influence capabilities too. If we argue that functionings are measurable achievements given the level of capabilities, there is no sense in assuming that they affect capabilities (they should simply reflect how 'well' the capabilities are converted to actual achievements). In our opinion, it is more meaningful to make capabilities mutually dependent and keep the relationship between capabilities and functionings just one way.

Let us now identify some special cases of our model that are of interest in our field of application.

Case 1

If y is continuous, $g(\cdot), h(\cdot)$ linear and there is no w we get the standard LISREL model (cf. Joreskog (1973)) (with observed rather than latent exogenous, refer to an earlier remark in this respect).

Case 2

With ordinal y and no w we have LISREL with ordinal variables (cf. Joreskog (2002), Muthen (1983, 1984)). The latter author has two types of measurement equations: 'inner' measurement equations and 'outer' measurement equations as he allows for *latent* response variables and *observed* response variables.

Case 3

If y^* scalar, $A = 1$, no z, no w, y continuous we have the MIMIC model (cf. Joreskog and Goldberger (1975)).

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 and $A = I$, then we have the SUR model (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 absence of any of these special cases, we have the general mixed simultaneous equation model as mentioned earlier. Though these types of models are discussed in Maddala (1983) he does not include the possibility of some latent variables having continuous responses. His model has some latent and some observed endogenous variables like ours but the latent variables are all observed as qualitative responses. In general these models can be estimated by two-stage methods as described in Maddala (1983). First a reduced form ML (probit if dichotomous, tobit if censored etc.) - univariate or bivariate or multivariate - is performed to get estimates of y^* to be used in the structural form which can then be estimated by ML for the latent ones and IV/GMM methods for the observed z[4]. All these estimates are consistent and asymptotically normal though the asymptotic standard errors obtained in the second stage have to be corrected for the heteroscedasticity resulting from the fact some of the explanatory variables are estimated.

6 Empirical Application

6.1 The Model

Let us recall that we interpret Human Development as an unobservable latent concept which cannot be directly measured and as a multidimensional one enveloping diverse social, economic, political, cultural and environmental dimensions. Our empirical application combines three of these dimensions that can be considered to be fundamental in any measure of human development namely, "knowledge" or "education" (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 stock" in each of them. They are the unobservable endogenous variables of our structural model forming our (3×1) y^* vector.

[4]In fact one might employ methods similar to the ones suggested by Muthen (1983,1984) for LISREL with categorical data for our reduced form.

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 education, the appropriate indicators are adult literacy rate and gross enrollment ratio. A high level of education at the macro-economic level is normally 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[5]. 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 etc. It is scored on a 0 to 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 to 6 scale, where 0 is the lowest degree of freedom and 6 is the highest. Voice and accountability index also 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) than the first two (CIFP). This indicator is scored on a 0 to 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. Some of them were redefined by us to suit this positive 'slope' requirement.

The above mentioned 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

$$E(v) = 0$$

and

$$V(v) = \Psi, \text{ diagonal.}$$

Note that all our indicator variables are considered to be continuous random variables.

[5]Data sources are given later along with the list of variables.

As we 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 realised 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: 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, 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 to 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 simultaneous equation model (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. Furthermore there are no observed endogenous variables in our empirical model though we included them in our theoretical framework due to the additional complication that it entails in the computation of factor scores (which is our ultimate aim). They were in turn substituted in terms of the exogenous variables for simplicity of calculations (that is the system was partially solved for them.). This is one of the reasons why income or GDP does not directly appear in our system, the other reason being its "instrumental" role in promoting human development rather than being a component of it. Hence we are not convinced of its place as a dimension of human development.

The SEM is thus written as

$$Ay^* + Cx + u = 0$$

with $E(u) = 0$; 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 technologi-

cal factors (within the limitations of data availability). The political factors were the earlier ones plus "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 to 99 point scale, where 0 to 39 is regarded as having a not-free press, 40 to 69 as having a partly-free press and 70 to 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 summarise our list of variables giving them 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

UNDP:	Human Development Data
World Bank Group:	World Development Indicators
World Bank Group:	Worldwide Governance Research Indicators
CIFP:	Risk Assessment Indicators

The first three sources are well-known and do not require any explanation. The fourth one, CIFP (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 United Nations Development Programme, the United Nations High Commissioner for Refugees, the Stockholm International Peace Research Institute, and the Minorities at Risk and POLITY IV data sets from the University of Maryland. The web pages corresponding to all our data sources are given in the list of references at the end.

List of Variables

The latent endogenous variables	
y_1^*:	Knowledge
y_2^*:	Health
y_3^*:	Political Freedom
The 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 & tertiary gross enrolment ratio (%)
y_8:	Infant mortality rate (per 1,000 live births)
y_9:	Under-five mortality rate (per 1,000 live births)

List of Variables: contd.

Possible exogenous variables (observed)	
For the structural part	
x_1:	Government Effectiveness
x_2:	Regulatory Quality
x_3:	Population using improved water sources (%)
x_4:	Cellular mobile subscribers (per 1.000 people)
x_5:	Public expenditure on health (% of GDP)
x_6:	Total debt service (% of GDP)
x_7:	Density (persons per sq.km.)
x_8:	Political Stability
x_9:	Population Growth Rate (Annual %)
x_{10}:	Urban Population Growth Rate (Annual %)
x_{11}:	Youth Bulge (Pop. 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 (PPP USD)
x_{17}:	Gross fixed capital formation (PPP USD)
x_{18}:	Trade (PPP USD)
For the 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)

6.2 Results

Our data relate to a cross section of 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 due to 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 implemented using the software MPLUS.

Two general remarks: 1) only significant (or nearly significant considering the small sample) are reported; and 2) almost all the coefficients have the expected sign.

a) *Results of the measurement model*

The results of the measurement model are given in Table 1.

(i) *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 "education". 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. Let us add that we could only retain one of the two mortality indicators 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.

(ii) *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 though not significant effect on the infant mortality rate. Public expenditure on education has a positive and significant effect on adult literacy rate and combined primary, secondary and tertiary gross 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.

Table 1. Results of the Measurement Model

Dep. var. / Expl. var.	y_1	y_2	y_3	y_5	y_6	y_7	y_8
y_1^*	—	—	—	—	1 (0)	0.708 (0.056)	—
y_2^*	—	—	—	1 (0)	—	—	−3.865 (0.343)
y_3^*	1 (0)	0.662 (0.035)	0.395 (0.019)	—	—	—	—
w_3	—	—	—	0.042 (0.029)	—	—	−0.103 (0.092)
w_5	—	—	—	—	1.719 (0.823)	1.584 (0.834)	—
R^2	0.921	0.880	0.951	0.834	0.868	0.796	0.969

Figures inside parentheses are standard deviations.

b) *Results of the structural equation model*

The results of the structural equation model are given in Table 2.

(i) *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.

(ii) *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 (that is a more democratic regime seems to favour higher achievement in education). Population growth rate and population density have an important negative effect on education. Percentage of population using improved water sources and number of physicians per 100000 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 GDP in our model or if our model had a separate dimension corresponding to material welfare.

The R^2 values in both Tables 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.

Table 2. Results of the Structural Equation Model

Dependent variables / Explanatory variables	y_1^*	y_2^*	y_3^*
y_1^*	—	—	0.011 (0.004)
y_2^*	1.374 (0.269)	—	—
y_3^*	—	0.284 (0.308)	—
w_1	—	—	0.614 (0.180)
w_4	—	0.065 (0.023)	—
x_7	−0.030 (0.005)	—	—
x_{11}	−64.293 (30.547)	—	—
x_{12}	—	0.001 (0.006)	—
x_{13}	—	—	0.077 (0.005)
x_{14}	0.584 (0.588)	—	—
x_{15}	—	−4.003 (0.481)	—
R^2	0.821	0.798	0.892

Figures inside parentheses are standard deviations.

Based on the above model, we estimated the latent variables and normalised 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. Thus health and political freedom receive more weight than education in our measure. This aggregate score can be interpreted as an index reflecting multiple dimensions (education, health and political freedom in our application) and taking account of various interactive mechanisms operating within the society. Thus there two main differences from HDI: the political freedom element and the derivation based on the underlying structural model. Let us point out 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 HDI (see Tables 3,4,5,6) we see that there is a strong correlation between the two measures (0.861 for the ranks and 0.851 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 Bulgaria, Mauritius, Thailand, Kazakhstan, Sri Lanka, Dominican Republic, Kyrgystan, Bolivia, Morocco, and to a certain extent Algeria, Syria and Jordan all do better in terms of HDI than $\hat{H}$. Similarly, Peru, Uzbekistan, Egypt, Cambodia, Kenya, and to a certain extent Guyana, Romania, Indonesia and Ghana do better in terms of 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 HDI whether it is in terms of ranks or the values themselves. The correlation between HDI and y_3^* values is only 0.426 and that between their ranks is 0.528. 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 HDI as we saw earlier due to the fact that the other two components (y_1^* and y_2^*) are also present in 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 HDI and 18th according to $\hat{H}$ but 50th (out of 56) in y_3^* (political freedom). Because of the fact that it performs better in the other two dimensions, its overall rank is higher. In fact it has a higher rank in $\hat{H}$ than HDI because it is more advanced in health and education than even in GDP (the third component of HDI but absent in $\hat{H}$) compared to other developing countries and this compensates for the low score in political freedom.

Turning to the comparison between per capita GDP (normalised to the 0-1 scale) and $\hat{H}$, the correlation between the two is less than that between HDI and $\hat{H}$ though it can be still considered to be reasonably high. The correlation between the *values* of $\hat{H}$ and GDP is much less than that between HDI and GDP values whereas there is little difference between the two rank correlations. Thus HDI is 'closer' to GDP than $\hat{H}$.

Table 3. Explanations of abbreviations used in rank tables

hdi:	human development index
$\hat{H}$:	our aggregate index based on estimated factor scores
GDP:	Gross Domestic Product per capita
y^*1:	'knowledge' or 'education' dimension
y^*2:	'health' dimension
y^*3:	'political freedom' dimension
rhdi:	rank according to HDI
rhhat:	rank according to $\hat{H}$
rgdpn:	rank according to (normalised) GDP
ry^*n:	rank according to y_n^* for n=1,2,3

Table 4. Rank Correlations

rhhat,rhdi	rhav,rhdi	rhdi, ry*1	rhdi, ry*2	rhdi, ry*3	rhdi,rgdpn	rhhat,rgdpn
0.861	0.915	0.917	0.916	0.528	0.756	0.756
hdi,hhat	hdi,hav	hdi,y*1	hdi,y*2	hdi,y*3	hdi,gdpn	hhat,gdpn
0.851	0.914	0.948	0.94	0.426	0.891	0.796

Table 5. Country Rankings

COUNTRY	rankhdi	rankhhat	rankgdpn	ranky*1	ranky*2	ranky*3
Argentina	1	2	2	2	3	6
Hungary	2	6	1	5	2	12
Slovakia	3	5	3	1	4	2
Chile	4	3	31	9	5	31
Uruguay	5	4	6	3	6	5
Costa Rica	6	12	12	4	9	3
Mexico	7	8	4	10	1	29
Panama	8	9	5	16	12	19
Bulgaria	9	19	7	18	21	8
Romania	10	1	15	17	19	4
Colombia	11	10	11	23	8	9
Mauritius	12	23	23	8	10	35
Venezuela	13	16	9	11	23	10
Thailand	14	29	20	21	13	23
Brazil	15	14	14	6	22	1
Philippines	16	15	30	15	7	16
Kazakhstan	17	31	8	7	11	51
Peru	18	7	17	29	14	14
Jamaica	19	21	26	25	15	15
Turkey	20	13	13	14	16	54
Sri Lanka	21	37	10	34	32	47
Paraguay	22	22	22	22	33	37
Dominican Rep.	23	35	18	31	25	7
Uzbekistan	24	11	29	13	37	41
China	25	18	38	28	27	50
Iran	26	27	27	33	36	38
Jordan	27	34	16	20	34	13
Kyrgyzstan	28	38	25	24	18	18
Guyana	29	20	19	26	26	27
Algeria	30	41	36	36	20	46

Table 5. Country Rankings: contd.

COUNTRY	rankhdi	rankhhat	rankgdpn	ranky*1	ranky*2	ranky*3
South Africa	31	39	39	35	39	21
Syria	32	36	21	12	24	22
Vietnam	33	28	32	19	29	34
Indonesia	34	26	34	37	28	11
Bolivia	35	47	37	27	38	39
Egypt	36	17	28	32	30	49
Honduras	37	46	40	30	17	20
Guatemala	38	25	24	40	46	28
Morocco	39	51	35	38	41	42
Zimbabwe	40	33	41	42	31	48
Ghana	41	32	33	43	35	36
Cambodia	42	30	53	49	43	45
Kenya	43	24	52	41	40	43
Pakistan	44	50	44	47	45	17
Togo	45	43	48	39	50	26
Bangladesh	46	40	42	45	44	55
Madagascar	47	42	45	44	42	40
Mauritania	48	45	46	51	47	52
Zambia	49	49	50	50	53	53
Senegal	50	54	55	46	51	30
Benin	51	44	43	53	49	44
Guinea	52	53	51	55	52	25
Gambia	53	48	47	52	55	24
Mali	54	55	54	48	48	32
Chad	55	52	49	54	54	33

Table 6. Rank Differences

COUNTRY	rhdi-rhhat	rgdpn-rhhat	ry*1-rhhat	ry*1-rhdi	ry*3-rhhat	ry*3-rhdi
Argentina	-1	0	0	1	4	5
Hungary	-4	-5	-1	3	6	10
Slovakia	-2	-2	-4	-2	-3	-1
Chile	1	28	6	5	28	27
Uruguay	1	2	-1	-2	1	0
Costa Rica	-6	0	-8	-2	-9	-3
Mexico	-1	-4	2	3	21	22
Panama	-1	-4	7	8	10	11
Bulgaria	-10	-12	-1	9	-11	-1
Romania	9	14	16	7	3	-6
Colombia	1	1	13	12	-1	-2
Mauritius	-11	0	-15	-4	12	23
Venezuela	-3	-7	-5	-2	-6	-3
Thailand	-15	-9	-8	7	-6	9
Brazil	1	0	-8	-9	-13	-14
Philippines	1	15	0	-1	1	0
Kazakhstan	-14	-23	-24	-10	20	34
Peru	11	10	22	11	7	-4
Jamaica	-2	5	4	6	-6	-4
Turkey	7	0	1	-6	41	34
Sri Lanka	-16	-27	-3	13	10	26
Paraguay	0	0	0	0	15	15
Domin. Rep.	-12	-17	-4	8	-28	-16
Uzbekistan	13	18	2	-11	30	17
China	7	20	10	3	32	25
Iran	-1	0	6	7	11	12
Jordan	-7	-18	-14	-7	-21	-14
Kyrgyzstan	-10	-13	-14	-4	-20	-10
Guyana	9	-1	6	-3	7	-2
Algeria	-11	-5	-5	6	5	16

Table 6. Rank Differences: contd.

COUNTRY	rhdi-rhhat	rgdpn-rhhat	ry*1-rhhat	ry*1-rhdi	ry*3-rhhat	ry*3-rhdi
South Africa	-8	0	-4	4	-18	-10
Syria	-4	-15	-24	-20	-14	-10
Vietnam	5	4	-9	-14	6	1
Indonesia	8	8	11	3	-15	-23
Bolivia	-12	-10	-20	-8	-8	4
Egypt	19	11	15	-4	32	13
Honduras	-9	-6	-16	-7	-26	-17
Guatemala	13	-1	15	2	3	-10
Morocco	-12	-16	-13	-1	-9	3
Zimbabwe	7	8	9	2	15	8
Ghana	9	1	11	2	4	-5
Cambodia	12	23	19	7	15	3
Kenya	19	28	17	-2	19	0
Pakistan	-6	-6	-3	3	-33	-27
Togo	2	5	-4	-6	-17	-19
Bangladesh	6	2	5	-1	15	9
Madagascar	5	3	2	-3	-2	-7
Mauritania	3	1	6	3	7	4
Zambia	0	1	1	1	4	4
Senegal	-4	1	-8	-4	-24	-20
Benin	7	-1	9	2	0	-7
Guinea	-1	-2	2	3	-28	-27
Gambia	5	-1	4	-1	-24	-29
Mali	-1	-1	-7	-6	-23	-22
Chad	3	-3	2	-1	-19	-22

7 Conclusions

What are the lessons to be learnt from our model results and rank comparisons? The most important message is that a better social and political environment not only helps the 'realisation' 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 role to play and a positive one 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 all important dimensions 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.

Now 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 utilisation of our results in terms of deriving multidimensional poverty indices from our individual and aggregate factor scores.

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