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James, M.J.

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JEFFREY JAMES

PRODUCTIVITY INDICATORS FOR THE RURAL POOR IN DEVELOPING COUNTRIES

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ABSTRACT. Meeting the Millennium Development Goals will necessarily require a heavy focus on rural areas, where most of the world's poor are to be found. More specifically, policy will need to raise the productivity of this group, which includes farmers, wage labourers and those suffering from disease and malnutrition. Yet, at present, no index exists which can assess countries on the basis of technological indicators that bear heavily on the productivity of the rural poor. A wide variety of unresolved problems notwithstanding, this paper constitutes the first attempt to construct an index that is designed specifically to assist those who are concerned with rural-specific policies towards meeting the MDGs.

KEY WORDS: aggregation bias in data collection, cross-country rankings, index of technological indicators, Millennium Development Goals, outliers, productivity of the rural poor

1. INTRODUCTION

Perhaps the most telling policy conclusion that can be drawn from the need to meet the Millennium Development Goals by the year 2015, is that a heavy focus on rural, rather than urban areas of developing countries, will need to occur. This is the case, for example, with regard to the income, gender disparity and education goals, as the following quotation clearly indicates. For,

> in spite of rapid urbanization, three billion or 60 per cent of the people in developing countries ... still live in rural areas.
> Three quarters of the world's poor, those earning less than a dollar a day, live in rural areas. One in five children in the South still does not attend primary school and, while rural–urban statistics on education are scarce, many countries report that non-attendance in school, early dropout of students, adult illiteracy and gender inequality in education are disproportionately high in rural areas, as is poverty (UNESCO, 2002, p. 30).

Or again, the environmental sustainability objective of the MDGs is partly to broaden the access of people to basic infrastructural facilities such as potable water. But in this, as with most of the MDGs, the problem to be confronted does not bear equally on rural and urban areas. 'Urban populations', that is to say '*are significantly better served* than rural populations in access to drinking water, sanitation, and power' (World Bank, 1994, p. 26, emphasis added).

It is not our intention in this paper to explore the many policy interventions that will be required to redress the specifically rural aspects of meeting the MDGs. The goal, rather, is to construct a cross-country index of indicators that are likely to bear heavily on the productivity of small farms in developing countries (and in some cases, also to other groups living in poverty in rural areas). Our motivation for this focus is based largely on the fact that:

> The productivity on small farms in developing countries must increase if the Millennium Development Goals for poverty and hunger are to be achieved. ... Increasing productivity, which reduces unit costs of production, can help poor farmers and farm workers out of poverty, generate employment and incomes in non-farm rural enterprises, and it can make available more food to poor consumers at lower prices. (Pinstrup-Andersen, nd).

Increasing the productivity on small farms, in turn, depends on a range of technological factors, such as techniques of production, education and infrastructure. And in the absence of comparable cross-country data regarding the productivity of small farms in developing countries, technological variables such as these, can, in principle, serve as useful proxy indicators. Even if productivity data *were* available, moreover, it would be useful for policy purposes to compare countries according to the technological variables that underlie such data. As it happens, recent years have seen the emergence of several new measures of national technological capabilities, based on a number of indicators that reflect a country's ability to create new technology, to diffuse recent and older skills (especially those that are related to science, mathematics and engineering). (Archibugi and Coco, 2004b) As we seek to demonstrate in the following section, however, these new indices of national technology achievements throw little or no light on the factors that bear most heavily on the productivity of small farmers in developing countries. In the subsequent sections, therefore the task is to develop an entirely new set of indicators that, on the one hand, need to meet certain minimum conditions and on the other hand, are subject to severe data constraints. (One such constraint – which we have termed 'aggregation bias' – is an especially pervasive problem in our attempt to gather suitable cross-country data and warrants particular attention). The core section of the paper, however, describes what can be done empirically, given the constraints imposed by aggregation bias and other difficulties. In particular, this section contains (as far as we are aware) the first attempt to compare developing countries according to a set of technological indicators that are designed, as far as possible, to capture the determinants of productivity among the rural poor. What we hope is that by examining their performance on the components of the overall index, countries bent on achieving the MDGs will be better able to discern the policy areas that demand particular attention in raising the productivity among this group. By comparing the ranking of countries on our index with the ranking of the same countries according to one of the recent attempts to measure technological capabilities described above, we hope, furthermore, to isolate and learn from the outlier cases; cases, that is to say, where the difference in ratings between the indices is highest. The final section concludes with a plea to reduce the degree of aggregation bias in the way that data are collected, and thereby make available to researchers, more accurate measures of the technological factors that determine the productivity of the rural poor. Let us begin, however, by noting how little, even disaggregated (by say sectors), versions of recent measures, would help towards this end, because many of the indicators that they use have so little to do with rural areas in general and with the poor inhabitants of those areas in particular (James, 2005).

2. THE RELEVANCE OF RECENT MEASURES

One of the best-known recent measures of national technological capabilities is the Technology Achievements Index (TAI) proposed by the UNDP in 2001 (UNDP, 2001) and it is to this particular index that I shall address my critical observations. In so doing, fortunately not much is lost by neglecting the other recent measures, since 'the various approaches contain significant similarities. *In fact many indicators are identical*' (Archibugi and Coco, 1994b, p. 8, emphasis added). Thus, the following criticisms of the TAI, apply with more or less the same force to the other indicators as well (originating, as they do, from the World Economic Forum, UNIDO, the Rand Corporation and from Archibugi and Coco, known as the ARCO index).

Let us begin then, with a statement of the four major dimensions of the TAI and the indicators associated therewith, as shown in Table I.

From the point of view of its relevance to the rural sector and its poor inhabitants, the 'technology creation' dimension is the most susceptible to criticism. For, it is this dimension that is almost entirely dominated by rich countries and the modern sector of a relatively few developing countries (such as Korea and Brazil). In particular, it is still the case that more than 90% of all global patents are owned by the developed countries, to whom

TABLE I

Dimensions and indicators of the TAI

Dimension	Indicators
Creation of technology	(a) Patents granted per capita (b) Receipts of royalty and license fees from abroad per capita
Diffusion of recent innovations	(a) Internet hosts per capita (b) High and medium technology exports as a share of all exports
Diffusion of old innovations	(a) Logarithm of telephones per capita (b) Logarithm of electricity consumption per capita
Human skills	(a) Mean years of schooling (b) Gross enrolment ratio at tertiary level in science, mathematics and engineering

Source: UNDP (2001, p. 47)

the vast majority of royalties and license fees must accordingly have accrued. Quite apart from the fact that this measure diverts attention from the much more fundamental capabilities associated with the use and assimilation of existing technologies, it is irrelevant to many developing countries whose score on royalties and license fees is zero or negligible. (Even India, one of the more industrialized developing countries, receives a quasi-zero score on these measures of technology creation). To this extent, therefore, disaggregation of the national score by urban and rural sectors would yield no extra information about the latter, where, if anything, technology creation in the sense defined by the TAI, is even less likely to occur.

Much the same problem arises in relation to the second dimension of the TAI: diffusion of recent innovations. With regard to the diffusion of Internet hosts, the difficulty is again that for many developing countries, especially, but only in Sub-Saharan Africa the total number per 1000 people at the national level is not much above zero. And thus, given the tendency for rural areas to lag behind in the adoption of recent IT innovations, disaggregation of the national measure by rural vs. urban areas would again make little sense. (The second indicator, based on exports of high and medium technology goods, suffers less from irrelevance as measured by negligible scores recorded at the national level, but more from the fact that such exports are unlikely to emanate from the rural sector).

When one adds to these examples, the irrelevance to rural areas of measuring human skills by the gross enrolment ratio at the tertiary level in science, mathematics and engineering, it cannot but strike the reader that the concepts and indicators used in the TAI, often seem to be far more relevant to developed rather than developing countries and within the latter, to urban rather than rural areas. To this extent, therefore, the TAI could scarcely be further removed from the technological capabilities that really matter to the rural poor (though, to be fair, the indicators dealing with the diffusion of 'old' innovations, could, if disaggregated by sector, serve as useful proxies for rural productivity). It must by now be equally clear to the reader, that anyone interested in constructing a rural, pro-poor index of technological indicators, will need to proceed in what is basically a diametrically opposite direction from the TAI and it is to just such a task that we now turn.

3. TOWARDS THE CREATION OF A NEW INDEX

The iterative procedure that gave rise ultimately to the new rural index, was governed by the need to satisfy certain basic requirements. These were that:

(a) at least four major dimensions of productivity had to be included, namely, education, health, infrastructure and factor intensity.
(b) the sample size should be large enough to satisfy the demands of major statistical software packages, if the data are to be used for popular purposes such as regression analysis. This form of analysis requires a minimum number of observations in order to attain statistical significance.
(c) the composition of the sample should reflect a wide geographical dispersion of countries and include some of the poorest nations in the world.
(d) the number of empty cells in the data matrix should be close to zero.

3.1. *The Notion of Aggregation Bias*

Most developing countries do not publish their data separately for urban and rural areas. This is appropriate if the same policy decision is made for rural and urban areas. Recall that the value of data is equal to the increase in the value of the decision, compared to the value of the decision without the data. Thus, if no rural-specific decisions are taken, then no rural-specific data are required. However, the MDG effort must be rural intensive. Specific rural investments are required. This generates a high value for rural data to support these decisions.

3.2. *The Choice of Indicators*

One of the requirements of our index was that it should contain at least four of the key technical factors that determine the productivity of the rural poor. The dimensions selected do not purport to represent the only, or the most important options available. The much more modest claim is that they do exert an important influence on the variable under discussion, via a reasonably broad range of causal mechanisms. The four technical factors that were selected, have to do with health, education, infrastructure, and the means of production (and as in the case of the TAI referred to above, each of these factors is measured by at least one indicator). Let us now consider each of them in turn.

3.2.1. *Health and Nutrition.* 'Illness', writes Vernon Ruttan 'is a significant constraint on labor productivity in many developing countries. Farm workers are often incapacitated – too ill to work – for 15–20 days each year. And even when they are at work, productivity may be severely constrained by a combination of malnutrition and parasitic and infectious diseases' (Ruttan, 2001, p. 205). This same combination – which tends to bear most heavily on the rural poor – also has a negative impact (and in some cases a powerfully negative influence) on the performance of children at school and hence on a country's ability to build up its human capabilities. One of the ways in which this occurs is through the effect of malnutrition on children's concentration in class and hence on their learning achievements.

Data on the incidence of parasitic and infectious diseases among different rural income groups, are not, as far as I am aware, available at the cross-country level. As a proxy for these data, a variable described by the WHO as 'health' equality has been used (see below). The idea being that the more unequally is health distributed, the less will be the opportunity for low-income groups to access the resources needed to treat infectious and parasitic diseases. And again, facing the same data constraint on percentages of malnourishment at different rural income levels, I have chosen to use cross-country measures of malnourishment instead (that is, the percentage of malnourishment at the level of the country as a whole). With regard to both proxies, it well bears emphasizing that the links to productivity do not take place only via the workplace. Rather, they occur also from the school and indeed the entire population that has to deal with malnutrition and infectious diseases.

3.2.2. *Infrastructure.* As far as infrastructure is concerned, the MDGs mention only the need to halve the numbers of people without access to safe drinking water. Yet, it is infrastructure in a much broader sense that is important for ensuring that growth is consistent with poverty reduction, a topic covered in *World Development Report 1990: Poverty* (World Bank, 1994, p. 20). Four years later, the *World Development Report 1994* was devoted specifically to the role of various types of infrastructure on productivity, growth and poverty reduction. Thus,

> Different infrastructure sectors have different effects on improving the quality of life and reducing poverty. Access to clean water and sanitation has the most obvious and direct consumption benefits in reducing mortality and morbidity. It also increases *the productive capacity of the poor and can affect men and women differently*.
> For example, the poor – women in particular – must commit large shares of their income or time to obtaining water and fuelwood, as well as to carrying crops to market. This time could otherwise be devoted to high-priority domestic duties, such as childcare, or to income-earning activities. (The World Bank, 1994, p. 20, emphasis added).

Apart, thus, from indicating the variety of infrastructural services that ought to be taken into account in the formulation of the MDGs, this citation also reinforces an important and recurring theme of this section, namely, that the benefits of improved productivity are spread among a *wide* range of groups living in rural poverty. From among the infrastructural variables that bear heavily on the productivity of these groups, data on the penetration of rural roads are unavailable, while for three others, untypically, it is possible to obtain rural as well as national estimates. (In particular, I use the percentage of the rural population with access to improved water, sanitation and irrigation, as the three indicators of the infrastructural dimension).

3.2.3. *Educational Achievements.* I have already referred to the deplorable lack of information about rural education in developing countries. In the crucial area of primary schooling, however, the so-called Monitoring Learning Achievement (MLA) project has generated some useful cross-country data, that reflect the stock of knowledge and hence the extent of technological capabilities, in the rural sector of the countries concerned.[1] Primary school enrolment rates, for example, constitute one possible measure of how well countries are doing in this regard and the MLA project has collected such data for the rural areas in some 20 odd countries (see note 1 below).

As indicated at the outset of the paper, however, we have sought to provide an index of rural technology indicators that includes a certain minimum number of countries, with a negligible total of empty cells in the data matrix. As such, therefore, the MLA sample of countries with primary school enrolment rates is simply too small for our purposes. In any case, moreover, enrolment rates say nothing whatever about what children actually *achieve* in terms of acquired knowledge and skills. Enrolment rates, that is to say, are merely inputs into a process that, through a variety of mechanisms, culminates in more or less of what Sen would call educational 'functionings' (Sen, 1985).

For both these reasons, I have chosen to use another indicator of educational achievements at the primary school level, based again on data collected by the MLA project. These alternative data are concerned with literacy achievements and they indicate, in particular, urban/rural differences in mean literacy scores 'from tests administered to samples of pupils usually in grades 3 or 4 or 5' (Lakin and Gasperini, 2003, p. 101). In the vast majority of countries, the mean scores in urban areas exceeded those in rural locations, with quite sharp variations between countries in the extent of this 'urban advantage'. How, though, can these relative (as opposed to absolute) magnitudes serve as an indicator of educational achievements in rural areas of developing countries? The answer we propose turns on the assumption that 'urban advantage' reflects mainly various forms of urban bias, especially in educational allocations but also in health, sanitation and so on. In particular, government and donor investments in education tend to be biased (as argued by Lipton) in favour of urban areas, even though a unit of capital invested in rural schooling (especially if it is accompanied by nutritious school lunches), would almost certainly be more efficiently spent than a unit of capital invested in urban schools. And the bigger are the differences in scores, we assume, the greater will tend to be the opportunity cost (in terms of educational achievements) of neglecting the rural sector.

3.2.4. *Means of Production.* Previous sections have discussed a number of mechanisms through which the productivity of the rural poor could be increased. These included the effects of nutrition, health, infrastructure and education on the different groups that are described as living in poverty in developing countries. In this final section, I focus on the means of production used by farmers and in particular on capital accumulation, which by increasing the capital to labour ratio, has a positive effect on the productivity of labour. Indeed, according to one prominent scholar 'The growth of capital stock is the prime explanation for the 19-fold growth of per capita income in the advanced economies between 1820 and 1998'. (Maddison, cited in Szirmai, 2005).

At any rate, the ideal data for our purposes would be cross-country estimates of the average capital stock available to farmers that fall below some consistent measure of poverty or size. That measure, predictably, is unavailable and the only option, as far as I could tell, was a large set of data relating the capital stock per agricultural worker to the prevalence of malnutrition in a country (this relationship, one should note is not a continuous one. Rather, countries are assigned a value of the capital stock in agriculture according to whether the prevalence of malnutrition falls into one of four discrete categories).

4. RESULTS

The outcome of our attempt to compute an index of technological indicators that is oriented towards the poorest members of the rural sector, is shown in Table II. For each of the seven indicators described in the previous section, a normalized value (between 0 and 1) is shown for 28 countries and the overall index is a simple average of these indicators (as shown in Table III). The sample contains countries from each continent, although Asia is under-represented compared to Latin America and Sub-Saharan Africa.

Of the top three countries, only Korea (0.88) can be described as a totally predictable entry; Lebanon (0.82) and Cuba (0.68), on the other hand, would certainly not be predicted by income or any other well-known variable (as discussed in more detail below). Again, at the bottom end of the ranking, it is no surprise to find three countries from Sub-Saharan Africa, but one country from that region, Ivory Coast, has a score of almost 0.5, which is higher than the indices of numerous countries with far higher incomes (this, too, will be discussed at a later stage).

The second and third columns of Table III show the scores, for each country in our sample, of the TAI and ARCO indices described above. They raise the obvious question of whether and in which respects, the index we have constructed, adds to the information about national technical indicators that is already provided by the existing literature. Let us first approach this question from the standpoint of the TAI, which bore the brunt of our critique in the previous section. Most striking in this respect is that our index is able to include many of the poorest countries in the developing world, countries which are excluded from the TAI because of data unavailability, itself partly a symptom, we suggested, of the choice of indicators that are heavily biased towards the circumstances prevailing in the developed world. The data problems we encountered, by contrast, often stem from what was described as an aggregation bias, rather than any irrelevance of the desired indicators to the problems of the rural poor.

ARCO differs from the TAI in that it does seek to assign missing data to the poorest countries, albeit on the rather vague basis of ‘national sources, interview with country experts, and performance of comparable countries’. Indeed, so contrived had to be this effort that in extreme cases the minimum value had to be adopted in a group of similar countries. Here again,

TABLE II
Calculating the rural index

N nourish	*N* water	*N* sanitation	*N* health	*N* irrig	*N* education	*N* k stock	Average	Country
0.75	0.53	0.41	0.219251	0.003	0.87988	0.189189	0.425903	Botswana
0.77	0.27	0.11	0.26738	0.007	0.540541	0.189189	0.30773	Burkina Faso
0.75	0.24	0.21	0.144385	0.003	0.870871	0.189189	0.343921	Cameroon
0.6	0.1	0.03	0.101604	0.351	0.60961	0.116216	0.272633	Madagascar
0.67	0.44	0.51	0	0.016	0.93994	0.189189	0.395018	Malawi
0.8	0.38	0.21	0.037433	0.018	0.78979	0.189189	0.346345	Mali
0.64	0.55	0.05	0.016043	0.013	0.864865	0.116216	0.321446	Niger
0.75	0.28	0.4	0.438503	0.031	0.948949	0.189189	0.433949	Senegal
0.79	0.32	0.55	0.262032	0.001	0.786787	0.189189	0.414144	Uganda
0.5	0.27	0.1	0.085561	0.009	0.807808	0.116216	0.269798	Zambia
0.97	1	1	0.529412	0.38	0.888889	1	0.824043	Lebanon
0.93	0.14	0.18	0.406417	0.13	0.81982	0.22973	0.405138	Morocco
0.65	0.85	0.3	0.331551	0.448	0.345345	0.116216	0.43445	Bangladesh
0.91	0.89	0.07	0.459893	0.383	0.927928	0.22973	0.552936	China
0.998	0.77	1	0.802139	0.604	0.978879	1	0.879017	Korea
0.77	0.81	0.64	0.73262	0.163	0.795796	0.22973	0.591592	Philippines
0.989	0.24	0.42	0.679144	0.063	0.558559	1	0.564243	Argentina
0.77	0.22	0.39	0.368984	0.042	0.237237	0.189189	0.316773	Bolivia
0.9	0.31	0.43	0.42246	0.049	0.603604	0.189189	0.414893	Brazil
0.85	0.81	0.51	0.032086	0.01	0.960961	0.22973	0.486111	Cote d'Ivoire
0.87	0.48	0.33	0.764706	0.24	0.22973	0.798799	0.530462	Colombia
0.87	0.85	0.85	0.780749	0.204	0.22973	0.948949	0.676204	Cuba
0.74	0.67	0.83	0.481283	0.173	0.189189	0.573574	0.522435	Dominican Rep.
0.79	0.53	0.53	0.363636	0.036	0.189189	0.249249	0.384011	Honduras
0.95	0.62	0.26	0.652406	0.238	0.22973	0.48048	0.490088	Mexico
0.86	0.06	0.44	0.695187	0.029	0.22973	0.435435	0.392765	Paraguay
0.89	0.24	0.1	0.449198	0.419	0.22973	0	0.332561	Peru
0.81	0.46	0.05	0.229947	0.883	0.22973	0.897898	0.508653	Uzbekistan

Source: Based on data in Appendix 1.

therefore, a certain advantage can be claimed for our rural poor index, which has no need to make contrived and vague assumptions in order to include the poorest countries, because the indicators themselves are relevant to the issues at hand. Still, the ARCO index does contain more or less reliable data for our sample countries and it is worthwhile examining the correlations between the first and third columns of Table III.

Though the respective Pearson and Spearman correlations of 0.69 and 0.62 indicate a strong relationship between these, one should bear in mind that the Pearson correlation between the ARCO and TAI indicators is well over 0.9 (Archibugi and Coco, 2004b). Thus, whereas the former comparison reasonably admits of a search for outliers, the latter does not. Indeed, Figure 1

TABLE III

Ranking of sample countries and scores on other indices

Country	Ranking according to our index (in descending order)	TAI score	ARCO
Korea	0.88	0.67	0.6
Lebanon	0.82	na	0.37
Cuba	0.68	na	0.32
Philippines	0.59	0.3	0.32
Argentina	0.56	0.38	0.43
China	0.55	0.3	0.31
Colombia	0.53	0.27	0.33
Dominican Rep.	0.52	0.24	0.31
Uzbekistan	0.51	na	0.32
Mexico	0.49	0.39	0.36
Ivory Coast	0.49	na	0.14
Bangladesh	0.43	na	0.12
Senegal	0.43	0.16	0.15
Botswana	0.43	na	0.25
Brazil	0.41	0.31	0.33
Uganda	0.41	na	0.13
Morocco	0.41	na	0.22
Malawi	0.4	na	0.13
Paraguay	0.39	0.25	0.32
Honduras	0.38	0.21	0.25
Mali	0.34	na	0.07
Cameroon	0.34	na	0.19
Peru	0.33	0.27	0.35
Niger	0.32	na	0.03
Bolivia	0.32	0.28	0.3
Burkina Faso	0.31	na	0.05
Madagascar	0.27	na	0.12
Zambia	0.27	na	0.24

indicates the size of the deviance between the ARCO and our own index for the 28 countries in the sample and it suggests that Lebanon, Cuba and the Ivory Coast are the countries for which this magnitude is largest. It is accordingly to these cases that one needs to turn in order best to appreciate what is added by the explicitly rural focus adopted in the sections above.

According to the 2001 edition of the *World Development Indicators*, published by the World Bank, Cuba outperformed almost every other developing country in terms of its performance in health and education. Because this was achieved at a relatively low per capita income level (of some 1700 US dollars in 1999), the Cuban case clearly illustrated the effectiveness of egalitarian policy in these key areas. And in terms of our indicators, the effect of such policy manifests itself in one of the most equitable health systems and one of the least urban-biased educational outcomes in the sample. (Due, more specifically, to an explicit strategy of reaching children in isolated rural areas with 'adequate levels of human and physical resources as well as special features to meet their needs').[2]

The Ivory Coast, by contrast, has no obvious claim to being an outlier in the sense that we are now using the term. Yet, on a number of the indicators that comprise our index, this country performs remarkably well in relation to Sub-Saharan Africa as a whole. According to the *Human Development Report* of

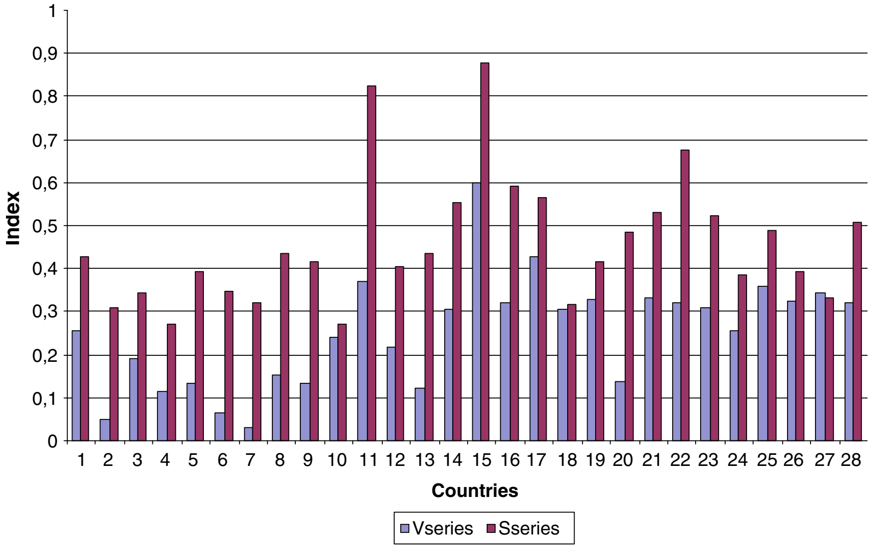

Fig. 1. *Notes*: (1) The V&S series refer, respectively, to the values of the ARCO index and that of our own calculations. (2) The country numbers correspond to those found in Appendix A.

1995, for example, the percentage rural access to safe water in the Ivory Coast was 81, as compared with the figure of 35 for the region as a whole.[3] As regards the percentage of the population that is described as being undernourished in 1996/8, the corresponding figures are 14 and 34. Or again, in terms of the equality of literacy scores between primary school children from urban and rural areas, the Ivory Coast ranks behind only Korea in the results presented in Table II. Those same results, however, indicate quite the opposite tendency in the distribution of health care, which is one of the most unequal in the entire sample. This is an apparent anomaly, which those concerned with meeting the MDGs would do well to address.

Turning to our final outlier, Lebanon, the puzzle is not about indicators that point in diametrically opposite directions. It has, rather, to do with the fact that although this country has a similar ARCO score to Latin American countries such as Argentina, Brazil, Mexico and Peru, it performs substantially better according to the index we have constructed (indeed, its score on this latter index is only marginally lower than that of Korea). Whatever turns out to explain this divergence, it will almost certainly have to do with the 15-year civil war in Lebanon and the remarkable attempts made thereafter to raise the level of social indicators to their relatively high pre-war levels.[4]

4.1. *Decomposing the Correlation between Indices*

The previous section was concerned with outliers from the overall pattern of correlation between what might be called a rural and an industrial index of technological achievements, without, however, paying any attention to that relationship itself (a relationship, which, for example, is stronger than one might initially have expected). Table IV, accordingly, tries to decompose the overall correlation coefficient into each of its separate components. That is to say, it shows the Pearson correlation between the ARCO index and each of the seven indicators that we have chosen, for the 28 countries in our sample.

What the Table reveals is a highly divergent pattern of correlations among the seven indicators, ranging from near zero at the one extreme to 0.8 at the other. The two most significant results appear in relation to improved water access and irrigation and it is thus mainly to these infrastructural indicators that one needs to turn in explaining the overall correlation (0.69) between the ARCO index and the index made up of the indicators shown in Table II. In particular, what needs to be identified is a variable (or set of variables) that is closely associated with water access and

TABLE IV

Correlations of the ARCO index with each indicator of the rural-based alternative

(ARCO with)						
Access to water	Sanitation	Health inequality	Irrigation	Urban/rural literacy achievement	Malnourishment	K-stock
0.597**	0.162	0.163	0.796**	0.407*	−0.073	0.009
Sig. (2-tailed)						
0.001	0.410	0.406	0.000	0.032	0.714	0.615
$N = 28$	28	28	28	28	28	28

**Significant at 0.009. *Significant at 0.042.

irrigation, on the one hand and the ARCO index on the other. That variable, in our view, is per capita income, for the following reasons. On the one hand, it has long been recognized that certain infrastructural variables are closely related to per capita income in developing countries. On the other hand, as we have seen, the ARCO index is very closely correlated with the TAI, which, in turn, appears to have the same empirical relationship to per capita income (UNDP, 2004).

5. CONCLUSIONS

Underlying this paper are two fundamental recognitions. The first of them being that progress towards meeting the MDGs, will require a heavy policy focus on rural rather than urban areas. For, it is not only in the former that the vast majority of the world's poor are concentrated, but also those most lacking in education, gender disparities and so on. The second recognition is that, although technological variables play an important role in determining the productivity of the rural poor (defined to include not just farmers but also the workforce and the malnourished), existing attempts to capture such variables are biased in favour of urban rather than rural variables. There is, accordingly, a pressing need to design an index that is specifically oriented to the circumstances confronting the rural poor and it is to this difficult and novel task that our efforts have mainly been devoted.

Many and varied were the problems involved in constructing a set of technical indicators that bore heavily on the productivity of the rural sector in general and the rural poor in particular. By no means the least of these problems was termed aggregation bias, a bias that severely inhibits the prospect of finding suitable data. The point is that the rural specific data required to support specific rural investments, are difficult to find because of a tendency to aggregate national data.

To a large extent, therefore, the rural index that is presented in this paper, can be viewed as a series of proxies for data that are made unavailable by the workings of aggregation bias (in one form or another). The particular proxies that were selected, however, did have to meet certain criteria, the most important of which was the need to cover at least four of the main technical factors underlying the productivity of the rural poor. In imposing this requirement, we were, of course, aiming to construct an index, which was not susceptible to the charge that it covers only a small part of the influence exerted by technical factors on rural productivity and poverty. And the four factors chosen, that have to do with health, infrastructure, education and the means of production (defined by the capital stock per worker), do, we feel, manage to achieve this objective. At the same time, however, our insistence on including these four key influences, meant, inevitably, that the sample size was smaller than it would otherwise have been with a lesser number of causal mechanisms. Too small a sample, on the other hand, would have made it unamenable to basic statistical analysis (of the kind performed, for example, by widely used software packages). Ultimately, a balance between these two conflicting constraints was struck with a data-set comprising seven technological indicators and 28 countries, drawn mainly from Africa and Latin America. These countries were ranked according to a simple averaging of the chosen indicators.

What value, we then asked, does this new ranking add to the existing measures, such as the TAI and ARCO, which neglect the rural sector in general and the rural poor in particular. With regard to the former, one clear advantage of our index is that it is able to include many of the poorest developing countries, where efforts to meet the MDGs will need to be most intensive and especially heavily oriented towards the rural sector. Unlike the TAI, the ARCO index does contain scores for all the countries scores for all the countries in our sample and the result of a correlation between the two, yielded three outliers, namely, Lebanon, Cote d'Ivoire and Cuba. Such lessons as could be drawn from these countries, constitute information that would not be available if only the ARCO index was used. At a more disaggregated level of analysis, furthermore, it turns out that a close positive correlation occurs only in the case of two of our seven indicators. These, like the ARCO index itself, are known to interact strongly with levels of per capita income. About most of the other indicators, however, ARCO has little or nothing to say and explanatory variables unrelated to that index need thus to be investigated.

Appendix A

The dataset

Country	% Rural access to improved water	% Rural access to sanitation	Distribution of health care	Irrigation as % of total cropland	Rural/urban difference in school	% Malnourished	K stock in agriculture by percentage of malnourished population
1. Botswana	53	41	146	0.3	4	25	1.4
2. Burkina Faso	27	11	137	0.7	15.3	23	1.4
3. Cameroon	24	21	160	0.3	4.3	25	1.4
4. Madagascar	10	3	168	35.1	13	40	0.86
5. Malawi	44	51	187	1.6	2	33	1.4
6. Mali	38	21	180	1.8	7	20	1.4
7. Niger	55	5	184	1.3	4.5	36	0.86
8. Senegal	28	40	105	3.1	1.7	25	1.4
9. Uganda	32	55	138	0.1	7.1	21	1.4
10. Zambia	27	10	171	0.9	6.4	50	0.86
11. Lebanon	100	100	88	38	3.7	3	7.4
12. Morocco	14	18	111	13	6	7	1.7
13. Bangladesh	85	30	125	44.8	21.8	35	0.86
14. China	89	7	101	38.3	2.4	9	1.7
15. Korea	77	100	37	60.4	0.7	0.2	7.4
16. Philippines	81	64	50	16.3	6.8	23	1.7
17. Argentina	24	42	60	6.3	14.7	1.1	7.4
18. Bolivia	22*	39	118	4.2	25.5	23	1.4

Appendix A
Continued

Country	% Rural access to improved water	% Rural access to sanitation	Distribution of health care	Irrigation as % of total cropland	Rural/urban difference in school	% Malnourished	K stock in agriculture by percentage of malnourished population
19. Brazil	31*	43	108	4.9	13.2	10	1.4
20. Cote d'Ivoire	81	51	181	1	1.3	15	1.7
21. Colombia	48	33	44	24	6.7	13	1.7
22. Cuba	85	85	41	20.4	1.7	13	1.7
23. Dominican Republic	67	83	97	17.3	14.2	26	1.4
24. Honduras	53	53	119	3.6	25	21	1.4
25. Mexico	62	26	65	23.8	17.3	5	1.7
26. Paraguay	6	44	57	2.9	18.8	14	1.7
27. Peru	24	10	103	41.9	33.3	11	1.7
28. Uzbekistan	46	5	144	88.3	3.4	19	1.7

Notes: Refers to 1990.*Sources*: Cols. 1, 2 and 4 from World Bank, *Rural Indicators Handbook*, 2000 (data refer to 1998).Col. 3 from *World Health Report*, 2000 (data refer to 1997).Col. 5 from Lakin and Gasperini (2003, p. 101).Col. 7 from *The State of Food Insecurity in the World*, 2002 (data refer to 1998–2000).

NOTES

[1] See most recently, the EFA Global Monitoring Report (2005) on the UNESCO site (http://portal.unesco.org).
[2] For more details on Cuba's educational policy see Lakin and Gasperini (2003). This country featured prominently as an example of how basic needs can be met even at low income levels during the 1970s. See, for example, Streeten et al. (1977).
[3] According to the Bureau of African Affairs at the US Department of State, the Ivory Coast has an 'outstanding' infrastructure compared to the standards of other developing countries. The March 2005 Background Note on this country is to be found at http:///www.state.gov/r/pa/ei/bgn/2846.htm (accessed 19 June, 2005).
[4] As summarized, among other institutions, by the World Bank. See, for example http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/LEBANONE (accessed 25 June, 2005).

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REFERENCES

Archibugi, D. and A. Coco: 2004a, 'A new indicator of technological capabilities for developed and developing countries', World Development 32(4), pp. 629–654.
Archibugi, D. and A. Coco: 2004b, 'Measuring technological capabilities at the country level. A comparison among different approaches', mimeo.
Eastwood, R. and M. Lipton: 2000, 'Rural–urban dimensions of inequality change', Discussion Paper in Economics 65, University of Sussex.
James J.: 2005, 'Measuring technological capabilities across countries: from developed-country bias to rural poverty and the Millennium Development Goals', mimeo.
Lakin, M. and L. Gasperini: 2003, 'Basic education in rural areas: status, issues, and prospects', in D. Atchoarena and L. Gasperini (eds.), Education for Rural Development: Towards New Policy Responses, FAO/UNESCO.
Lipton, M.: 1977, Why Poor People Stay Poor (Temple Smith, London).
Pinstrup-Andersen, P. (nd). Statement available from http://www.pipra.org/andersen-statement php. (accessed 17 March 2005).
Ruttan, V.: 2001, Technology, Growth and Development (Oxford University Press, New York).
Sen, A.: 1985, Commodities and Capabilities (North-Holland, Amsterdam).
Streeten, P., et al.: 1977, First Things First (Oxford University Press, New York).
Szirmai, A.: 2005, The Dynamics of Socio-Economic Development (Cambridge University Press, Cambridge).
UNESCO: 2002, Education for Sustainable Development, United Nations Decade 2005–2014.
UNDP: 2001, Human Development Report.
World Bank: 1994, World Development Report.

Department of Economics
Tilburg University
Warandelaan 2
5000 LE TilburgThe Netherlands
E-mail: m.j.james@uvt.nl