Employment Strategy Papers

Agricultural productivity growth, employment and poverty in developing countries, 1970-2000

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Preface

This paper was prepared as background research for the *World Employment Report 2004-05*, *Employment, Productivity and Poverty Reduction*. The topic of this year's *Report* was chosen based on the observation that it is not simply the lack of employment that leads to poverty, but rather the lack of *decent and productive* employment. In many parts of the developing world the poor are in fact employed, but employed in such poorly paid conditions that they and their families live on less than US$1 a day per person. Thus, unemployment is only the 'tip' of the iceberg of the decent work deficit. The *Report* concludes that not only do we need more jobs, but more *productive jobs* – jobs that allow workers to lifts themselves and their families out of the vicious cycle of poverty.

The background papers commissioned for this *Report* provide an overview of the important aspects involved in the links between employment, productivity and poverty reduction in both developing and developed economies. The papers were commissioned from experts in the field as well as various departments within the ILO and discuss different avenues through which poverty can be reduced, as well as the trade-offs that must be made in order to strike the right balance between productivity, employment and income growth. The research involves macroeconomic, sectoral and case study analysis that has helped form the basis of the chapters in the *Report*.

Based on the research from these background papers the *Report* concludes that increasing the opportunity for decent and productive work is an important channel towards achieving a fairer globalization, and is vital for poverty reduction.

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Chapter 1. Introduction

Growth in agriculture and its productivity are considered essential in achieving sustainable growth and significant reduction in poverty in developing countries. Development economists view productivity growth in the agricultural sector as critically important if agricultural output is to increase at a sufficiently rapid rate to meet escalating demands for food (see, for example, Hayami and Ruttan, 1985; Mellor, 1976).

Historically, agriculture and the rural sector have been a major source of employment in developing countries. However, over the past three decades the share of agriculture in world gross domestic product (GDP) has been declining steadily in favour of manufacturing and the services sector. In many countries, the share of the services sector in GDP is outpacing that of manufacturing. These trends are evidenced by the increasing migration of labour to urban sectors and the decreasing contribution of agriculture to total employment. However, the decline in agriculture's contribution to GDP has been much faster than its decline as a provider of employment. Thus, the trend away from agriculture has not necessarily been matched by employment creation in non-agricultural sectors. Furthermore, the disproportionately high share of the services sector in many countries (such as those in South Asia) is considered by a number of commentators to be a cause for some concern (see for example, Tisdell 1999; Lewis 1966).

According to the World Bank's *World Development Report*, in 1990 over 1.3 billion people were subsisting on less than US$1 a day and around 2.7 billion people on less than US$2 a day. A decade later, these figures decreased to an estimated 1.1 billion and 2.1 billion people respectively, of whom between two-thirds to three-quarters live in rural areas. A total of 90 per cent of the world's poor inhabit Asia and sub-Saharan Africa (Thirtle et al., 2002). Poverty reduction is becoming a high-priority item on the political agenda. For example, one of the UN Millennium Development Goals is to halve global poverty by 2015 and countries are now required to prepare Poverty Reduction Strategy Papers (PRSPs).

The Food and Agriculture Organization regularly publishes estimates of the undernourished in the world, an interconnected issue which is being addressed by attempts to increase food production and supply. However, land availability is becoming a constraint. The supply of arable land per capita is fast diminishing, combined with rapid population growth and the resulting need for human settlement and rising urbanization. Significant improvements are required in productivity growth in agriculture in order to increase agricultural output through technological innovations and efficiency. Since the mid-1960s, the Green Revolution in many Asian countries has been perceived as the force of transformation for agricultural production in the developing world. Given the high percentage of people who depend on agriculture for their livelihood, little progress can be made on poverty reduction if this sector languishes with a slow rate of growth.

In light of the above, the measurement of productivity and the analysis of agricultural-sector performance at national, regional and global levels are essential steps in a systematic study of the relationship between agricultural-sector productivity, growth in per capita income and real GDP and the incidence of poverty. The present study embraces three main objectives. First, it systematically measures growth in agricultural output and productivity over the past three decades (1970-2000). Second, it traces the main sources of this growth, analyses the trends observed and identifies the factors influencing productivity. Third, it assesses the significance of agricultural productivity as a determinant of the incidence of poverty in developing countries. In addition, the role of various institutional factors is examined with a view to providing a guide to poverty reduction in rural areas.

The report is structured as follows. Chapter 2 describes the basic data used in the analysis, the countries and years covered and the levels and shares of global agricultural production. The output and input variables used in productivity measurement are described in detail. Chapter 3 outlines the conceptual framework underlying the current research project, with the methods used in measuring total factor productivity levels and trends over time. Chapter 4 presents the empirical results, highlighting the characteristic features of productivity performance in global and regional agriculture. Chapter 5 focuses on productivity levels and trends and the political, institutional, geographic and macroeconomic factors that distinguish inter-country differences in productivity performance in agriculture. Chapter 6 analyses the nexus between agricultural productivity and the incidence of poverty in developing countries. This relationship is examined in a wider context of identifying determinants of poverty incidence across countries. The report argues that agriculture has a special place in developing countries – its declining share in GDP notwithstanding.

Chapter 2. Basic data

Productivity growth in agriculture has been the subject of intense research over the past five decades. Development economists and agricultural economists alike have examined the sources of productivity growth over time and of productivity differences among countries and regions. During the 1970s and 1980s a number of major analyses of cross-country differences in agricultural productivity were conducted, including Hayami and Ruttan (1970); Kawagoe and Hayami (1983, 1985); Kawagoe, Hayami and Ruttan (1985); Capalabo and Antle (1988); and Lau and Yotopoulos (1989).

Most of these studies used cross-sectional data on approximately 40 countries to estimate a Cobb-Douglas production technology using regression methods. The focus was generally on estimating production elasticities and investigating the roles of farm scale, education and research in explaining cross-country labour productivity differentials. A number of studies have conducted panel data analysis of agricultural sector comparisons. Coelli and Rao (2001) provide a brief review of the recent literature: most of these tend to focus on small groups of less developed countries, a few cover a large number of countries.

The present research attempts to cover as many countries as possible and also to extend the period analysed. The principal source of data is the website of the Food and Agriculture Organization of the United Nations (www.fao.org) and, in particular, the agricultural statistics provided by the AGROSTAT system, supported by the Statistics Division of the FAO.[1] The following are the main features of the data series used.

2.1. Country coverage

This analysis spans a total of 111 countries. These countries account for more than 95 per cent of global agricultural output and 98 per cent of the world population. Thus, coverage is truly global in scope. Countries are divided into eight regions,[2] As Table 2.1 shows.

[1] The authors of the report are grateful to the FAO for maintaining an excellent site and for devoting resources to the compilation and dissemination of data through the Internet.
[2] Regional groupings are based on their geographical location and on groupings used in Craig et al., (1997).

Table 2.1. Distribution of countries by region

Region 1: North Africa and the Middle East Algeria Egypt Morocco Tunisia Iran Iraq Israel Saudi Arabia Syria Turkey	***Region 2: Sub-Saharan Africa*** Angola, Mali Burundi, Mozambique Cameroon, Niger Chad, Nigeria Ethiopia PDR, Rwanda Ghana, Senegal Guinea, South Africa Côte d'Ivoire, Sudan Kenya, Tanzania Madagascar, Uganda Malawi, Burkina Faso Zimbabwe
Region 3: North America and the Pacific Canada United States Australia New Zealand	***Region 4: Latin America*** Argentina, El Salvador Bolivia, Guatemala Brazil, Haiti Chile, Honduras Colombia, Mexico Costa Rica, Nicaragua Cuba, Paraguay Dominican RP, Peru Ecuador, Uruguay Venezuela
Region 5: Asia – excluding China Bangladesh, Malaysia Myanmar, Mongolia Sri Lanka, Nepal India, Pakistan Indonesia, Philippines Japan, Thailand Cambodia, Viet Nam Korea Rep, Papua New Guinea Laos	***Region 6: China***
Region 7: Europe Austria, Italy Bel-Lux, Netherlands Denmark, Norway Finland, Portugal France, Spain Germany, Sweden Greece, Switzerland Ireland, United Kingdom	***Region 8: Transition Countries*** Bulgaria, Kyrgyzstan Czechoslovakia, Latvia Hungary, Lithuania Poland, Russian Federation Romania, Slovakia Yugoslav SFR, Slovenia USSR, Tajikistan Belarus, Turkmenistan Czech Republic, Ukraine Georgia, Uzbekistan Kazakhstan

Several points should be noted on the country coverage and groupings. The analysis includes all the transition countries. This means that data on the USSR, Czechoslovakia and Yugoslavia cease to exist after the formation of the new republics. Similarly, data on the new countries are available only from 1995. In order to maintain coverage through time, all these countries have been included. Growth rates for output and productivity for the transition region need to be interpreted with caution. In recognition of its size and due to differences in its accounting practices over time, China is treated as a region by itself. The only other point is the inclusion of Australia and New Zealand in the North American region. The alternatives are to include them either in Asia or Europe. Notwithstanding their geographical location, Australia and New Zealand have most in common with Europe or North America and, due to their closer proximity to the latter, it was decided to group these two countries under North America and the Pacific.

2.2. Time period

This project covers a 40-year period from 1961 to 2000. The starting point coincides with the first year of publication of data in the FAO series.[3] Data on all variables have been drawn from the FAO sources. All data used in this analysis are provided in Appendix A1.[4] Although data are available for all the years, a preliminary analysis suggested that data for the early 1960s may not be reliable. This is also the case for China, one of the largest countries in the study. Consequently, results are presented and analysed only for the period 1970 to 2000.

2.3. Output series

The FAO data series provides detailed information on agricultural production in different countries, involving primary production data on 200 agricultural commodities. It is necessary to aggregate the commodity outputs to form value aggregates. The present study uses two output variables – crops and livestock. The output series for these two variables are derived by aggregating detailed output quantity data on 185 agricultural commodities. Construction of output data series was as follows. First, output aggregates for 1990 are drawn from Table 5.4 in Rao (1993), using international average prices (expressed in US dollars) derived by using the Geary-Khamis method (see Rao 1993, Chapter 4 for details) for the benchmark year 1990.[5] Since all crop and livestock aggregates are formed using this method, it is possible to aggregate these two to form total agricultural output, where necessary. Thus the output series for 1990 are at constant prices, expressed in a single currency unit.

The second step extends the 1990 output series to cover the whole survey period 1961-2000, by using the FAO production index number series for crops and livestock separately.[6] The production index number series show growth in output (for crops and livestock separately) using 1990 as the base. The series derived by using this approach are essentially equivalent to the series constructed using 1990 international average prices and the actual quantities produced in different countries in various years.

Data compilation for transition countries required an additional step. Since none of these countries was included in the Rao (1993) study using 1990 as the benchmark year, it was necessary to use data from a more recent study (Rao, Ypma and van Ark (2004), in which international comparisons of agricultural output using 1995 as the benchmark year have been reported. Output aggregates for the transition countries are expressed relative to the United States in 1995 and rebased using the United States as the link between the two series in order to arrive at output aggregates for the transition countries in 1995, expressed in 1990 international dollars. Once these are calculated, the FAO production index numbers again provided a basis for constructing output series for the period 1995-2000 for these countries.

It is important to remember that the output series is based on 1990 international average prices. The series could change slightly when the base is shifted from 1990 to another

[3] Collection of primary data from national sources was not a feasible option given the resources and time constraints. Therefore much of the data used in this analysis is compiled from secondary sources.

[4] The electronic version of this report includes Appendix A1. For reasons of space, the hard-copy version does not include Appendix A1, which can be obtained free of charge by contacting the ILO, Geneva.

[5] The Geary-Khamis international average prices are based on prices (in national currency units) and quantities of 185 agricultural commodities in 103 countries.

[6] See the 1997 FAO *Production Yearbook* for details regarding the construction of production index numbers.

period, thus potentially influencing the final results. Even though results are available for a more recent benchmark year, 1995, it was decided that 1990 comparisons would form a more appropriate basis for the current project.

2.4. Input series

Given the constraints on the number of input variables that could be used in the Data Envelopment Analysis (DEA), this reports opts to consider only five input variables, described below.

Land

This variable covers arable land, land under permanent crops and land under permanent pasture. Arable land includes land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land for market and kitchen gardens and land that is temporarily fallow (less than five years). Land under permanent crops is cultivated with crops that occupy the land for long periods and need not be replanted after each harvest. This category includes flowering shrubs, fruit and nut trees and vines but excludes land under trees grown for wood or timber. Land under permanent pasture is land used permanently (five years or more) for forage crops, either cultivated or growing wild.

Tractors

This variable includes the total number of wheel and crawler tractors (but excludes garden tractors) used in agriculture. It is important to note that only the number of tractors is used as the input variable with no allowance made to their horsepower,[7] an aspect that will be examined in future work.

Labour

This variable refers to the economically active population in agriculture, defined as all persons working or looking for work, whether as employers, own-account workers, salaried employees or unpaid workers assisting in the operation of a family farm or business. It includes all economically active persons engaged in agriculture, forestry, hunting or fishing. This variable obviously overstates the labour input used in agricultural production, where the extent of overstatement is likely to depend upon the level of development of the country.[8]

Fertilizer

Following other studies (Hayami and Ruttan, 1970; Fulginiti and Perrin, 1997) of inter-country comparisons in agricultural productivity, this analysis uses the sum of nitrogen (N), potassium (K) and phosphate (P) contained in the commercial fertilizers applied. This variable is expressed in thousands of metric tons.

Livestock

The livestock input variable used is the sheep-equivalent of the five categories of animals used in constructing this variable. Categories considered are: buffaloes, cattle, pigs, sheep and goats. Numbers of these animals are converted into sheep equivalents using

[7] Assuming that farming in developing countries is on fragmented land, average horsepower of tractors in these countries could be significantly lower than those used in countries with large farms using highly mechanized farming techniques. This could understate the productivity levels and changes in developing countries.

[8] A significant percentage of the labour force (as defined here) could actually be in disguised unemployment.

conversion factors: 8.0 for buffalo and cattle; and 1.00 for sheep, goats and pigs.[9] Chicken numbers are not included in the livestock figures.

2.5 State of global agriculture

This section outlines the size and distribution of global agricultural production and its trends over time. From the basic data on all outputs and inputs for all countries, given in Appendix A1, a number of summary statistics have been compiled. Without pre-empting the results presented in Chapter 5, it is possible to provide a brief overview of the state of world agriculture.

Agricultural output in the world doubled over the 30-year period, increasing from 645.88 billion (1990) dollars to 1,297.1 billion dollars. In the same period, labour input (as measured by population economically active in agriculture) increased only by 40 per cent – from 898 million to 1,267 billion. This implies that almost 20 per cent of the world's population is currently engaged in agricultural production. Table 2.2 and Figures 2.1-2.7 show some salient features of agricultural output in different regions and in the world from 1970 to 2000.

Chapter 3. Conceptual framework and methodology

The conceptual framework used in this report is well established in the productivity and efficiency measurement literature. This chapter outlines a basic overview of the concepts and methods applied. Material for the basic concepts is drawn from Coelli, Rao and Battese (1998). The present report also makes extensive use of shadow prices, for agricultural inputs and outputs, derived using the data envelopment analysis (DEA). These shadow prices are used in computing total factor productivity levels for all analysed countries for different years. The DEA method is also used in computing productivity growth using the Malmquist productivity index and provides a decomposition of this index into efficiency and technical change components.

3.1. Basic concepts

A brief description of the terms and concepts used in the current analysis follows. The basic (or partial) productivity measures used in the study of agriculture are labour and land productivity. Labour productivity is measured as output per person employed in agriculture; land productivity is measured as output per hectare or some other measures of land input. These measures are essentially partial productivity measures. When considered in isolation, they may sometimes provide a misleading indication of overall productivity. For example, it is possible to achieve increased land productivity by the utilization of extra labour (or fertilizer, etc.), which may or may not result in improved overall productivity.

Overall or total factor productivity measures aggregate output per aggregate input used in production. It is not often feasible to measure aggregate input and output levels. In such cases, index number methods are used to construct output and input indices, which are in turn used in the construction of productivity index numbers.

The following additional concepts are used in studying the performance of a country's agricultural sector.

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9 The conversion figures used in the present analysis correspond closely with those used in the 1970 study of Hayami and Ruttan.

The ***technical efficiency*** of a country is defined as the degree to which it is able to convert its agricultural inputs efficiently into outputs – relative to best practice, where best practice is defined by the production frontier. The true production frontier is rarely known in practice. It is generally estimated using sample data on a number of countries. Methods of frontier estimation are discussed later in this chapter.

It is possible to distinguish between two types of technical efficiency measures – input-orientated and output-orientated measures. Input-orientated efficiency scores measure the extent to which input usage can be reduced and yet still produce a given level of outputs. Similarly, output-orientated measures consider the possible expansion in outputs for a given set of input quantities. These measures coincide when the underlying technology (frontier) exhibits constant returns to scale. In the present analysis, conducted at the country level, it makes sense to work with the assumption of constant returns to scale.[10]

Countries operating on the frontier are technically efficient and have a technical efficiency score of one. Countries operating below the frontier have a technical efficiency score of less than one, which reflects the percentage of the technologically feasible output level (defined by the production frontier) achieved by a given country.

When one considers productivity comparisons over time, an additional source of possible productivity improvements is ***technical change***. It measures the extent to which the production frontier, representing the state of the technology in a particular time period, shifts upwards over time. Such shifts represent technological progress.

These two concepts are illustrated in Figure 3.1, where F_0' and F_1' represent the production frontiers for two periods 0 and 1 (in the case of a simple one-input, one-output technology). Focusing on F_0', for a given input level, the distance OB shows the level of output that could technically be produced under period 0 technology. If the actual production is below the technologically feasible level and it is given by level OA, then a measure of technical efficiency of the country (or farm) is given by the ratio OA/OB, which takes a value between zero and one, with one indicating technical efficiency. This is an output-orientated technical efficiency measure. An input-orientated technical efficiency measure is given by OC/OA showing the reduction input that is feasible, while maintaining the same output level. Technical change is measured by the shift in the frontiers represented by F_0' and F_1'. The measure of technical change varies according to the input (or output) level at which it measured. For example, in Figure 3.1 an output-orientated technical change measure is calculated as $0B_1/OB$, where a value greater than one indicates technical progress.[11] If one has data on several countries (or farms), then an average of the measures of technical change is taken as an overall measure of technical change for the industry.

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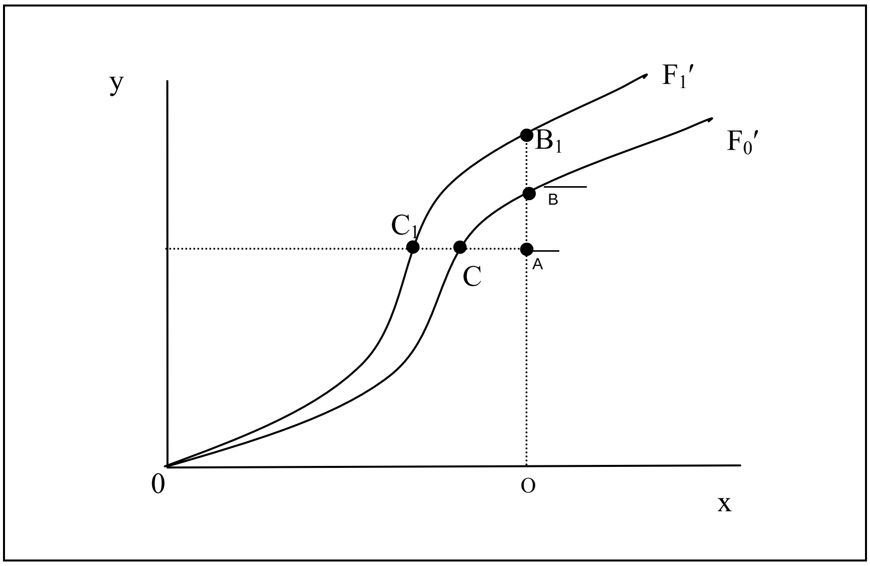
[10] If, for example, the analysis was conducted at farm level, the possible presence of increasing or decreasing returns to scale could be appropriate, depending upon the size of the farms under consideration.

[11] Note that the corresponding input-orientated technical change measure would be calculated as OC/OC_1.

Figure 3.1. Technical change and technical efficiency change



3.2 Measurement of productivity level differences

The productivity level differences across countries at any given point of time, i.e., spatial comparisons of productivity levels, are derived using the standard index number approach. The productivity index of country *k* relative to a base country *j* is measured as the ratio of output index to the input index, denoted by TFP_{jk},

$$TFP_{jk} = \frac{\text{Output index}_{jk}}{\text{Input index}_{jk}}, \tag{3.1}$$

where the output and input indices are computed using the Tornqvist index. Formulae for these indices are given by:

$$\text{Tornqvist output index} = T^{O}_{jk} = \prod_{i=1}^{2}\left[\frac{Y_{ik}}{Y_{ij}}\right]^{(w_{ij}+w_{ik})/2} \tag{3.2}$$

where Y_{ij} and Y_{ik} are outputs of i-th agricultural commodity in countries *j* and *k* respectively, and w_{ij} and w_{ik} are the output shares of i-th commodity in the two countries.
The Tornqvist input index is similarly defined. It is given by

$$\text{Tornqvist input index} = T^{I}_{jk} = \prod_{i=1}^{5}\left[\frac{X_{ik}}{X_{ij}}\right]^{(v_{ij}+v_{ik})/2} \tag{3.3}$$

where *X* denotes input quantities and *v* denotes input shares.

In this study, there are two agricultural outputs – crops and livestock – and five inputs: labour, land, fertilizer, tractors and livestock. The data from FAO, shown in Appendix A1[12] essentially consists of output and input quantities. In order to derive the output and input value shares it is necessary to have corresponding price data. Because price data are not available for this purpose, a methodology to arrive at the input and output shares was devised,

[12] The electronic version of this report includes Appendix A1. For reasons of space, the hard-copy version does not include Appendix A1, which can be obtained free of charge by contacting the ILO, Geneva.

using the method developed by Coelli and Rao (1998) and explained in more detail in Section 3.4 on data analysis development.

Once the productivity indices are computed for each pair of countries using formulae in (3.1) to (3.3) it is necessary to make some adjustments to ensure the internal consistency, known as transitivity, of the indices constructed. We make use of the Elteto-Koves-Szulc (EKS) procedure outlined in Coelli, Rao and Battese (1998). The EKS indices are given by:

$$EKS_{jk} = \prod_{\ell=1}^{M} \left[T_{j\ell} \times T_{\ell k} \right]^{1/M}, \quad (3.4)$$

where M refers to the number of observations (e.g. countries) being compared.

The EKS formula is used in conjunction with output indices produced using (3.2) and input indices computed using (3.3). Once the EKS input and output indices are computed, they are substituted into (3.1) leading to transitive indices of TFP.

All the indices produced in this analysis are presented relative to the United States with index for US equal to one.

3.3 Measurement of productivity growth

In this analysis the Malmquist productivity index is used to measure productivity growth.

The Malmquist index is defined using distance functions. These allow us to describe a multi-input, multi-output production technology without the need to specify a behavioural objective (such as cost minimization or profit maximization). One may define input-distance and output-distance functions. The first characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector. The second considers a maximal proportional expansion of the output vector, given an input vector. The present paper only considers an output-distance function in detail. However, input-distance functions can be defined and used in a similar manner.

A production technology may be defined using the output set, P(x), which represents the set of all output vectors, y, which can be produced using the input vector *x*. Thus,

$$P(x) = \{y : x \text{ can produce } y\}. \quad (3.5)$$

It is assumed that the technology satisfies the axioms listed in Coelli, Rao and Battese (1998, Ch. 3).

The output distance function is defined on the output set, P(x), as:

$$d_o(x,y) = \min\{\delta : (y/\delta) \in P(x)\}. \quad (3.6)$$

The distance function, $d_o(x,y)$, will take a value which is less than or equal to one if the output vector *y* is an element of the feasible production set, P(x). Furthermore, the distance function will take a value of unity if *y* is located on the outer boundary of the feasible production set, and will take a value greater than one if *y* is located outside the feasible production set. In this study we use DEA-like methods to calculate our distance measures. These are discussed briefly below.

The Malmquist TFP index measures the TFP change between two data points (e.g., those of a particular country in two adjacent time periods) by calculating the ratio of the distances of each data point relative to a common technology. Following Färe et al. (1994), the Malmquist (output-orientated) TFP change index between period *s* (the base period) and period *t* is given by:

$$m_o(y_s, x_s, y_t, x_t) = \left[\frac{d_o^s(y_t, x_t)}{d_o^s(y_s, x_s)} \times \frac{d_o^t(y_t, x_t)}{d_o^t(y_s, x_s)} \right]^{1/2}, \qquad (3.7)$$

where the notation $d_o^s(x_t, y_t)$ represents the distance from the period *t* observation to the period *s* technology. A value of m_o greater than one will indicate positive TFP growth from period *s* to period *t* while a value less than one indicates a TFP decline. Note that equation 3.6 is, in fact, the geometric mean of two TFP indices. The first is evaluated with respect to period *s* technology and the second to period *t* technology.

An equivalent way of writing this productivity index is

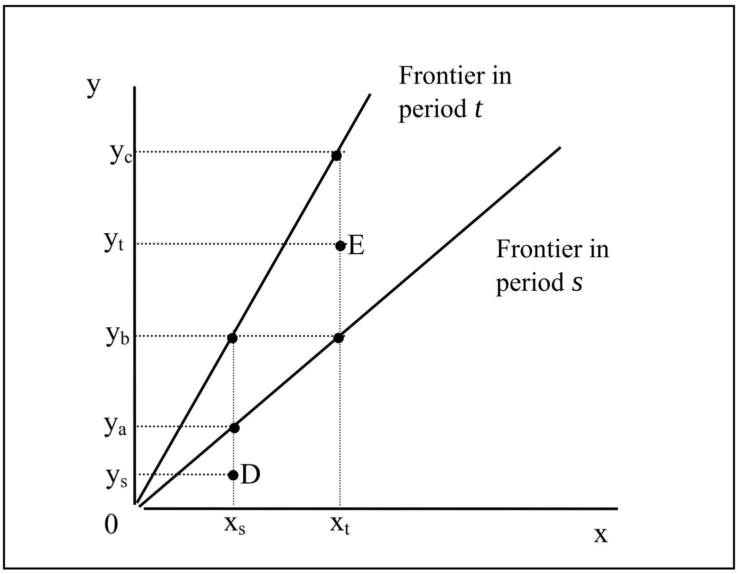
$$m_o(y_s, x_s, y_t, x_t) = \frac{d_o^t(y_t, x_t)}{d_o^s(y_s, x_s)} \left[\frac{d_o^s(y_t, x_t)}{d_o^t(y_t, x_t)} \times \frac{d_o^s(y_s, x_s)}{d_o^t(y_s, x_s)} \right]^{1/2}, \qquad (3.8)$$

where the ratio outside the square brackets measures the change in the output-orientated measure of Farrell technical efficiency between periods *s* and *t*. Thus, the efficiency change is equivalent to the ratio of the technical efficiency in period *t* to the technical efficiency in period *s*. The remaining part of the index in equation 2 is a measure of technical change. It is the geometric mean of the shift in technology between the two periods, evaluated at x_t and also at x_s. Thus we have the decomposition:

$$\text{Malmquist index} = m_o(y_s, x_s, y_t, x_t) = \text{Efficiency change} \times \text{Technical change}.$$

This decomposition can be illustrated using the diagram in Figure 3.2 (after Coelli, Rao and Battese, 1998), which depicts a constant returns-to-scale technology involving a single input and a single output. The firm produces at the points D and E in periods *s* and *t*, respectively. In each period the firm is operating below the technology for that period.

Figure 3.2. Malmquist productivity indices



Hence there is technical inefficiency in both periods. Using equations 3.7 and 3.8 we obtain:

$$\text{Efficiency change} = \frac{y_t / y_c}{y_s / y_a} \tag{3.9}$$

$$\text{Technical change} = \left[\frac{y_t / y_b}{y_t / y_c} \times \frac{y_s / y_a}{y_s / y_b}\right]^{1/2} \tag{3.10}$$

Following Färe et al. (1994) and given that suitable panel data are available, we can calculate the required distance measures for the Malmquist TFP index using DEA-like linear programmes. For the i-th country, we must calculate four distance functions to measure the TFP change between two periods, *s* and *t*. This requires solving four linear-programming (LP) problems. Färe et al. (1994) assume a constant returns-to-scale (CRS) technology in their analysis. The required LPs are:[13]

$$\begin{aligned}
&[d_o^t(y_t, x_t)]^{-1} = \max_{\phi,\lambda} \phi,\\
&\text{st} \quad -\phi y_{it} + Y_t\lambda \geq 0,\\
&\qquad x_{it} - X_t\lambda \geq 0,\\
&\qquad \lambda \geq 0,
\end{aligned} \tag{3.11}$$

$$\begin{aligned}
&[d_o^s(y_s, x_s)]^{-1} = \max_{\phi,\lambda} \phi,\\
&\text{st} \quad -\phi y_{is} + Y_s\lambda \geq 0,\\
&\qquad x_{is} - X_s\lambda \geq 0,\\
&\qquad \lambda \geq 0,
\end{aligned} \tag{3.12}$$

$$\begin{aligned}
&[d_o^t(y_s, x_s)]^{-1} = \max_{\phi,\lambda} \phi,\\
&\text{st} \quad -\phi y_{is} + Y_t\lambda \geq 0,\\
&\qquad x_{is} - X_t\lambda \geq 0,\\
&\qquad \lambda \geq 0,
\end{aligned} \tag{3.13}$$

and

$$\begin{aligned}
&[d_o^s(y_t, x_t)]^{-1} = \max_{\phi,\lambda} \phi,\\
&\text{st} \quad -\phi y_{it} + Y_s\lambda \geq 0,\\
&\qquad x_{it} - X_s\lambda \geq 0,\\
&\qquad \lambda \geq 0.
\end{aligned} \tag{3.14}$$

where

y_{it} is a M×1 vector of output quantities for the i-th country in the t-th period;
x_{it} is a K×1 vector of input quantities for the i-th country in the t-th period;
Y_t is a N×M matrix of output quantities for all N countries in the t-th period;
X_t is a N×K matrix of input quantities for all N countries in the t-th period;[14]
λ is a N×1 vector of weights; and
ϕ is a scalar.

[13] Refer to sub-section 3.4 on the DEA method for further discussion of the interpretation of the efficiency scores that can be derived from similar LPs.
[14] Period *s* variables are defined in the same way.

Note that in LPs (3.13) and (3.14), where production points are compared with technologies from different time periods, the ϕ parameter need not be greater than or equal to one (as it must be when calculating standard output-orientated technical efficiencies). The data point could lie above the production frontier. This will most likely occur in LP (3.14) where a production point from period *t* is compared to technology in an earlier period, *s*. If technical progress has occurred, then a value of $\phi<1$ is possible. Note that it could also possibly occur in LP (3.13) if technical regress has occurred, but this is less likely.

One issue that must be stressed is that the returns-to-scale properties of the technology are very important in TFP measurement. In this analysis, a constant returns-to-scale (CRS) technology is used for two reasons. First, given that we are using aggregate country-level data, it does not appear to be sensible to consider a variable returns-to-scale (VRS) technology. How is it possible for a *sector* to achieve scale economies? For example, the indices of crop output for India and the United States are similar, but their average farm sizes are quite different – thus, what can we sensibly conclude if we estimate a VRS technology and report that these countries face decreasing returns-to-scale? The use of a VRS technology is understandable when the summary data is expressed on an "average per farm" basis, because one can then discuss the scale economies of the "average farm" but, as this analysis deals with aggregate data, the use of a CRS technology is the correct option.

In addition to the above comment regarding the use of aggregate data, a second argument for the use of a CRS technology is applicable to both firm-level and aggregate data. Grifell-Tatjé and Lovell (1995) use a simple one-input, one-output example to illustrate that a Malmquist TFP index may not correctly measure TFP changes when VRS is assumed for the technology. Hence it is important that CRS be imposed upon any technology that is used to estimate distance functions for the calculation of a Malmquist TFP index. Otherwise the resulting measures may not properly reflect the TFP gains or losses resulting from scale effects.

3.4. Data envelopment analysis

Data envelopment analysis (DEA) is a linear-programming methodology, which uses data on the input and output quantities of a group of countries to construct a piece-wise linear surface over the data points. This frontier surface is constructed by the solution of a sequence of linear-programming problems – one for each country in the sample. The degree of technical inefficiency of each country (the distance between the observed data point and the frontier) is produced as a byproduct of the frontier construction method.

DEA can be either input- or output-orientated. If input-orientated, the DEA method defines the frontier by seeking the maximum possible proportional reduction in input usage, with output levels held constant, for each country. If output-orientated, the DEA method seeks the maximum proportional increase in output production, with input levels held fixed. The two measures provide the same technical efficiency scores when a CRS technology applies, but are unequal when VRS is assumed. This paper assumes a CRS technology (for reasons as outlined in the Malmquist discussion above). Hence the choice of orientation is not a big issue. However, we have selected an output orientation because we believe it would be fair to assume that, in agriculture, one usually attempts to maximize output from a given set of inputs, rather than the converse.15

If one has data for N countries in a particular time period, the LP problem that is solved for the i-th country in an output-orientated DEA model is as follows:

[15] Some obvious exceptions to this include, for example, where dairy farmers are required to fill a particular output quota, and attempt to do this with minimum inputs.

$$\begin{aligned} &\max_{\phi,\lambda} \phi, \\ &\text{st} \quad -\phi y_i + Y\lambda \geq 0, \\ &\quad\quad x_i - X\lambda \geq 0, \\ &\quad\quad \lambda \geq 0, \end{aligned} \tag{3.15}$$

where

y_i is a M×1 vector of output quantities for the i-th country;
x_i is a K×1 vector of input quantities for the i-th country;
Y is a N×M matrix of output quantities for all N countries;
X is a N×K matrix of input quantities for all N countries;
λ is a N×1 vector of weights; and
ϕ is a scalar.

Observe that ϕ will take a value greater than or equal to one, and that ϕ-1 is the proportional increase in outputs that could be achieved by the i-th country, with input quantities held constant. Note also that 1/ϕ defines a technical efficiency (TE) score which varies between zero and one (and that this is the output-orientated TE score reported in our results).

The DEA problem presented in equation (3.15) above has a nice intuitive interpretation. Essentially, the problem takes the i-th firm and then seeks to radially expand the output vector, y_i, as much as possible, while still remaining within the feasible production set. The outer boundary of this set is a piece-wise linear frontier (see Figure 3.2), determined by the observed data points (i.e., all the firms in the sample). The radial expansion of the output vector, y_i, produces a projected point, ($X\lambda$,$Y\lambda$), on the surface of this technology. This projected point is a linear combination of these observed data points. The constraints ensure that this projected point cannot lie outside the feasible set.

The above LP is solved N times – once for each country in the sample. Each LP produces a ϕ parameter and a λ vector. The ϕ-parameter provides information on the technical efficiency score for the i-th country and the λ-vector provides information on the *peers* of the (inefficient) i-th country. The peers of the i-th country are those efficient countries that define the facet of the frontier against which the (inefficient) i-th country is projected.

The DEA problem can be illustrated using a simple example. Consider the case in which a group of five countries producing two outputs (e.g., wheat and beef). Assume for simplicity that each country has identical input vectors. These five countries are depicted in Figure 3.3. Countries A, B and C are efficient countries because they define the frontier. Countries D and E are inefficient countries. For country D the technical efficiency score is equal to:

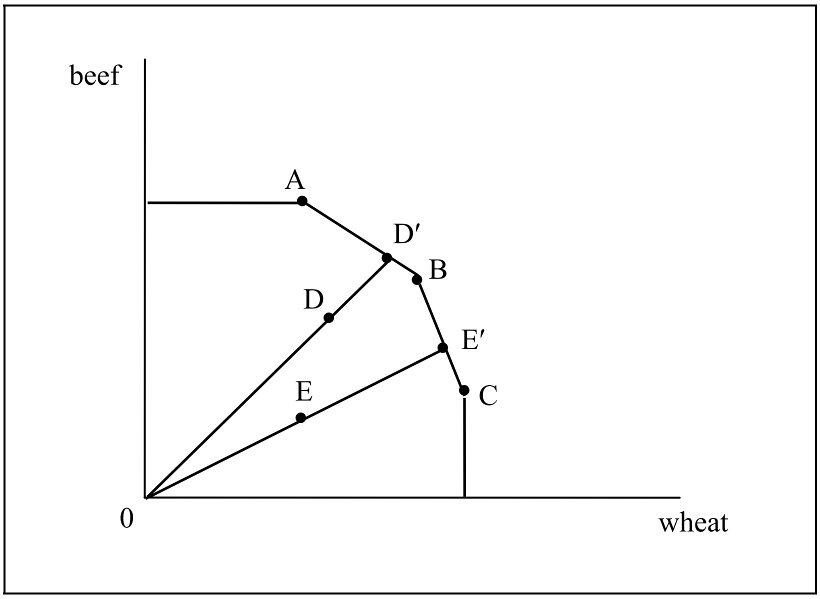
$$TE_D = OD/OD' \tag{3.16}$$

and its peers are countries A and B. In the DEA output listing this country would have a technical efficiency score of approximately 70 per cent and would have non-zero λ-weights associated with countries A and B. For country E the technical efficiency score is equal to:

$$TE_E = 0E/0E', \tag{3.17}$$

and its peers are countries B and C. In the DEA output listing this country would have a technical efficiency score of approximately 50 per cent and would have non-zero λ-weights associated with countries B and C. Note that the DEA output listing for countries A, B and C would provide technical efficiency scores equal to one and each country would be its own peer. For further discussion of DEA methods see Coelli, Rao and Battese (1998, Ch. 6).

Figure 3.3. Output-orientated data envelopment analysis



3.5. Computation of shadow prices and shares

The linear programme defined in equation (3.15) is what is known as the *envelopment* form of the DEA problem. An alternative, and equivalent, *dual* form of this problem is discussed below. The envelopment form is generally preferred to the dual form because it usually involves substantially fewer constraints, relative to the multiplier form (K+M versus N+1). The envelopment form is also attractive because it provides a range of useful information, including targets and peers (see Coelli et al., 1998 for a more detailed discussion).

However, the dual DEA problem also provides some interesting information on shadow prices that can be used to help derive the implicit value shares used later in this analysis.

The dual form is derived from the envelopment (or primal) form using the standard primal-dual linear programming results that are presented in many operations research textbooks (e.g., see Taha, 1987 Chapter 4). A number of papers, including Charnes et al. (1981), introduce the dual form by first presenting the more intuitive *ratio* form. In the ratio form one seeks to obtain an efficiency measure defined as the ratio of a weighted sum of all outputs over a weighted sum of all inputs, such as $u'y_i/v'x_i$, where *u* is an M×1 vector of output weights and *v* is a K×1 vector of input weights. Optimal weights are obtained by solving the mathematical programming problem:

$$\max_{u,v} (u'y_i/v'x_i),$$

$$\text{st} \quad u'y_j/v'x_j \le 1, \quad j=1,2,...,N,$$

$$u, v \ge 0. \qquad (3.18)$$

This involves finding values for *u* and *v*, so that the efficiency measure for the i-th firm is maximized, subject to the constraints that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions.[16] To avoid this, one can impose the constraint $u'y_i = 1$, which provides:

$$\min_{\mu,\nu} (\nu' x_i),$$

$$\text{st} \quad \mu' y_i = 1,$$

$$\mu' y_j - \nu' x_j \leq 0, \quad j=1,2,...,N,$$

$$\mu, \nu \geq 0, \qquad (3.19)$$

where the change of notation from *u* and *v* to μ and ν is used to stress that this is a different linear programming problem. The form in equation (3.19) is generally known as the *dual* form of the DEA linear programming problem. *The elements in the vectors μ and ν may be interpreted as normalized shadow prices.*

One can then easily derive expressions for the input and output value shares by using an output-orientated CRS DEA model. The m-th output share is equal to $\mu_m y_m$, while the k-th input share is equal to $\nu_k x_k \phi$, where ϕ (ϕ>1) is the efficiency parameter from the output-orientated CRS DEA which expands the output vector. For more on this method, see Coelli et al. (1998).

This simple calculation can be made even more attractive by noting that these dual weights can be easily obtained from the final simplex tableau of the *envelopment* (or primal) DEA model specified in equation (3.15).[17] Thus, if we wish to obtain information on peers, targets *and* shadow prices, we need only to solve the envelopment DEA problem[18] and not both forms of the DEA problem.

Chapter 4 provides a summary of results derived from applying the methodology described in detail above to the agricultural data set described in Chapter 2.

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[16] That is, if (u*,v*) is a solution, then (αu*,αv*) with α>0, is also a solution.

[17] For a description of how this information is derived from the final simplex tableau, see Taha (1987).

[18] Alternatively, one could also solve the dual DEA problem to obtain this information. However, as noted earlier, the envelopment form often involves substantially fewer constraints and is generally preferred.

Chapter 4. Total factor productivity levels and growth in agriculture, 1970-2000

This chapter summarizes the results derived using the empirical application of the methodology described in Chapter 3 to the agriculture data set described in Chapter 2. Results are based on the DEA and TFP calculations. Application of data envelopment analysis for the purpose of Malmquist index calculations involves solving a large number of linear programming problems. Our data set of 111 countries over 30 years required solutions to 111×(30×3-2) = 9768 linear programming (LP) problems. These LPs have been run using the DEAP software package,[19] which results in a great volume of output, consisting of information on the efficiency scores and peers for each country in each year. The programme also produces technical efficiency change, technical change and TFP change indices for each country in each pair of adjacent years. The results of the linear programmes can also be used in deriving shadow shares for the two outputs and five inputs considered in the multi-output and multi-input production technology associated with agriculture.

Section 4.1 deals with levels of total factor productivity of each country for each of the years from 1970 to 2000. These levels are contrasted with levels of labour and labour productivity. Efficiency scores and peer analysis are also presented. Section 4.2 presents results on growth in total factor productivity and analyses the main sources of growth in terms of efficiency change and technical change.

4.1. Total factor productivity levels

Estimates of productivity levels provide useful background information in any analysis of productivity growth. It is possible that countries with rapid productivity growth are indeed those which start from a low base in terms of productivity levels at a given point in time. Any commentary on catch-up and convergence requires estimates of productivity levels as well as productivity change over time.

Two measures of productivity levels can be used in the current context. First, the standard TFP index computed using a selected country as the base; the second measure is based on the efficiency score of the country computed using DEA for the given year. Of these two measures, the first is more appropriate and is discussed first.

Total factor productivity indices

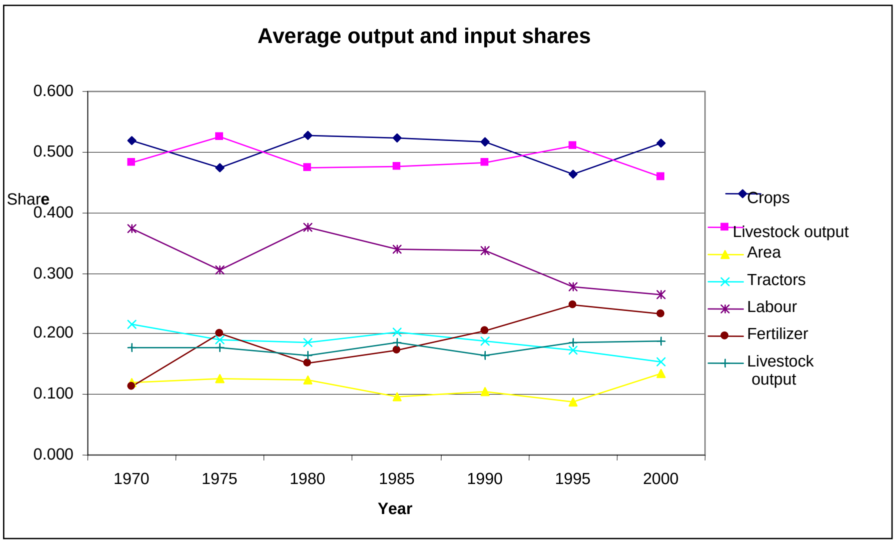
The TFP indices reported here are computed using the EKS multilateral index defined in Chapter 3. This index provides multilateral comparisons from all binary productivity indices computed using the Tornqvist index. Its application to compute output and input indices requires the knowledge of output and input shares in different countries at a given point in time. The basic data set compiled from the FAO has no price information, consequently no value shares could be computed using the basic data. For the present analysis, the value shares are obtained from the solutions of the linear programmes associated with the DEA models. Following the procedure outlined in Section 3.5, the *shadow* output and input shares are obtained for each country for each year. The country-specific shadow shares vary considerably across countries depending upon the slack-regions identified in the linear programmes. As a result, for each year, output and input shares are averaged across all countries and are used as weights in Tornqvist index calculations. For example, the average shares for crops and livestock outputs in 1970 are 51.8 and 48.2 per cent respectively. Input

[19] DEAP is a computer software package developed by Tim Coelli (1996). This software can be downloaded free of charge from the CEPA website: www.uq.edu.au/economics/cepa.

shares in 1970 are 12.1, 21.6, 37.4, 11.3 and 17.6 per cent respectively for land, tractors, labour, fertilizers and livestock inputs.

Figure 4.1 shows trends in output and input shares over the sample period, at five-year intervals. The output shares are fairly stable over the period analysed, with the livestock share exceeding the crops share during the 1980s. Of considerable interest is the movement in the share of labour, which exhibits a general decline. The share of fertilizers shows a significant increase over the period until 1995. The shares of land and livestock have remained relatively stable.

Figure 4.1. Trends in output and input shares 1970-2000



TFP indices for all the countries for all the years, at five-year intervals, are shown in Appendix Table A4.1. All indices in Table A4.1 are expressed relative to the United States. Total factor productivity, labour productivity, and land productivity indices by regions and selected countries expressed at five-year intervals and relative to the United States are presented in Appendix Tables A4.2 and A4.3, respectively. Average TFP levels for the years from 1970 to 2000 are presented in Table 4.1. These indices are all computed using unweighted as well as weighted averages of countries in the regions.

Table 4.1. Average total factor productivity levels in agriculture, selected countries, 1970-2000 (USA=1.00)

Year	Unweighted annual mean			Weighted annual mean		
	Labour productivity	Land productivity	TFP	Labour productivity	Land productivity	TFP
1970	0.048	0.858	0.517	0.086	1.120	0.549
1975	0.048	0.840	0.616	0.083	1.090	0.578
1980	0.049	0.858	0.421	0.084	1.117	0.443
1985	0.045	0.850	0.439	0.075	1.119	0.445
1990	0.048	0.895	0.468	0.073	1.181	0.452
1995	0.050	0.857	0.553	0.066	1.273	0.550
2000	0.042	0.808	0.499	0.055	1.228	0.528
Mean	**0.047**	**0.852**	**0.498**	**0.074**	**1.160**	**0.504**

Table 4.2. Total factor productivity levels in agriculture, selected countries, 1970-2000 (USA=1.00)

	1970	1975	1980	1985	1990	1995	2000
Netherlands	1.270	1.321	1.190	1.081	1.245	1.368	1.394
Poland	0.583	0.572	0.365	0.365	0.433	0.433	0.391
China	0.290	0.298	0.186	0.240	0.258	0.427	0.450
India	0.316	0.328	0.205	0.213	0.212	0.256	0.250
Syria	0.429	0.591	0.529	0.440	0.383	0.454	0.467
Brazil	0.441	0.443	0.328	0.370	0.411	0.510	0.462
Egypt	0.583	0.635	0.428	0.534	0.618	0.816	0.639
Nigeria	0.767	0.637	0.355	0.409	0.431	0.750	0.663

Table 4.2 shows total factor productivity levels for selected countries, expressed relative to the United States. Countries listed are selected from different regions and according to their significance in their respective regions. The TFP index for the Netherlands is not unexpected. Given its limited land resources, this country has an impressive TFP index at a level roughly 25 per cent above that of the United States. While there are some shifts in TFP levels in different years, these indices are quite stable over time. In India, the level has deteriorated somewhat during the period analysed, implying that growth in TFP in India has not kept pace with that of the United States. In China, TFP was around 0.3 in the 1970s and has grown to 0.45, but still shows a fairly large gap in productivity compared with that of the United States, despite China's impressive growth rates in output and total factor productivity (see Section 4.2). Interestingly, both Egypt and Nigeria have high levels of TFP in comparison with China and India.

A glance at the country-specific TFP indices in Appendix Table A4.1 shows that some countries have unexpectedly high TFP levels. For example, Rwanda and Haiti appear to have

TFP levels well above the United States but this may be attributable to data-related problems, as well as to the factor shares that have been taken as the same for all countries.

Technical efficiency levels of countries

The DEA technique provides estimates of technical efficiency of different countries for each year in the analysis. As explained in Chapter 3, an output-orientated technical efficiency level shows the ratio of each country's actual output in relation to what is feasible (given the available technology in that period). Technology in each period, identified using the DEA technique, is a piece-wise linear envelopment of all the observed points in the multi-output and multi-input Euclidean space. The countries that determine the technology frontier are known as the "peers" or best-performing countries. Peer countries have a technical efficiency score of one and usually there are several peers in each year.

Table 4.3 shows mean technical efficiency for different regions in 1970, 1980, 1990 and 2000.

Table 4.3. Mean technical efficiency by region, 1970-2000

Region	Countries	1970	1980	1990	2000
North Africa, Middle East	1,6,15,24,55-57,67,68,70	0.634	0.632	0.667	0.674
Sub-Saharan Africa	2-5,7-14,16-23,25-26	0.707	0.635	0.680	0.757
North America, Australia, NZ	28,38,94-95	1.000	0.940	0.994	1.000
Latin America	29-37,39-48	0.880	0.843	0.874	0.875
Asia	49-51,53-54,58-66,69,71,96	0.832	0.721	0.749	0.776
China	52	0.488	0.366	0.515	0.872
Europe	72-73,76-80,82-85,87,89-92	0.768	0.730	0.753	0.791
Transition countries*	74-75,81,86,88,93,97-111	0.281	0.253	0.247	0.591
Mean	**1-111**	**0.686**	**0.633**	**0.661**	**0.756**

* Not all the countries listed here are included in the calculation in all years. Figures for the transition countries need to be treated with caution.

Several features are worth noting in Table 4.3. The mean technical efficiency for the North America (and Australasia) region has an average score of 1.00 in 1970 and in 2000. This implies that the four countries categorized in this region (Canada, United States, Australia and New Zealand) are all on the technology frontier in 1970 and 2000, each with an efficiency score of 1.00. Averages for all the regions are above 0.5 in most years. Overall mean scores, despite the low averages for the transition countries, are all in excess of 0.6. A more encouraging feature is that the average is increasing over time, indicating that countries are operating closer to the technology frontier as time goes on.

4.2. Trends in total factor productivity

Movements in total factor productivity are measured using the Malmquist productivity index. Using the output-oriented approach, the index provides a measure of how much more can be produced using observed input data – at the technologies observed at two different points of time. The Malmquist productivity index can be decomposed into output increases due to efficiency change and those due to shifts in frontier technology.

The Malmquist index measures year-to-year changes in productivity. These indices and the associated efficiency and technical change components for all countries covered in the analysis from 1970 to 2000 are given in Appendix Table A4.4. Some salient features of these findings are summarized below.

Table 4.4 shows the annual mean technical efficiency change and TFP change, averaged over all countries.

Table 4.4. Annual mean technical efficiency change, technical change and TFP change, 1970-2001

Year	Efficiency Change	Technical Change	TFP Change
1971	0.982	1.011	0.993
1972	0.991	0.960	0.951
1973	1.000	0.983	0.983
1974	1.010	1.023	1.033
1975	0.992	1.043	1.035
1976	0.974	1.021	0.994
1977	0.989	0.978	0.967
1978	1.006	1.002	1.008
1979	0.978	1.003	0.981
1980	0.983	1.044	1.026
1981	1.016	0.977	0.992
1982	0.990	1.038	1.027
1983	0.993	1.002	0.995
1984	1.023	0.986	1.008
1985	0.993	1.027	1.020
1986	1.029	0.979	1.008
1987	0.988	0.982	0.971
1988	1.018	1.039	1.059
1989	1.016	0.986	1.002
1990	0.989	1.034	1.023
1991	1.009	1.017	1.026
1992	1.025	0.978	1.002
1993	1.021	0.988	1.009
1994	1.031	0.947	0.977
1995	0.988	1.037	1.025
1996	1.005	1.049	1.055
1997	1.013	0.978	0.990
1998	0.999	1.045	1.044
1999	0.983	1.051	1.034
2000	0.997	1.007	1.004
2001	1.005	1.002	1.007
Mean	**1.001**	**1.007**	**1.008**

The information in Table 4.4 shows an average annual TFP growth of 0.8 per cent over the period, averaged over all countries. A major contributor to TFP growth is technical change. In a number of years, negative growth in TFP has been observed. It is possible that the agricultural productivity decline in some of those years could be due to unfavourable weather conditions. There are also several years where technological regress has been observed. This is possible in data envelopment analysis if countries defining the frontier move inwards (due to adverse weather conditions, etc.). In this case the estimated production frontier may also move inwards, leading to a negative technical change or technological regression.

Results in Table 4.4 are based on unweighted averages across countries, giving equal weight to all the countries irrespective of the size of the country. To derive an estimate of aggregate TFP growth for the world, is would seem wise to use weighted averages. These are presented in Table 4.5.

The estimates of total factor productivity growth reported in Table 4.5 are more encouraging. These show an overall productivity growth of 1.5 per cent a year in global agriculture. A major portion of the TFP growth is again due to technical change. For purposes of assessing regional and global performance, using weighted averages (across countries) of annual growth rates seems more appropriate.

Table 4.5. Weighted annual mean technical efficiency change, technical change and TFP change, 1970-2001

Year	Efficiency Change	Technical Change	TFP Change
1971	0.960	1.039	0.997
1972	0.973	0.986	0.960
1973	1.005	1.003	1.008
1974	0.987	1.009	0.997
1975	0.964	1.035	0.998
1976	0.976	1.021	0.996
1977	1.005	1.005	1.010
1978	1.009	1.004	1.013
1979	0.993	1.016	1.009
1980	0.992	1.013	1.005
1981	1.004	1.023	1.027
1982	0.986	1.034	1.020
1983	1.008	0.987	0.994
1984	1.028	1.014	1.042
1985	1.006	1.022	1.027
1986	1.021	0.984	1.004
1987	0.991	1.007	0.998
1988	1.025	0.995	1.020
1989	1.017	1.009	1.026
1990	0.982	1.051	1.033
1991	1.011	1.007	1.018
1992	1.104	0.993	1.096
1993	1.039	0.980	1.019
1994	1.029	0.967	0.995
1995	0.978	1.053	1.030
1996	1.025	1.015	1.040
1997	1.034	1.013	1.048
1998	1.004	1.014	1.018
1999	0.981	1.043	1.023
2000	0.997	1.020	1.018
2001	0.992	0.996	0.988
Mean	**1.004**	**1.011**	**1.015**

Table 4.6 presents estimates of weighted mean annual TFP growth by regions. The region (in this particular case the country) with the highest TFP growth is China, with an impressive 3.0 per cent average annual growth in TFP, largely attributable both to efficiency change and technical change. The North America, Australia and New Zealand region and the European region also posted impressive regional TFP growth rates of 2.2 and 1.9 per cent a year, respectively.

Table 4.6. Weighted means of annual technical efficiency change, technical change and TFP change, all regions, 1970-2001

Regions	Efficiency change	Technical change	TFP change
North Africa and the Middle East			
Sub-Saharan Africa	1.001	1.006	1.006
North America and Australasia	1.003	1.000	1.003
Latin America	1.000	1.022	1.022
Asia	1.002	1.005	1.007
China	0.995	1.008	1.003
Europe	1.016	1.013	1.030
Transition countries	1.003	1.016	1.019
	1.008	1.007	1.014
Mean	**1.004**	**1.011**	**1.015**

Table 4.7 shows the average annual average changes for groups of countries classified by their efficiency scores in 1970.

Table 4.7. Weighted means of annual technical efficiency change, technical change and TFP change for efficient and inefficient groups of countries, 1970-2001

Efficiency level in 1970	Efficiency change	Technical change	TFP change
TE < 0.6	1.010	1.012	1.022
0.6 ≤ TE < 0.8	1.002	1.012	1.014
0.8 ≤ TE < 1.0	0.994	1.010	1.004
TE = 1.0	1.000	1.013	1.013
Mean	**1.004**	**1.011**	**1.015**

The first group, consisting of countries whose efficiency scores were less than 0.6, posted an annual TFP growth rate of 2.2 per cent driven by a 1.2 per cent annual technical change and 1.0 per cent efficiency change (or catch-up) per year. The second group, consisting of countries with 1970 efficiency scores between 0.6 and 0.8, also posted an impressive 1.4 per cent TFP growth, whereas countries in the range 0.8 to 1.0 only posted 0.4 per cent growth in total factor productivity. Countries on the frontier in 1970 also posted a 1.3 per cent growth, which is entirely due to technical change. The major contribution of technical efficiency (TE) change in the third group (those countries with less than 0.6 TE in 1970), suggests a level of catch-up by countries that were the least technically efficient at the start of the sample period. Appendix Table A4.5 presents country-specific growth rates, with countries listed in the order of TFP growth in respective regions. An interesting point to note is the number of African countries that have posted negative TFP growth over the analysis period.

Some summary findings

Some salient features of the empirical findings on growth in total factor productivity are provided here. Figure 4.2 shows the growth in TFP in world agriculture over the analysis period. Both weighted and unweighted average (across countries) growth rates are presented.

Figure 4.2. Average annual growth over time, 1971-2001

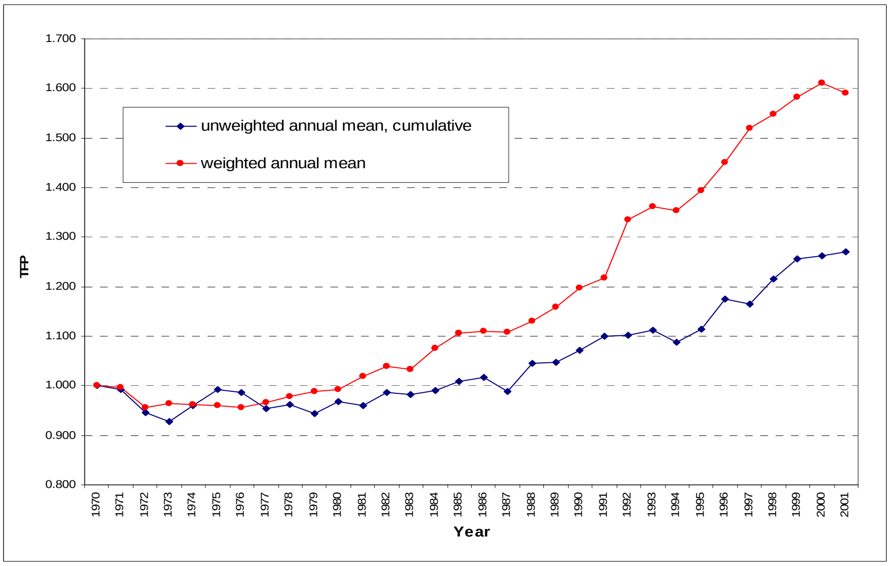


Figure 4.2 very clearly demonstrates the need to use weighted geometric averages to measure total factor productivity growth. There has been a 60 per cent growth in TFP over the analysis period. Figure 4.3 highlights significant regional variations in TFP growth.

Figure 4.3. Weighted average annual growth over time, by region, 1970-2000

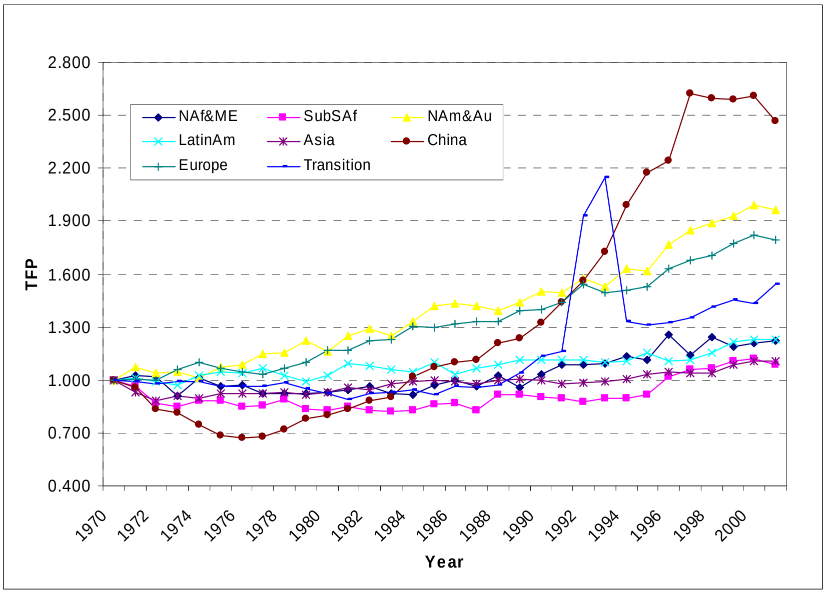
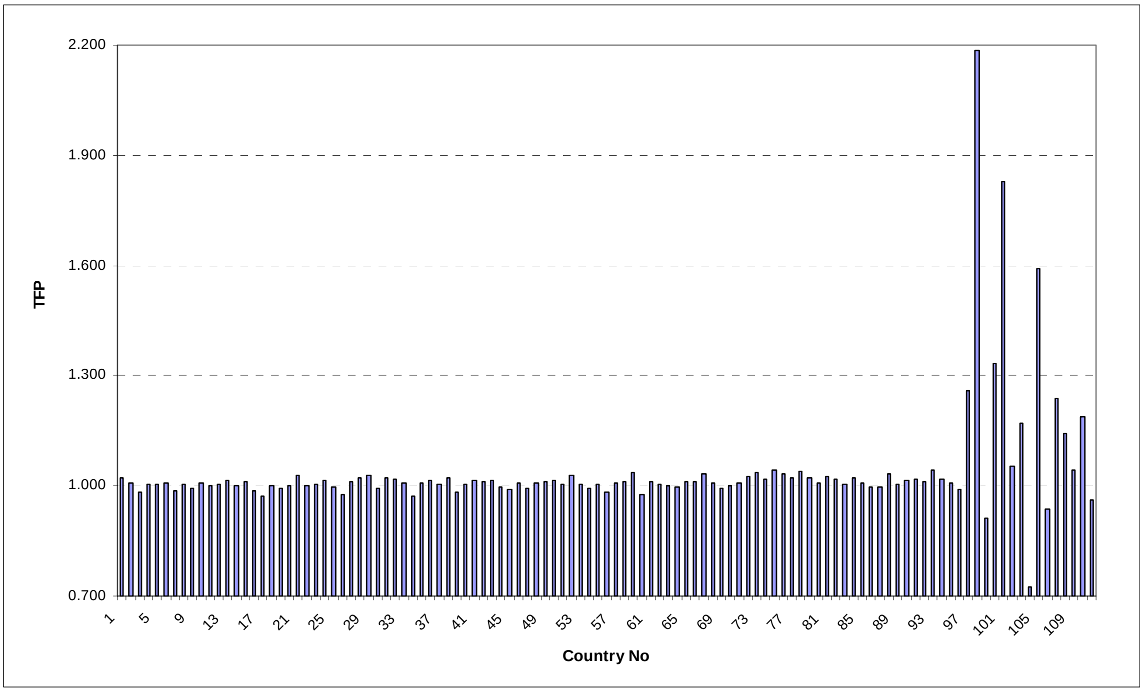


Figure 4.3 amply highlights regional variations in productivity growth performance. Overall, the most impressive region is China, followed by North America. At the other end of spectrum, Africa has the lowest growth performance. Throughout the analysis period, Africa as a whole posted negative cumulative growth until 1996. Figure 4.4 presents annual average TFP for all countries from 1970 to 2001.

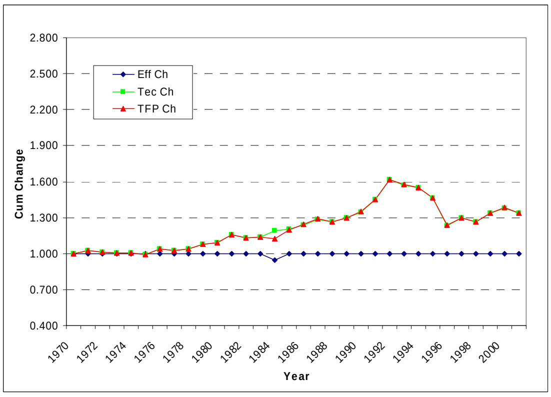
Figure 4.4. Annual average TFP for 111 countries, 1970-2000



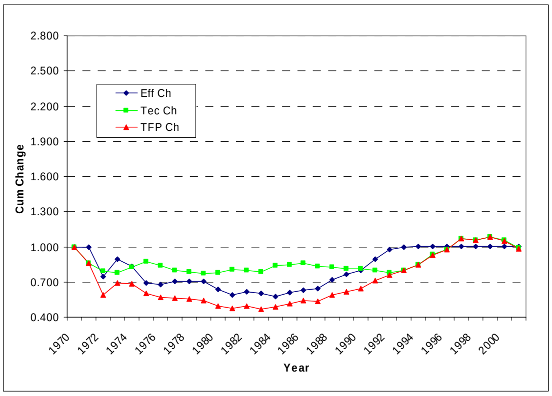
The set of graphs in Figure 4.5 shows TFP growth, technical efficiency and technical change components for selected countries from different regions.

Figure 4.5. TFP growth, technical efficiency change and technical change, selected countries, 1970-2000

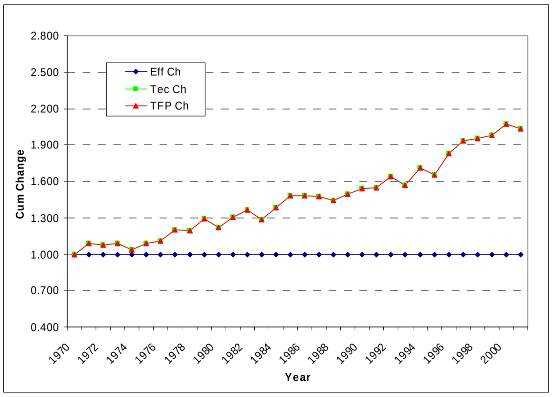
Egypt

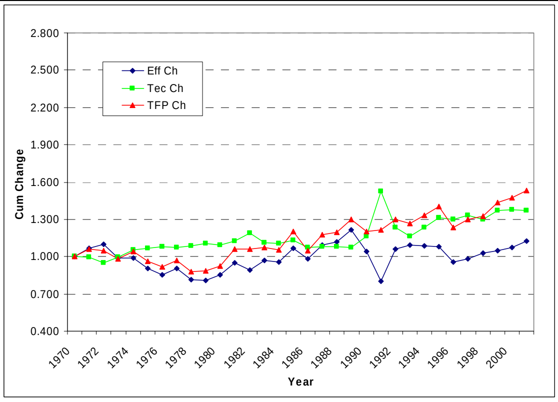


Nigeria



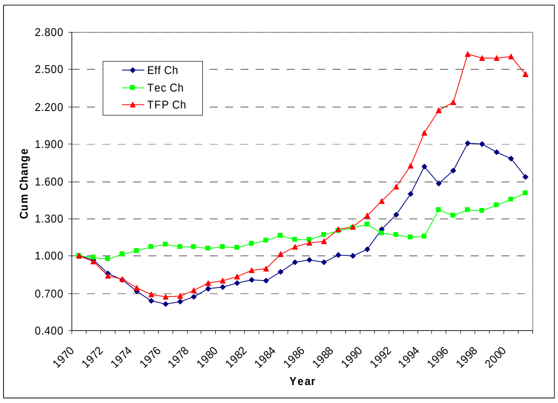
USA	Brazil

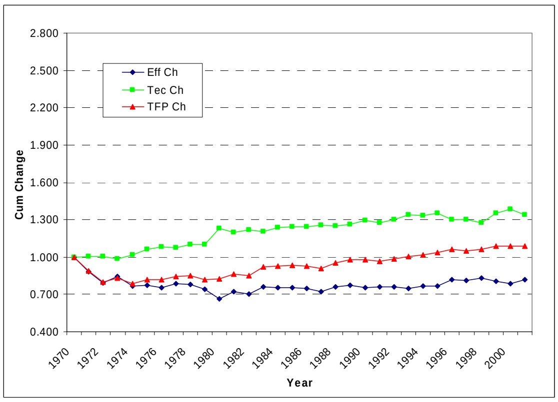




China

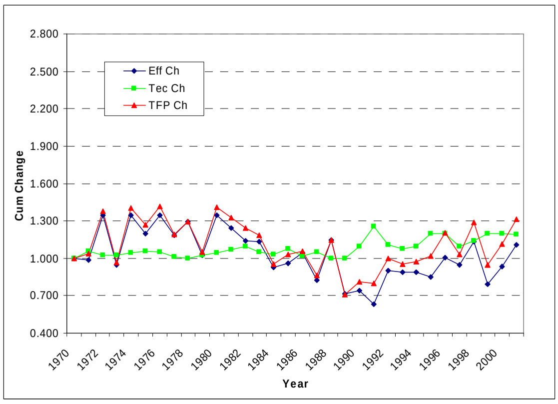
India

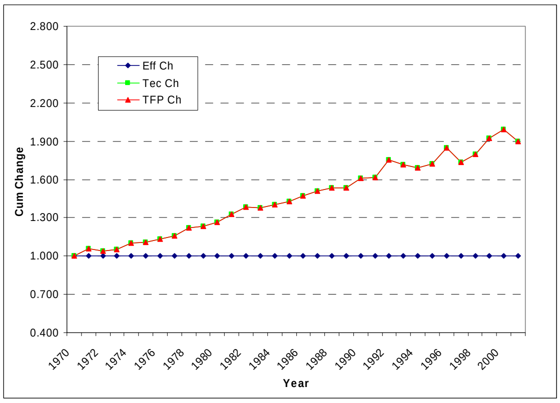




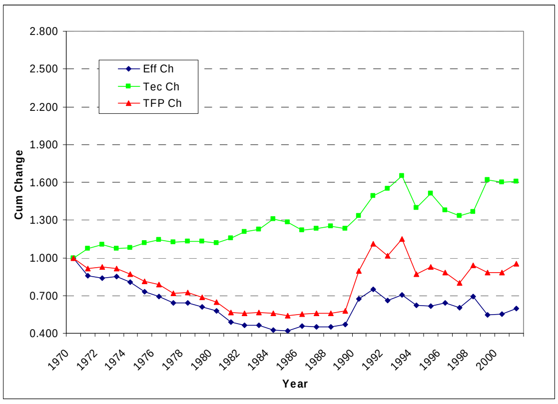
Syria

Netherlands





Poland



These nine countries provide an interesting array of agricultural productivity performances over the analysis period. Throughout 1970 to 2000, the United States and the Netherlands have efficiency change equal to one, suggesting that these two countries have always remained on the technology frontier. Both would clearly belong to the set of "peer" countries that define the production frontier and both posted impressive TFP change, entirely due to technical change. In contrast, Egypt has remained on the frontier but technical change in this section of the technology frontier has not been as impressive: it posted a cumulative growth of under 30 per cent. Another African country, Nigeria, has a very different performance story to tell. Since 1970, cumulative growth has been negative and has only shown marginal improvements in 1996.

The performance of the two Asian giants, China and India, offers a contrasting picture. China, with a very average performance until the mid-1980s, suddenly gathered momentum and efficiency change, technical change and total factor productivity growth accelerated rapidly in the 1990s. The Chinese agricultural sector performance appears to match its performance in the manufacturing sector and its overall GDP growth in the 1990s.

On the other hand, the cumulative growth in total factor productivity in India between 1970 and 2000 is fairly low, resulting in 0.3 per cent average annual growth. The Indian performance deserves closer scrutiny. The low TFP growth is partly attributable to the high base in 1970, which was followed by marked declines in TFP. India's performance would have been more significant had it been measured from a base year of 1972. It would be interesting to devote a closer examination to this country's performance – a task outside the scope of the present report. An equally interesting phenomenon is the main contributor to India's productivity performance – in this case, it is technical change and not the efficiency change that ensured a reasonable performance of Indian agriculture. The technical change component may be due to the so-called Green Revolution. Despite the technical change and associated shifts in the frontier, the efficiency change has not kept pace, resulting in a rather neutral performance for India in terms of total factor productivity growth.

Growth rates for sub-periods

Output and productivity growth rates for the period 1970-2000 at the country, regional and global level are likely to mask some important features of productivity performance in different sub-periods. Table 4.8 reports some summary measures for each of these three decades. Average output and productivity growth rates for all countries for sub-periods are shown in Appendix Table A4.6.

Table 4.8. Annual average growth rates in sub-periods, by region, 1970-2000

Growth rate: 1970-1980

Region	Output	Land	Labour	TFP	Land prod.	Labour prod.
North Africa and the Middle	3.823	0.060	0.202	0.932	3.763	3.639
East	1.438	0.134	1.784	0.827	1.303	-0.322
Sub-Saharan Africa	1.454	0.451	0.734	1.163	1.001	0.721
North America, Australia, NZ	2.608	0.770	0.790	1.028	1.835	1.807
Latin America	2.276	-0.101	0.929	0.933	2.380	1.345
Asia	3.469	1.463	1.952	0.833	1.977	1.488
China	1.880	-0.409	-2.242	1.166	2.300	4.240
Europe	2.327	-0.117	-2.685	0.922	2.448	5.188
Transition countries*						
Mean	**2.218**	**0.129**	**0.248**	**0.963**	**2.091**	**2.007**

Growth rate: 1980-1990

Region	Output	Land	Labour	TFP	Land prod.	Labour prod.
North Africa and the Middle East	4.227	0.567	-0.138	1.110	3.623	4.413
Sub-Saharan Africa	2.033	0.320	2.201	1.095	1.708	-0.158
North America, Australia, NZ	1.499	-0.140	-0.885	1.289	1.642	2.480
Latin America	1.936	0.745	0.721	1.083	1.188	1.212
Asia	2.903	0.928	0.972	1.067	1.978	1.946
China	5.387	1.351	1.957	1.647	3.983	3.365
Europe	0.835	-0.285	-2.130	1.197	1.125	3.048
Transition countries*	0.587	-0.110	-2.420	1.230	0.697	3.086
Mean	**2.103**	**0.396**	**0.277**	**1.203**	**1.702**	**1.859**

Growth rate: 1990-2000

Region	Output	Land	Labour	TFP	Land prod.	Labor prod.
North Africa and the Middle East	1.991	0.610	0.129	1.169	1.380	1.878
Sub-Saharan Africa	3.335	0.155	1.694	1.235	3.187	1.620
North America, Australia, NZ	2.542	-0.182	-1.095	1.327	2.729	3.687
Latin America	2.697	0.236	0.447	1.106	2.463	2.245
Asia	2.906	0.660	0.538	1.112	2.268	2.378
China	6.019	0.759	0.330	1.972	5.221	5.670
Europe	0.405	-0.612	-3.053	1.289	1.027	3.576
Transition countries*	-1.254	-0.109	-1.911	1.217	-1.147	0.691
Mean	**1.827**	**0.126**	**-0.272**	**1.282**	**1.707**	**2.122**

*Growth rate is calculated at the time levels of 1995 and 2000

Table 4.8 has several interesting features. The first point to note is the marginal differences in average annual TFP growth over the three periods under consideration. A rate of growth for the period 1970-80 is the lowest among the three decades, a surprising result.

This is the period immediately after the Green Revolution. The low TFP growth is largely driven by China, sub-Saharan Africa and Asia. The main contributors to growth are Europe and North America and Australia and New Zealand. The last two decades of the twentieth century have been more encouraging in terms of TFP growth, with the last decade posting an annual growth of 1.3 per cent TFP. The main contributor to this remarkable performance is China, whose average growth rates were 1.65 and 2.00 per cent during 1980-90 and 1990-2000 respectively. These TFP growth are consistent with the spectacular growth in the Chinese economy in the past two decades. In both of these sub-periods, all regions have posted reasonable growth in total factor productivity in agriculture. The growth rates observed in agriculture over the past two decades can provide a basis for sustainable growth in these economies.

This chapter has largely focused on levels and trends in total factor productivity, which have been analysed to provide estimates of regional and global productivity in agriculture. The most significant finding is the performance of China in terms of growth in agricultural output as well as total factor productivity. The results also show some signs of catch-up by countries that were found to be inefficient (efficiency levels of less than 0.6) in 1970. This is an encouraging sign.

Chapter 5 continues the story of national, regional and global agricultural performance by investigating the main factors that drive growth in agricultural productivity.

Chapter 5. Factors influencing total factor productivity level differences among countries

Chapters 2, 3 and 4 of this report focused on the measurement of productivity and estimating productivity growth from 1970 to 2000. This chapter (and Chapter 6) present results from the statistical analysis of the results reported in Chapter 4. Two thought-provoking issues emerge: 1.What factors influence agricultural productivity levels and trends? 2. Are institutional factors important? Both issues are of considerable interest. The present report is constrained by time as well as resources. Much of this analysis uses data from secondary sources and also from more easily accessible sources. It is hoped that the results reported here will generate further research in this consequential area.

Explaining growth in productivity is a topic into which considerable research effort has been channelled over the past 50 years. Numerous studies have endeavoured to explain the trends and levels in labour productivity in agriculture, manufacturing and the economy as a whole. A whole body of literature is devoted to systematically accounting for growth in labour productivity using capital intensity, human capital, land quality and other factors (Maddison, 2001). Some recent studies have attempted to measure the influence of information and communication technologies on productivity growth (van Ark, 2000) and the influence of research and development (R&D) expenditure on growth in productivity (Craig et al., 1997; Thirtle et al., 2002).

In a fairly comprehensive and influential study Hayami and Ruttan (1985) elaborate on the role of agriculture in development. They provide estimates of land and labour productivity for a large number of countries and then explore the causes of productivity differentials across countries. Much of their analysis focused on labour productivity and its determinants in the form of changing land/labour ratios and the use of fertilizers and tractors in agricultural production. Their work also addressed the issues of resource constraints and sources of technical change (Hayami 2002) affecting productivity growth.

In sharp contrast to some of the earlier work on productivity in agriculture that emphasizes labour productivity, this report focuses on multi- or total factor productivity growth, which takes into account all the main measurable inputs into agriculture. In addition to labour, the present analysis considers land, fertilizer, tractors and livestock inputs into agricultural production and productivity growth as the Solow residual. Much of the past work on agricultural productivity was based on estimated production functions or index number calculations, whereas this analysis uses non-parametric frontier methods to estimate productivity change over time.

Once the traditional inputs into agriculture are taken into account, any productivity growth (or change) has to be explained using other factors. Recently, Craig et al. (1997) investigated the role of input quality, infrastructure and research in explaining total factor productivity growth. Improvements (in agricultural labour skills, better quality fertilizers, tractors with greater horsepower, enhanced seed varieties) are examples of input quality that have a direct influence on productivity. Pardey et al. (1997) deal with the effect of research outlays on agricultural productivity.

Empirical analysis in this chapter follows the general tradition of explaining productivity level differences across countries using econometric techniques. The factors considered herein to influence TFP follow the traditional approach and are described below.

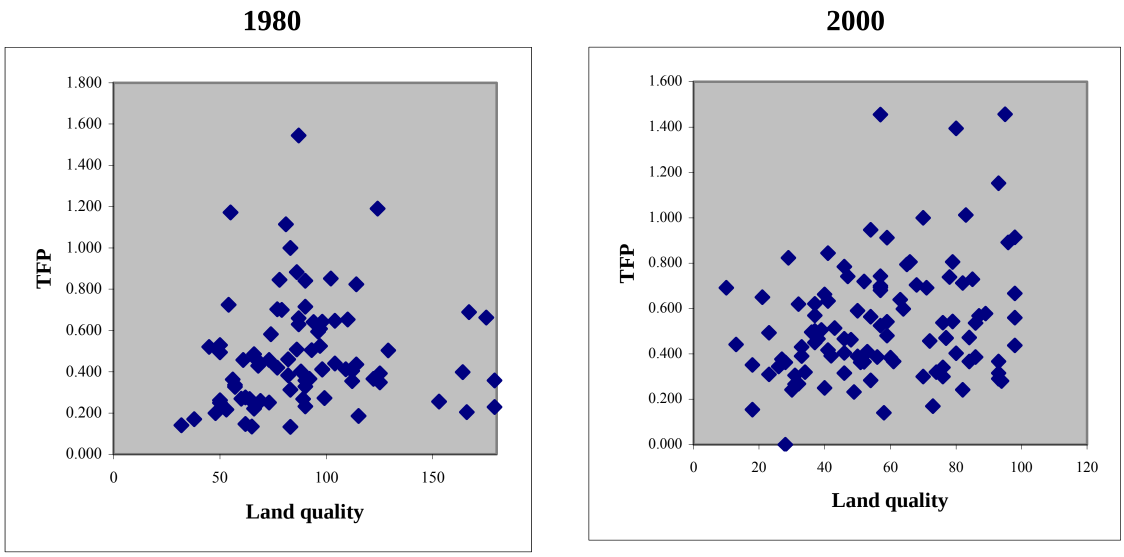
5.1 Factors influencing total factor productivity in agriculture

This report assesses total factor productivity levels in a total of 111 countries (of which a group of countries belonging to the transition economies only appears in the years after 1995). The current analysis covers countries from all regions and from low-, middle- and high-income countries. Thus, explaining productivity level differences is indeed a difficult issue. For purposes of econometric analysis, two levels of analysis are conducted: first, a simple cross-sectional regression analysis for all countries covered in the empirical analysis for the years 1980 and 2000 – which have been selected because of the availability of some measures of land quality that roughly corresponds to these years. Second, a more complex and rich econometric analysis is based on the full data set consisting of a panel of all the countries in North Africa and the Middle East, Asia, Latin America and sub-Saharan Africa over the period 1970-2000. All transition countries have been dropped from the analysis, owing to the unavailability of reliable data. The main reason for restricting the analysis to the above developing countries is to identify the institutional, climatic and other factors that may influence productivity in agriculture. All variables used in the analysis are described briefly below.

Productivity levels: Productivity level of each country, relative to USA (1.00), was determined using the methodology described in Chapter 3 for the year 1970. Using these levels for the base year 1970, productivity levels of each country in subsequent years are calculated using the TFP growth estimates derived using the application of data envelopment analysis. These TFP levels and trends were fully described in Chapter 4.

Land quality: Land quality indices for the years around 1980 and 2000 are obtained from two well-known sources. However, due to differences in the methods used in constructing these indices it is difficult to compare them over time. Figure 5.1 illustrates the nature of the relationship between land quality and productivity levels.

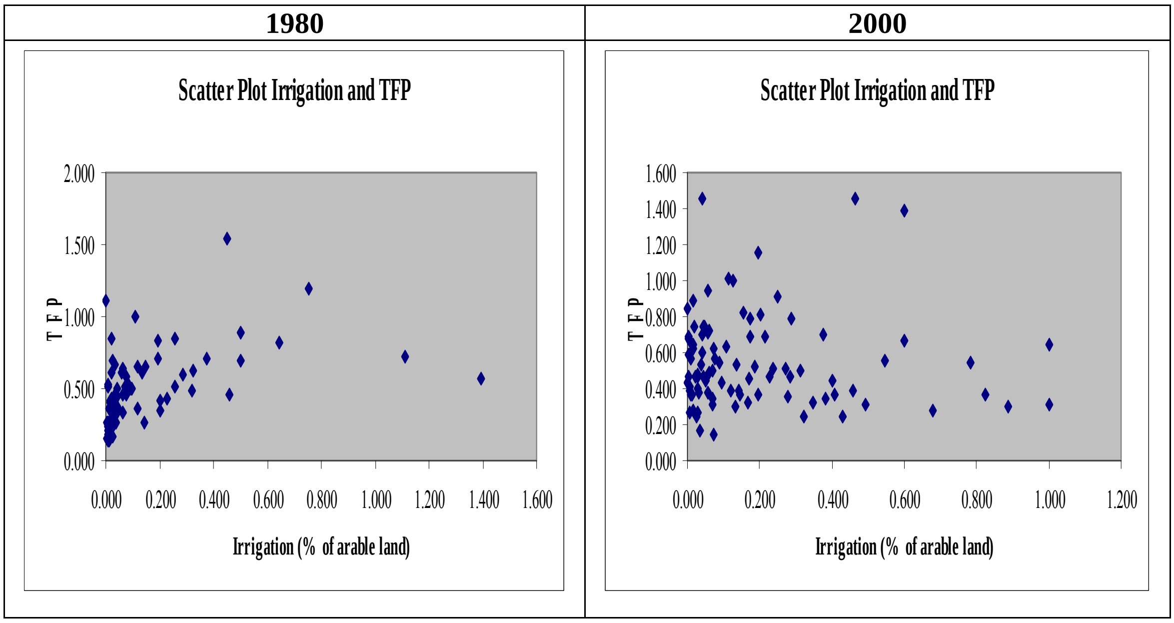
Figure 5.1. TFP and land quality



These figures reveal only a weak relation between land quality and TFP levels. In 1980, there appears to be a clearer positive (but weak) influence on total factor productivity levels. In 2000, an extremely weak relation is observed. More detailed measures of soil quality and climate and water quality are needed in this context.

Irrigation: Another important factor closely associated with productivity is the extent of irrigation used in agriculture. A higher percentage of irrigated land is also likely to reduce variability in agricultural production levels and also reduce volatility. This variable is drawn from the FAO AGROSTAT database. It is defined as the proportion of arable and crop land under irrigation. Figure 5.2 shows the relationship between the irrigation variable and TFP levels.

Figure 5.2. Irrigation and TFP levels, 1980 and 2000

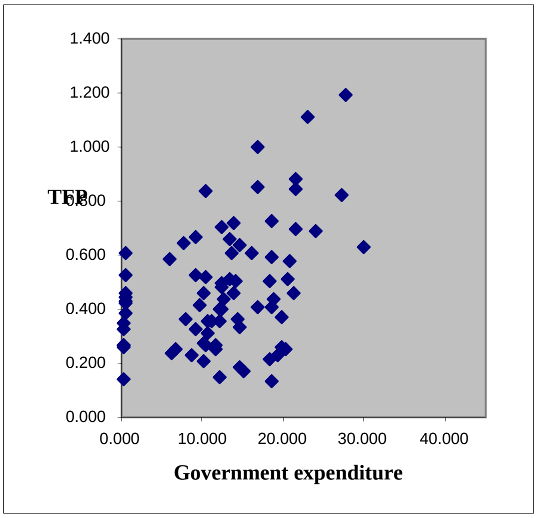
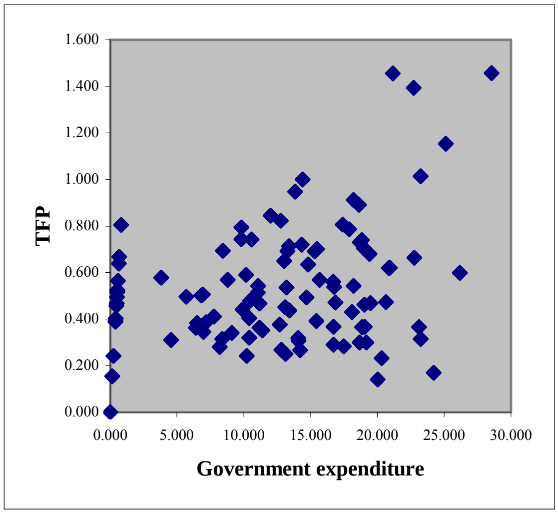


Illiteracy rate: Rates of illiteracy are measured as the percentage of population considered illiterate. Data on this variable is drawn from the World Development Indicators (WDI) of the World Bank (online data bank). This variable is taken as a proxy for education and quality of labour. Higher illiteracy rates imply lower quality of labour input.

Government expenditure as a percentage of GDP: This variable measures government expenditure as a percentage of GDP from the expenditure share. It is expected that government expenditure in developing countries is a principal source of services such as health and education to the general public. Higher government expenditure may also imply better infrastructure facilities and, possibly, expenditure on R&D through funding to specialist research institutes. WDI is again used as a source of data for this variable. Figure 5.3 shows the relationship between TFP levels and government expenditure.

It is clear from these plots that there is a significant positive correlation between these two variables. Countries close to the Y-axis represent developed countries where the share of the government is usually small. Another feature of the graph is greater dispersion of the observed points in 2000.

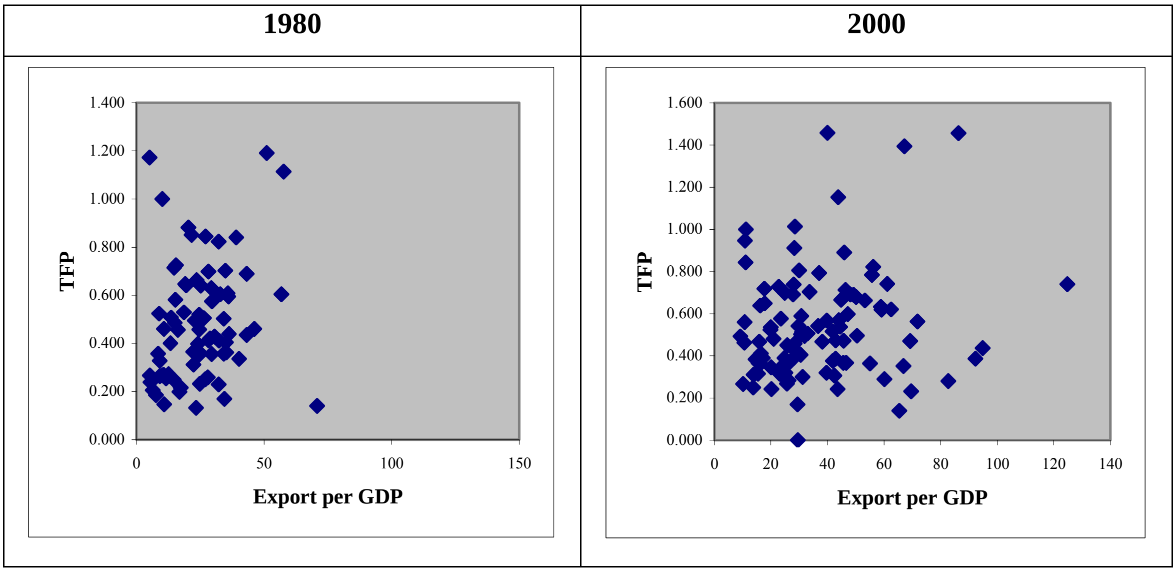
Figure 5.3. TFP and government expenditure as a percentage of GDP, 1980 and 2000

1980	2000
	

Total exports and total trade (exports + imports) as a percentage of GDP: These two variables are used as measures of openness. Total trade as a percentage of GDP is a standard measure of openness. It may be surmised that open economies are more likely to adopt new technologies from abroad. Further openness is an indicator of lack of market distortions. A wide-open economy is expected to have efficient labour and commodity markets leading to a more efficient allocation of resources and productivity. Figure 5.4 shows the correlation between TFP and exports.

These two scatter plots, both drawn to the same scale, show different levels of association. In 1980, a strong positive linear relationship between TFP levels and openness is evident. This relationship is more diffused for 2000 and will manifest in the estimated regression relationships.

Figure 5.4. Exports as a percentage of GDP and TFP, 1980 and 2000



From the above brief discussion, a general observation may be made that the data for 2000 appears to be more variable – partly attributable to the inclusion of transition countries and also the quality of data. Table 5.1 shows the descriptive statistics for the countries used in the analysis.

Table 5.1. Variability: Data for 1980 and for 2000 (2 sets)

Descriptive statistics (1980 data)

Variable Names	Mean	Std	Variance	Minimum	Maximum
TFP	0.49	0.26	0.07	0.13	1.55
Irrigation/arable land	0.13	0.20	0.04	0.00	1.11
Government expenditure	13.35	7.57	57.31	0.14	40.05
Illiteracy rate	31.42	28.07	787.97	1.00	92.05
Land quality	98.97	43.13	1860.20	32.00	224.00
Export/GDP	25.23	13.35	178.14	5.16	70.77

Descriptive statistics (2000 data, includes transition economies)

Variable Names	Mean	Std	Variance	Minimum	Maximum
TFP	0.55	0.26	0.07	0.14	1.46
Irrigation/arable land	0.19	0.23	0.05	0.00	1.00
Government expenditure	13.65	6.50	42.22	0.24	28.54
Illiteracy rate	18.05	21.61	466.92	0.20	84.04
Land quality	56.71	22.51	506.88	10.00	98.00
Export/GDP	36.23	20.40	416.20	9.16	124.80

Descriptive statistics (2000 data, includes transition economies)

Variable Names	Mean	Std	Variance	Minimum	Maximum
TFP	0.56	0.27	0.07	0.14	1.46
Irrigation/arable land	0.19	0.22	0.05	0.00	1.00
Government expenditure	13.42	6.61	43.75	0.24	28.54
Illiteracy rate	20.15	21.96	482.31	0.44	84.04
Land quality	56.49	22.83	521.11	10.00	98.00
Export/GDP	34.44	19.93	397.37	9.16	124.80

5.2 Explaining TFP levels using period regressions

This section presents regression results for the years 1980 and 2000. These years have been selected since 1980 represents the immediate post-era of the Green Revolution and 2000 belongs to the era of globalization. The following section presents results from panel data regression equations. The panel data analysis can accommodate considerably more phenomena that influence total factor productivity in agriculture.

Models 5.1, 5.2, 5.3 and 5.4 show estimates of regression coefficients and associated t-ratios and elasticities computed at mean values of the variables involved. These regressions are designed to show the robustness of the results to changes in the specification of the model. Variations in models are due to inclusion/exclusion of variables such as irrigation, exports as a percentage of GDP or trade as a percentage of GDP.

Model 5.1. Regression (1980, with irrigation)

VARIABLE	Without export/GDP			With Export/GDP		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Irrigation/arable land	0.264	1.803	0.070	0.276	1.887	0.073
Government expenditure	0.011	3.420	0.312	0.010	2.937	0.279
Illiteracy rate	-0.003	-3.540	-0.221	-0.003	-3.276	-0.207
Land quality	0.000	0.270	0.029	0.000	0.310	0.034
Export/GDP				0.002	1.147	0.107
Constant	0.397	4.325	0.810	0.350	3.496	0.715
R-squared			0.506			0.515
R-squared adjusted			0.477			0.479

The statistical quality of the model in terms of R^2 is quite good. For a cross-sectional regression, an R^2 value in excess of 0.5 is very good. Model 5.1 shows that irrigation, government expenditure and illiteracy rates all have significant influence on TFP levels. An increase in the percentage of arable irrigated land improves TFP levels. Government expenditure has a positive and significant influence on TFP levels. This is an important finding since government expenditure, particularly in developing countries, could be used in education, provision of infrastructure such as roads, and also outlays on agricultural research and development. All these categories of government expenditure have the potential to influence productivity through improvements in the adoption of existing technology, as well as providing access to new technology. Government expenditure on health is also a main source of medical services in developing countries. Thus the strong relationship between government expenditure and TFP levels is indeed consistent with expectations arising out of the existing theories of development.

Rates of illiteracy have significant influence on TFP levels. A rise in illiteracy reduces TFP levels – and shows that it is important to invest in education. This finding is quite robust to various specifications and subsets of data used in the present analysis.

The exports variable (exports as a percentage of GDP) is also significant with a positive sign. Since the export variable is taken as a proxy for "openness" this implies that countries with more open economic policies have higher TFP levels in agriculture. This may indicate that the more open the country, the greater the likelihood of technology transfer.

From a theoretical standpoint, a surprising result in this regression is the insignificance of the land quality variable. Land quality and irrigation may be closely related, resulting in a degree of multi-co-linearity.

Model 5.2. Regression (1980, without irrigation)

VARIABLE	Without export/GDP			With Export/GDP		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Government expenditure	0.014	4.270	0.370	0.013	3.802	0.344
Illiteracy rate	-0.004	-4.973	-0.275	-0.004	-4.730	-0.266
Land quality	0.000	-0.140	-0.015	0.000	-0.121	-0.013
Export/GDP				0.002	0.993	0.094
Constant	0.451	5.117	0.920	0.412	4.275	0.841
R-squared			0.483			0.490
R-squared adjusted			0.461			0.461

Model 5.2 estimates still show that land quality has no influence on productivity levels across countries. This is not entirely surprising since the scatter plots actually showed no significant correlation. This may in part be due to the methodology used in the construction of land quality itself.

The following regressions refer to 2000, a year in which several new transition countries appear. Regressions are run with and without irrigation for 2000.

The value of R^2 is considerably lower than the regressions reported for 1980. This may be due to the inclusion of the transition economies and, to check this, separate regressions were run with and without the transition economies. A marginal improvement in R^2 is observable.

Model 5.3. Regression (2000, includes transition economies, with irrigation)

VARIABLE	Without export/GDP			With Export/GDP		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Irrigation/arable land	0.026	0.240	0.009	0.036	0.327	0.012
Government expenditure	0.010	2.330	0.237	0.010	2.313	0.236
Illiteracy rate	-0.003	-2.533	-0.105	-0.003	-2.076	-0.092
Land quality	0.001	0.883	0.109	0.001	0.879	0.108
Export/GDP				0.001	0.762	0.067
Constant	0.416	4.189	0.750	0.371	3.207	0.669
R-squared			0.203			0.208
R-squared adjusted			0.166			0.162

Model 5.4. Regression (2000, excludes transition economies, with irrigation)

VARIABLE	Without export/GDP			With Export/GDP		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Irrigation/arable land	0.112	0.937	0.037	0.130	1.079	0.043
Government expenditure	0.011	2.525	0.259	0.011	2.498	0.256
Illiteracy rate	-0.004	-2.883	-0.137	-0.003	-2.315	-0.117
Land quality	0.001	0.970	0.124	0.001	1.010	0.129
Export/GDP				0.002	1.163	0.102
Constant	0.404	3.839	0.717	0.331	2.708	0.588
R-squared			0.263			0.276
R-squared adjusted			0.225			0.229

All results are similar to those observed for 1980, the only difference being that the irrigation variable is insignificant in 2000 regressions even though it has the right sign. Government expenditure and illiteracy are significant with expected signs. Export variable is less significant, though with a correct sign.

Models 5.5 and 5.6 use *trade, exports plus imports* as a percentage of GDP as an explanatory variable, instead of just exports.

Model 5.5. 1980 (with trade, with and without irrigation)

VARIABLE	With Irrigation			Without Irrigation		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Irrigation/arable land	0.276	1.913	0.073			
Government expenditure	0.009	2.641	0.253	0.012	3.460	0.317
Illiteracy rate	-0.003	-3.449	-0.212	-0.004	-4.923	-0.270
Land quality	0.000	0.282	0.030	0.000	-0.152	-0.016
Trade/GDP	0.002	1.753	0.192	0.002	1.631	0.182
Constant	0.325	3.285	0.665	0.385	4.026	0.787
R-squared			0.527			.502
R-squared adjusted			0.493			0.473

Model 5.6. 2000 (with trade and including transition economies)

VARIABLE	With Irrigation			Without Irrigation		
	Coeff.	t-ratio	Elasticity	Coeff.	t-ratio	Elasticity
Irrigation/arable land	0.036	0.326	0.012			
Government expenditure	0.009	2.288	0.234	0.009	2.281	0.227
Illiteracy rate	-0.003	-2.208	-0.096	-0.003	-2.226	-0.096
Land quality	0.001	0.882	0.109	0.001	0.921	0.113
Trade/GDP	0.000	0.680	0.064	0.000	0.646	0.060
Constant	0.375	3.234	0.677	0.386	3.489	0.696
R-squared			0.207			0.206
R-squared Adjusted			0.161			0.170

Models 5.5 and 5.6 are very similar to those models in which exports are used as an explanatory variable. In 1980, trade has a strong positive effect on productivity levels. Government expenditure and illiteracy continue to be significant. Land quality and irrigation are both insignificant in these regressions.

In sum, the preliminary regression reported above has the following main implications.

- There is a change in the relationship between TFP levels and various explanatory variables over the period 1980 to 2000.
- In both years, government expenditure and illiteracy seem to have an influence on productivity.
- Irrigation has a positive impact on productivity in all 1980 regressions but turned out to be insignificant in all 2000 year regressions.
- The land quality variable is significant in any of the regressions, largely because these measures may not be capturing differences in soil quality, etc.
- Openness, as measured by exports or trade as a percentage of GDP, has a significant positive influence on productivity levels in 1980, but less significant in 2000 regressions.

5.3 Role of institutional, political and macroeconomic variables in Asia, Africa and Latin America

Analysis in Section 5.2 included all the countries and is a standard analysis of some of the general factors influencing productivity levels. However, these regressions cannot be used to draw any conclusions on the role of geographical and institutional factors that might explain differences in productivity levels in different countries and in different years. The analysis also focuses on Asia, Africa and Latin America – three regions consisting predominantly of low-income countries. It is surmised that geographical, institutional and political factors could be as relevant as some of the macroeconomic variables in explaining productivity levels in developing countries.

This section undertakes to explain total factor productivity performance in agriculture by considering a number of economic, geographical and institutional factors. Our dependent variable is the level of total factor productivity (TFP) in agriculture (see Chapter 4) measured for 52 low- and middle-income developing countries. High-income and transition economies are excluded as well as several countries for which limited data were available (Angola, Burundi, Cambodia, Chad, Cuba, Guinea, Iraq, Iran, South Korea, Laos, Mongolia, Myanmar, Nepal, Rwanda, Saudi Arabia and the Sudan). In order to explain the cross-country variation in agricultural productivity a range of measures (largely from the new growth literature) are considered. Table 5.2 provides a summary. These variables were originally collated in Headey (2003) for cross-country growth regressions. Many of them perform admirably well in accounting for variation in agricultural total productivity performance.

Some standard macroeconomic indicators, such as Gross Domestic Investment (GDI), Central Government Consumption (GOVCON), Total Trade over Gross Domestic Product (TRADE), Foreign Direct Investment (FDI) – all measured in proportion to GDP per capita (GDP) – are described below. These variables (all from the World Bank's *World Development Indicators*), are normally expected to be positively correlated with agricultural productivity, provided there are no substantial urban biases in terms of public or private expenditure. In particular, higher levels of government expenditure would normally be associated with better provision of physical infrastructure, but also investments in human capital (see below) and investment in R&D. Similarly, private capital flows (the private component of GDI as well as FDI) may include flows of technology embodied in physical capital or in foreign technical expertise. And, likewise, the TRADE variable – since the ability or propensity of a country to import foreign goods allows it to access foreign technology. TRADE may also be an indicator of a country's policies and is often used in this capacity (i.e. as a measure of openness) in growth empirics.

Table 5.2. Data summary of variables

Variable	Code	Data source	Notes
The ratio of irrigated land to arable land	IRRIGATED	AGROSTAT database of the Food and Agriculture Organization, Rome	
The air distance from a country's capital city to the nearest core city (Amsterdam, New York or Tokyo)	AIR DISTANCE	ArcWorld Supplement Database. All geographical data is available at the Harvard University Centre for International Development website	
Proportion of population in tropics	TROPICAL	GIS population database, ArcWorld Supplement Database. All data is available at the Harvard University Centre for International Development website	
The change in malaria incidence from 1965 to 1994	MALARIA	GIS population database, ArcWorld Supplement Database. All data is available at the Harvard University Centre for International Development website	
War intensity	WAR	POLICON III Database.	"A two+one level assessment of the number of battle-related casualties per year in the conflict period covered by the observation, plus a special level indicating conflict history in low-intensity conflicts." Strand, Wilhelmsen and Gleditsch (2003
The degree of democracy less the degree of autocracy	POLITY	POLITY IV Project: Political Regime Characteristics and Transitions, 1800-1999 Marshall and Jaggers (2003)	"Institutionalized Democracy: democracy is conceived as three essential, interdependent elements: the institutionalization of choice, constraints on the executive and civil liberties (Marshall and Jaggers, 2003)
Institutional quality	ICRG3	PRS Group's IRIS III data set (see Knack and Keefer 1995)	Revised version of variable. Computed as the average of the three components still reported after 1997
South Asia	POP	World Bank 2003	Dummy for countries in South Asia
Sub-Saharan Africa	SSA	World Bank 2003	Codes nations in the southern Sahara as sub-Saharan
East Asia	EASIA	World Bank 2003	Dummy for Countries in East Asia, including Papua New Guinea

Variable	Code	Data source	Notes
Population	POP	World Bank 2003	Natural logarithm
Exports plus imports over GDP (%)	TRADE	World Bank 2003	
The proportion of the population living in rural areas	RURAL	World Bank 2003	
Gross Domestic Product	GDP	World Bank 2003 in current local currency for all ratios, Summers-Heston Penn World Tables when used separately, in 1985 US$.	
Illiteracy rates (%)	ILLITERACY	World Development Indicators	
The ratio of dependents (below 15 years and above 65) to working age people (15 to 65)	AGEDEP	World Development Indicators	
Gross Domestic Investment over GDP (%)	GDI	World Development Indicators	
Government Consumption over GDP (%)	GOVCON	World Development Indicators	
Foreign Direct Investment over GDP (%)	FDI	World Development Indicators	

Descriptive statistics for key variables are presented in Table 5.3.

Table 5.3. Descriptive statistics for key variables

NAME	N	MEAN	STD. DEV.	MINIMUM	MAXIMUM
TFP	*1560*	*0.51*	*0.23*	*0.13*	*2.12*
TRADE	1496	50.35%	24.16	3.68	221.54
ILLITERACY	1560	39.21%	24.61	2.62	93.28
IRRIGATED	1560	13.19%	18.94	0.11	100.00
GDP	1542	2114	1591	185	8257
GDI	1502	20.97%	7.15	-5.74	52.10
FDI	1511	1.09%	1.66	-6.99	13.67
GOVCON	1481	12.60%	4.54	2.98	43.48
WAR (0,3)	1560	0.61	1.05	0.00	3.00
POLITY (-10,10)	1507	-0.82	6.91	-10.00	10.00
AGEDEPEND	1552	0.84	0.14	0.46	1.15
RURAL	1560	2.07%	10.40	0.10	82.60
AIRD (KM)	1560	5108	2079	1675	9080
TROPICAL	1560	0.39%	0.36	0.00	1.00
□MALARIA (% points)	1560	-0.04	0.18	-0.94	0.48
ICRG3 (1,6)	1551	2.61	1.05	0.00	5.28

Data was also collected on institutional and political factors. In particular we considered a common measure of the quality of government from the Inter-Country Risk Guide (as used in Knack and Keefer, 1995), a private firm which collects data on governance characteristics as measured by the subjective assessment scores of field experts. An equally weighted average of three measures – the quality of bureaucracy, the rule of law, and the honesty of government (lack of corruption) – is used (ICRG3). Second, we considered the effect of the political regime on agricultural productivity. The indicator of democracy is again formed by a subjective assessment of the characteristics of political regime. Ratings (from 1 to 10) of the prevalence of both democratic institutions and autocratic characteristics are formed and the latter is then subtracted from the former to indicate "polity" (POLITY), which is a good-governance measure. Finally, war intensity (WAR) is considered – a measure (from 0 to 3) largely based on the number of war deaths, from the *POLICON III* database. All three indicators would normally be expected to be positively correlated with total factor productivity.

Next is the role of human capital in agricultural technology. Human capital indicators include the illiteracy rate (ILLIT) as an indicator of educational attainment; infant mortality (MORTALITY); and the change in malaria prevalence from 1966 to 1994 (□MALARIA) as measures of health. Higher levels of human capital are expected to posses a strong, positive correlation with agricultural productivity. In essence, we are seeking to account for *effective labour*; that is, the raw quantity of labour augmented by the quality of the labour force.

We included a number of demographic and geographical measures, including several proxies for land quality. In particular the proportion of the population living in rural areas (RURAL), the age dependency ratio (the ratio of non-working age to working age people (AGEDEPEND), the proportion of arable land which is irrigated (IRRIGATED), the proportion of the population living in the tropics (as an indicator of soil quality, labour productivity and the prevalence of tropical diseases, TROPICAL) and, finally, an indicator of transport costs and geographical isolation, as measured by the air distance from a country's capital city to one of three core economies (AIR DISTANCE) – Japan, the Netherlands or the United States. Finally, we also used dummy variables (a fixed effects model) for continents. Thus we have Sub-Saharan Africa (SSA), East Asia (EASIA), South Asia (SASIA) and Latin America and the Caribbean (LATAM). It should be noted that these need not be considered geographical measures per se. Continental dummies could, for example, capture a number of (fixed) institutional effects.

These variables capture labour quality (as per human capital indicators), investment capacity, as well as land quality and transport costs. A greater rural population, for example, may be a measure of "surplus labour." For example, the well-known Lewis model of 1956 suggests that an abundance of rural labour results in a low or zero marginal product, so that extra workers contribute very little to increases in output. If labour quantity and labour quality are substitutes in the production process, then labour abundance will imply that investment in labour (e.g. education) has a high opportunity cost. The ratio of non-working age to working-age inhabitants is a measure of labour quality (very young and very old inhabitants are expected to be less productive) but also of the inability of farmers to save and reinvest. Cross-country regressions on savings rates have found this to be a robust correlation. According to Sachs and Malaney (2002), "Inhabitants of tropical countries are subject to nefarious tropical diseases and warmer climates." Tropical land is also less fertile, frequently subject to more volatile climatic conditions and may experience faster depreciation of capital. Finally, higher transport costs (AIR DISTANCE) indicate reduced access to imports and foreign investment, as well as an obstacle to successful export promotion and, therefore, agricultural incentives.

Looking at the regressions results in Table 5.4, regression 1 runs a large, general model, while regression 2 is a more specific and parsimonious derivative of 1. Regression 3 includes fixed effects (dummy variables) for continents, a common procedure in cross-country panel regressions. However, their inclusion makes very little difference to the overall performance of other variables in the model. The signs on the continental dummies indicate that agricultural productivity is, on average and after accounting for other factors, higher in Latin America and the Caribbean, sub-Saharan Africa and East Asia. The insignificance of the coefficient on South Asia confirms this report's earlier results, in particular the relatively poor performance of Indian agriculture (see Chapter 4). Lastly, regressions 4, 5 and 6 focus on sub-samples for each decade.

In general, these regressions perform quite well for yearly data of this nature, typically explaining about 35 per cent of the variation in total factor productivity levels for agriculture. A number of significant results emerge:

- Total factor productivity is, as expected, adversely influenced by the underdevelopment of human capital: illiteracy rates, high levels of age dependency and malaria.
- A number of measures of land quality and transport costs indicate the crucial impact of geographical disadvantage on total factor productivity. In particular, tropical countries which are isolated from the core economies have, on average, lower levels of agricultural productivity.

The above results seem surprising on examining the role played by macroeconomic and institutional factors.

- In particular, higher levels of domestic investment and government consumption are negatively associated with agricultural productivity, as is the governance measure (ICRG3).
- Interestingly, only foreign direct investment seems to have a positive effect on agricultural productivity, evidently capturing the transfer of superior foreign capital and technical know-how.
- Finally, the POLITY and WAR measures do not appear to systematically determine agricultural productivity, although regression 6 (for the 1990s only) appears to imply that more democratic political regimes were beneficial for agricultural productivity, while the complete opposite is true for the 1970s.

Are these results plausible? An examination of the data reveals that they are. Many of the best performers in terms of agricultural TFP do not perform well on the ICRG3, POLITY and WAR measures (see Chapter 4). Perhaps more troubling is the negative correlation between GDI, government consumption and TFP levels. Several points are worthy noting. First, this correlation holds net of the effect of other variables in the model such as illiteracy rates, which are largely a function of government expenditure. Second, as mentioned earlier, many countries that reportedly performed well in agricultural productivity have performed poorly in terms of increasing political freedom, cleaning up corruption, and improving their macroeconomic policies. Third, a different sample from Chapter 3 is being used so that the result, though counterintuitive, is not necessarily inconsistent with other findings in Section 5.2 in this chapter. Fourth, we must be willing to consider the potential for urban biases in the composition of public and private investment as well as government consumption. Policies promoting industrialization, import substitution, and urbanization may all discriminate against the rural sector. Such discrimination is the result of both early development thinking (e.g. the Lewis (1966) model of industrialization), but also of the biases inherent in political systems. Rural populations are typically dispersed over a wide geographical area, geographically isolated, less educated and often closer to subsistence standards of living. As such, their political leverage against the predominantly urban political elite is greatly reduced.

Table 5.4. Regressions on agricultural total factor productivity

Reg. No.	1	2	3	4	5	6
Sample	Full	Full	Full	1970-79	1980-89	1990-99
Observations	1400	1460	1460	485	485	450
R^2	0.32	0.31	0.39	0.30	0.32	0.47
R_a^2	0.31	0.31	0.38	0.28	0.31	0.45
TRADE	0.05	0.06	0.01	0.02	0.11	0.06
	(1.92)*	(2.42)**	(0.50)**	(0.31)	(2.00)**	(1.85)*
ILLITERACY	-0.36	-0.37	-0.19	-0.39	-0.37	-0.37
	(12.52)**	(15.05)**	(6.08)**	(8.85)**	(7.23)**	(8.44)**
ICRG3	-2.20	-1.98	-1.41	0.13	0.05	-0.74
	(3.69)**	(3.64)**	(2.66)**	(0.15)	(0.06)	(0.91)
GDI	-0.58	-0.55	-0.24	-0.31	-0.87	-1.08
	(6.52)**	(6.52)**	(2.85)**	(2.27)**	(5.10)**	(7.19)**
GOVCON	-0.38	-0.35	-0.21	-0.41	-0.56	-0.20
	(3.03)**	(2.91)**	(1.80)*	(1.69)*	(2.79)**	(0.97)
FDI	2.94	2.94	2.62	3.10	3.93	2.94
	(8.23)**	(8.46)**	(7.93)**	(4.05)**	(3.82)**	(7.13)**
TROPICAL	-0.06	-0.07	-0.17	-0.04	-0.03	-0.11
	(3.11)**	(4.27)**	(8.75)**	(1.42)	(1.18)	(4.32)**
MALARIA	-0.18	-0.17	-0.10	-0.14	-0.20	-0.15
	(5.99)**	(5.98)**	(3.60)**	(3.02)**	(3.85)**	(3.29)**
RURAL	-0.22	-0.21	-0.34	-0.39	-0.16	0.09
	(4.16)**	(3.99)**	(6.21)**	(5.11)**	(1.68)*	(0.97)
AIR DISTANCE	-0.14	-0.14	-0.18	-0.07	-0.17	-0.33
	(4.72)**	(4.88)**	(5.12)**	(1.47)	(3.23)**	(7.46)**
POLITY	-0.07	--	--	-0.68	0.20	0.53
	(0.79)	--	--	(4.86)**	(1.24)**	(3.82)**
IRRIGATED	0.01	--	--	--	--	
	(0.39)	--	--	--	--	--
WAR	-0.63	--	--	--	--	
	(1.15)	--	--	--	--	--
AGEDEPEND	-0.08	--	--	--	--	--
	(1.33)	--	--	--	--	--
SSA	--	--	0.18	--	--	
	--	--	(6.48)**	--	--	--
EASIA	--	--	0.18	--	--	
	--	--	(7.99)**	--	--	--
SASIA	--	--	0.01	--	--	
	--	--	(0.54)	--	--	--
LATAM	--	--	0.23	--	--	
	--	--	(11.41)**	--	--	--
CONSTANT	0.97	0.89	0.66	0.79	0.90	1.02
	(16.71)**	(28.80)**	(17.65)**	(13.42)**	(14.12)**	(18.42)**

(**) denotes significance at the 5 per cent level or better.

Finally, let us examine the elasticities of TFP with respect to those variables which are not fixed in time. Table 5.5 indicates that illiteracy rates have the largest effect on TFP levels. For example, a 1 per cent decrease in illiteracy will increase TFP in agriculture by 0.28 per cent, implying that the role of government in education may be vitally important for agricultural productivity and rural poverty. Worth noting here is the strong negative effect of increased investment and government consumption, a relationship which is perhaps unsatisfactorily explained by economic theory. The equal, but relatively small effects of trade and foreign direct investment may be telling a very similar story. Taken together, then, the role of cross-border flows, particularly in terms of technology transfers, appears to be an important determinant of agricultural productivity.

Table 5.5. Elasticity at means (from Regression 2, Table 5.4)

VARIABLE NAME	ELASTICITY AT MEANS
TRADE	0.06
ILLITERACY	-0.28
GDI	-0.23
GOVCON	-0.09
FDI	0.06

The role of geographical factors: with the exception of the reduction in malaria prevalence, the geographical variables previously considered are fixed. Limão and Venables (2000), however, consider transport costs as a function both of geographical factors and the quality of infrastructure. They show that a deterioration of infrastructure from the median to the 75th percentile raises transport costs by 12 percentage points and reduces traded volumes by 28 percentage points. Their analysis of African trade flows, in particular, indicated that this continent's relatively low level of trade is largely due to poor infrastructure. Furthermore, the above results indicate that countries which significantly reduce the prevalence of malaria can pave the way for significant improvements in agricultural productivity

Consider the contrasting stories of two countries, Bangladesh and Malawi, as shown in Figures 5.5 and 5.6. Bangladesh had, by 1994, managed to cut malaria prevalence to a quarter of its 1966 level, in contrast to Malawi, where malaria prevalence has doubled since 1966.

Figure 5.5. Malaria prevalence, Malawi and Bangladesh, 1966 to 1994

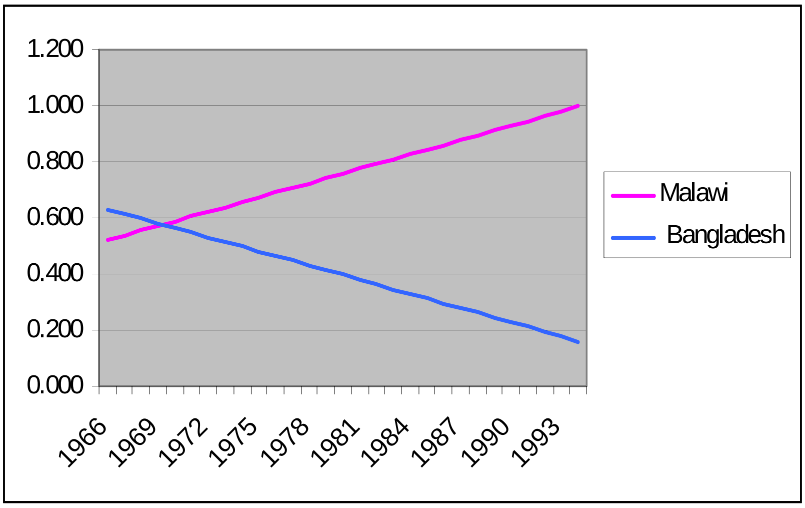
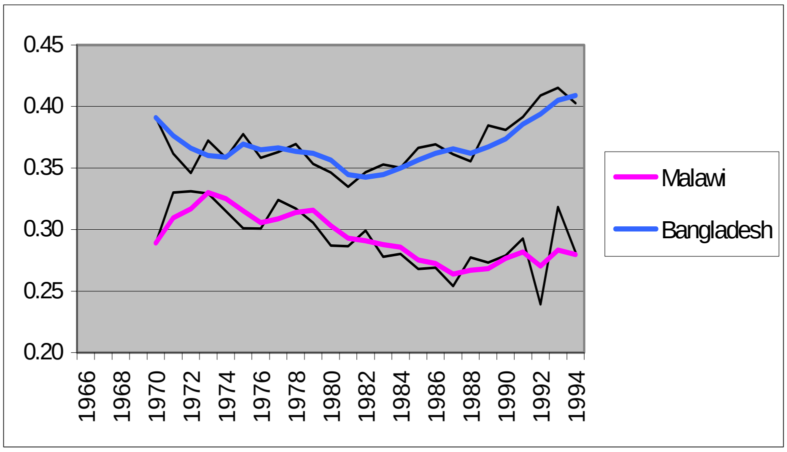


Figure 5.6. TFP growth, Malawi and Bangladesh, 1966 to 1994



This dramatic divergence in performance indicates that government health expenditure may be a vital ingredient in increasing agricultural productivity.

5.4. Conclusions

In sum, these results paint an interesting picture of the determinants of agricultural productivity. Many factors which determine agricultural productivity, particularly the quantities of land and labour, but also the geography of the land in terms of climate and distance to the core economy, are relatively fixed. Thus, sustainable rural development will not come through additions to these inputs. Rather, continued developed comes through increases in the quality of labour and land, and through decreasing transport costs through better infrastructure (i.e. roads, ports). These results suggest several avenues by which developing countries may increase their total factor productivity in the rural sector:

- investment in human capital through education and health outlays
- attracting foreign direct investment and promoting greater trade and
- improving physical infrastructure for the rural sector.

Chapter 6, arguing for a somewhat broader view of the conventional indicators of poverty, examines the question of whether or not the incidence of poverty is determined by agricultural productivity levels in developing countries.

Chapter 6. The poverty-agricultural productivity nexus

This chapter examines the relationship between agricultural growth and rural poverty in developing countries. It argues that "conventional indicators of poverty and its trends over time present the poor as a uniform mass – a statistical entity. Such indicators obscure the varying identities of the poor and the different reasons they are poor" (Bernstein, 1992, p. 26). The present report takes a somewhat broader view to examine the economic and social factors that lead to and perpetuate poverty. Emphasis is placed on the institutional aspects of governance and corruption.

Given that the bulk of the poor in the developing world live in rural areas and that the agro-rural sector is the predominant provider of employment, levels of agricultural productivity growth are likely to have a significant impact on poverty. While the existing literature provides sound theoretical reasoning, the empirical evidence on the poverty-agricultural productivity nexus is piecemeal and concentrates primarily on single-country analysis (Thirtle et al., 2002). In contrast, the present report undertakes a cross-country study with World Bank data on $1 a day and $2 a day poverty and income inequality data, also drawn from other sources and supplemented where possible.

6.1. Identifying the poor[20]

According to the *World Development Report 1990* (World Bank, 1990, p. 26) poverty is the "inability to attain minimal standard of living", measured in terms of basic consumption needs or the basic income to satisfy such needs. The expenditure necessary to attain this minimal standard is the basis used to define the poverty line. This definition, based on consumption, is concerned primarily with physical measures of relative well-being[21,22] and comprises:

(i) the amount needed for food and other basic necessities to a minimal living standard;

(ii a further amount (varying from country to country) that reflects the cost of participating in the daily life of society.

Criterion ii) tend to make poverty measurement and inter-country comparisons more difficult (given the subjectivity involved) while criterion i) is broadly consistent with the definitions that government policy-makers and donor agencies employ. However, Bernstein (1992, p. 18) points out: "The virtually exclusive concentration of governments and development agencies on consumption and income-based definitions of poverty means that they exaggerate this aspect at the expense of others." Such an emphasis also portrays a narrower definition of economic development as reflected in its quantitative dimension (growth) rather than its wider definition of both quantitative and qualitative dimensions (growth plus change). As Meier (1984, p. 6) rightly avers "Economic development is much more than the simple acquisition of industries. It may be defined as nothing less than the upward movement of the entire social system" (see also for example, Myrdal 1968, p. 869). Economic development may also be interpreted as the attainment of a number of ideals of modernization (raising productivity, social and economic equalization) to ameliorate the conditions that have perpetuated underdevelopment (Black, 1966). This broader view of economic development in the developing world is also echoed by Goulet (1971) and Todaro (1992).

Based on a longitudinal study of socio-economic changes in the rural areas of the western Indian state of Rajasthan, Jodha (1988) contends that an exclusive reliance on quantification can provide an inadequate and often misleading picture of poverty incidence. For the poor, achieving security, independence and self-respect (the qualitative dimension) is just as important as income gains (the quantitative dimension). Jodha suggests a preference to trade-off possible quantitative gains for qualitative indicators: "Households that have become poorer by conventional measurement of income in fact appear to be better off when seen through different qualitative indicators of their economic well-being" (p. 2421). He advocates the need for "supplementing conventional measurements of income by qualitative indicators of change to arrive at a realistic understanding of rural socio-economic change", identifying the following qualitative variables (see also Bernstein, 1992, p. 18):

[20] This section draws heavily on Alauddin and Hossain (2001), Chapter 11.

[21] Implicit in the World Bank (1990) discussion of poverty is the notion of relative poverty or deprivation. This is reminiscent of the seminal work of Townsend (1979) on poverty in the United Kingdom (see also Sen, 1983).

[22] Absolute poverty more specifically refers to the inability to attain minimal standards of consumption to satisfy basic physiological criteria (Bernstein, 1992, p. 16).

- reduced dependence on the support, patronage or mercy of the well-to-do households in the village;
- freedom from the debt-trap;
- Freedom from dependence and humiliation.

Poverty is a complex and multidimensional process and its analysis requires an investigation of complex realities rather than simple numbers or statistics (Chambers, 1988; see also Sen, 1999). The key dimensions of rural poverty can be identified as follows (see Bernstein, 1992, pp. 18–19; see also Chambers, 1988):

- structural factors regarding access to land and non-land resources;
- structural factors determining socio-economic power and status;
- access to resources and employment that determine the household's livelihood strategies;
- social relations governing gender status.

The recent literature takes a broader perspective on poverty. In this context it is worth considering the views of Sen (2000):

> There is plenty of evidence from the positive experience of East and Southeast Asia that the removal of social deprivation can be very influential in stimulating economic growth and sharing the fruits of growth more evenly. If India went wrong, the fault lay not only in the suppression of market opportunities but also in the lack of attention to social poverty (for example, in the form of widespread illiteracy). …The country has paid dearly for leaving nearly half the people illiterate. Social poverty has helped perpetuate economic poverty as well.

A brief review of the literature

Empirical literature is replete with studies that identify technological change (when consistent with socio-cultural and ecological conditions) as the leading determinant for agricultural productivity growth (see for example, Hayami and Ruttan, 1985; Lipton 1977; Mellor (1976, 2001) convincingly argues that agricultural productivity growth generates higher incomes for poorer farmers (who are in turn the source of increased demand for goods and also have implications for rural-urban migration). Furthermore, higher productivity growth leading to higher foodgrain production results in lower food prices that benefit both the urban and the rural poor (see, for example, Hayami and Herdt 1977; Alauddin and Tisdell 1991).[23] More recent literature provides ample evidence of the poverty-reducing effect of higher agricultural growth resulting from higher productivity growth.[24, 25]

While its critical importance in improving conditions for the poor, productivity growth alone may not be sufficient – and its relationship to poverty alleviation may not be straightforward. Factors such as education or the distribution of land and non-land resources, can accentuate income inequality and perpetuate poverty. For example, in Latin America the perverse effect of land distribution is aptly captured by de Janvry and Sadoulet (2000) who

[23] For an earlier literature on this view see Johnston and Mellor (1961).

[24] Important studies in this area are Datt and Ravallion (1999), Warr (2001), Fan et al. (1999), Gallup et al.(1997).

[25] Hayami and Ruttan (1985, pp.360-61) in the context of the Green Revolution contend that "In the absence of new technology, many developing countries would have moved closer to the Ricardian trap of stagnation and even greater stress over the distribution of income. The conclusion that should be drawn from this experience is not that growth has been "immiserizing" but that stagnation has."

report that “rural poverty has declined over the last three decades, but due to the level of inequality in land ownership, the main escape route for the rural poor has been migration to urban areas, so urban poverty has grown as rural poverty has fallen” (cited in Thirtle et al., 2002, p. 4).

In addition, institutional factors such as quality of governance or the incidence and extent of corruption play a significant part in misallocation of resources and often negatively affect poverty alleviation programmes. In South Asia as elsewhere in the developing world “a common method of exploiting a position of public responsibility for private gain is the threat of obstruction and delay; hence, corruption impedes the processes of decision-making and execution on all levels. Corruption introduces an element of irrationality in all planning and plan fulfilment by influencing the actual course of development in a way that deviates from the Plan” (Myrdal 1971, p. 237). People’s efforts to extricate themselves from the poverty trap may be curtailed by bad governance.

This report takes the above considerations into account in explaining the cross-country incidence of poverty.

6.2. The data

For the purposes of this report, two measures of incidence of poverty are used – the percentage of population earning less than \$1 a day and \$2 a day. Two measures of productivity are used as alternative explanatory variables – the TFP levels reported in Chapter 4 and agricultural output per labour. Other explanatory variables include:

- Illiteracy
- Gini index
- Land Gini
- Polity score
- Corruption index
- Degree of openness measured by trade as a percentage of GDP

The data sources are primarily World Development Indicators 2003; Peterson (1987); Penn World Tables; Lundberg and Squire (2003); and Sharpe (2003).

6.3. Modelling poverty

The broad picture

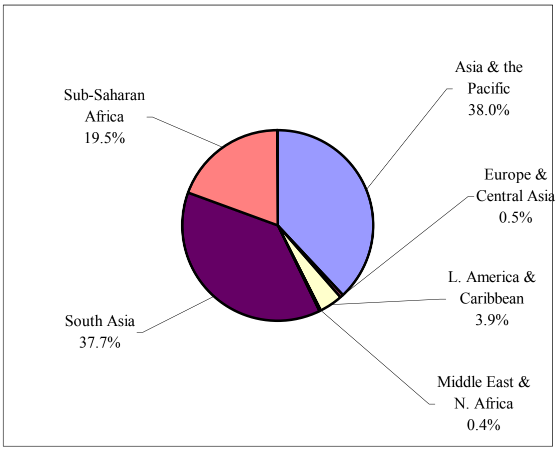
Before presenting the empirical results it is useful to provide a broad picture of the incidence of poverty. Based on World Bank data, Table 6.1 presents the two measures of incidence of poverty by country groups. (Although the country grouping differs from that used earlier in this report, it is unlikely to affect the portrayal of overall poverty.) In absolute numbers, people earning less than \$1 a day have declined from 1.2 billion in 1990 to 1.1 billion in 2000. On the other hand, people living on less than \$2 a day have increased by 84 million over the same period. If China is excluded, the absolute numbers increase in both cases by 19 million and 284 million respectively. In percentage terms there has been an overall decline in both measures of poverty incidence but regional variations exist. Percentages of people living below \$1 a day and \$2 a day have increased sharply for Central Asia and Europe (primarily because of the nature of the transition economies). This is followed by slight increases for the Middle East and North Africa, and sub-Saharan Africa. The East Asia and Pacific region *including* China has registered the most significant decline. This scenario does not change significantly when China is *excluded*. While South Asia has recorded a significant decline in \$1 a day poverty incidence, not much seems to have changed for the \$2 a day incidence. In 2000, 432 million people (nearly 40 per cent) of the world’s \$1 a day poor lived in South Asia and 1,052 million or nearly 38 per cent of those living on less than $2 a day. The highest percentage of the world's poorest inhabits two regions, South Asia and Sub-Saharan Africa. For a sharper focus, Figure 6.1 illustrates the distribution of the incidence of poverty according to the regions defined in Table 6.1.

Table 6.1. World Bank poverty incidence

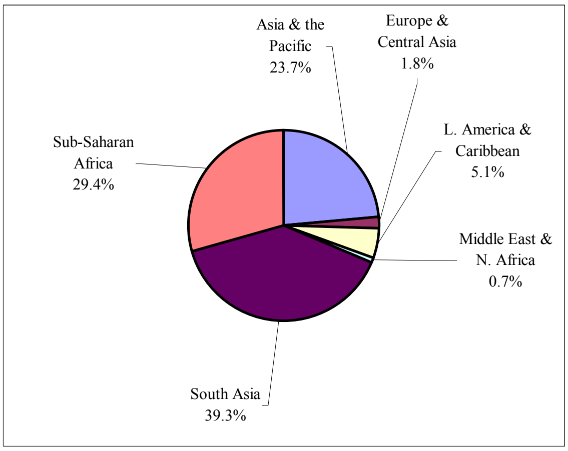
A: Number of people living under poverty line (millions)				
Developing Countries Groups	$1/day		$2/day	
	1990[a]	2000[a]	1990[a]	2000[a]
Asia and the Pacific	470	261	1,094	873
Excluding China	*110*	*57*	*295*	*273*
Europe and Central Asia	6	20	31	101
Latin America and Caribbean	48	56	121	136
Middle East and North Africa	5	8	50	72
South Asia	466	432	971	1,052
Sub-Saharan Africa	241	323	386	504
Total	**1,237**	**1,100**	**2,653**	**2,737**
Excluding China	*877*	*896*	*1,854*	*2,138*

B: Proportion of people living under poverty line (%)				
Developing Countries Groups	$1/day		$2/day	
	1990[a]	2000[a]	1990[a]	2000[a]
Asia and the Pacific	29.4	14.5	68.5	48.3
Excluding China	*24.1*	*10.6*	*64.9*	*50.8*
Europe and Central Asia	1.4	4.2	6.8	21.3
Latin America and Caribbean	11.0	10.8	27.6	26.3
Middle East and North Africa	2.1	2.8	21.0	24.4
South Asia	41.5	31.9	86.3	77.7
Sub-Saharan Africa	47.4	49.0	76.0	76.5
Total	**28.3**	**21.6**	**60.8**	**53.6**
Excluding China	*27.2*	*23.3*	*57.5*	*55.7*

Figure 6.1. Proportion of people living under the $1 a day poverty line, 1990 and 2000

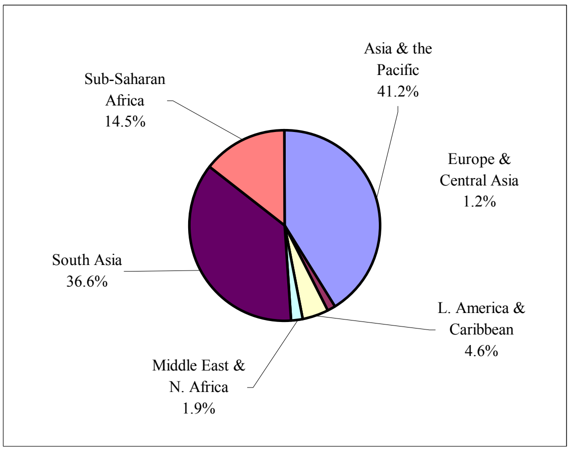


a) 1990

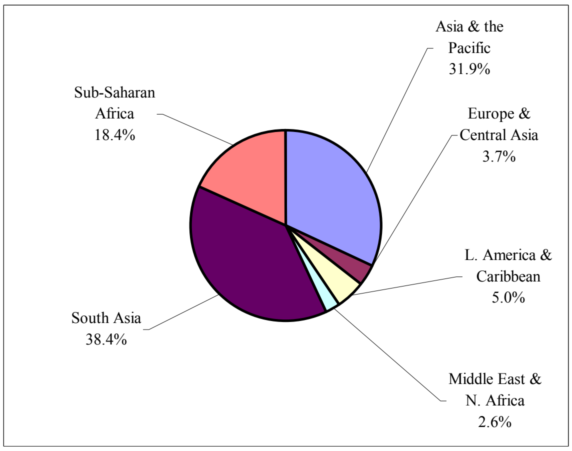


b) 2000

Figure 6.2. Proportion of people living under the $2 a day poverty line, 1990 and 2000



a) 1990



b) 2000

Hypotheses

This section examines the patterns and determinants of poverty in the developing world. The basic data are set out in Appendix Table A6.1 and the descriptive statistics are provided in Appendix Table A6.2. Two definitions of poverty are used as alternative measures of poverty. First, the Sala-i-Martin poverty incidence data of the percentage of population living on less than $1 and $2 a day are used as dependent variables. Note that this information is available for 1970, 1980, 1990 and 1998. In this report, the 1998 figures are assumed to represent those for 2000. World Bank data for the same variables are available for 2000. For the purposes of comparison, the World Bank data 2000 is also used. Note that data on these variables are sporadic and do not exactly match with 2000. It is assumed that the figures for the years closest to 2000 (e.g. 1998, 1999) are proxies for 2000.

It is also hypothesized that productivity is negatively associated with the incidence of poverty. In this report, two alternative measures of productivity – total factor productivity and agricultural output per labour – are used. This contrasts with Thirtle et al. (2002) who use only the partial measure of productivity. For reasons explained earlier (see Chapter 5), both total and partial measures of productivity are used. It is expected that higher per capita income will imply lower incidence of poverty.

Further, it is hypothesized that the institutional variables (scores on corruption and polity) which typify quality of governance will be negatively associated with the incidence of poverty. In this data, the higher the polity scores (on a scale of –10 (most undemocratic, autocratic) to +10 (most democratic, least autocratic) the lower the incidence of poverty and vice versa. Furthermore, the lower the corruption score (0 (most corrupt) to 10 (least corrupt) the higher the incidence of poverty. It is expected that inequality as measured by the Gini coefficient is likely to be positively associated with poverty – that is, inequality exacerbates and perpetuates poverty.

It can be hypothesized that the higher the percentage of rural population the higher the poverty incidence – implying that there are scant opportunities for productive employment outside the rural sector. It is also expected that a higher incidence of illiteracy is likely to reinforce poverty incidence.

Thirtle et al. (2002) included R& D per hectare of agricultural land and fixed investment as explanatory variables in their recursive model. These are productivity augmenting factors and are not included as variables, assuming that TFP subsume their effects.

For the purpose of regression all variables except corruption and polity scores are measured in natural logarithms. Therefore, the corresponding coefficients (except those for the corruption and polity variables) represent elasticities.

Empirical results

Table 6.2 gives the results of OLS regression for 1970 for 40 countries. Part A includes the log of GDP per worker as an explanatory variable while Part B excludes this variable. The overall explanatory powers of the equations are good, given that cross-sectional data is used. However, the estimated equations clearly show that all coefficients are not statistically significant. In Part A ($1 a day), neither agricultural output per labour nor total factor productivity has the expected sign, nor are they significant. The same applies to the polity indicator. The corruption score had neither the expected sign nor the statistical quality. Furthermore, it was thought that polity subsumes corruption. However, both the LogGDP per worker and LogGini are statistically significant and possess the expected sign. Thus a one per cent increase in GDP per worker leads to a 1.9 per cent reduction in poverty ($1 a day), while a one per cent rise in Gini leads to a rise in poverty incidence by 0.056 per cent. The scenario changes marginally in magnitude but not in sign when TFP is included as an explanatory variable in place of agricultural value added per labour. The percentage of rural population as an explanatory variable has the right sign but not the statistical significance in both equations. The corresponding equations in Part B (excluding GDP per worker) portray the right signs for the productivity variables but not the statistical significance. Gini in these equations have the opposite sign. The most significant variable is the percentage of rural population. The polity indicator has the right sign but not the statistical significance.

For the $2 a day poverty incidence, the most significant variable is the GDP per worker. However, while the other measures of productivity have the expected signs but are not statistically significant, the polity indicator has the opposite sign. Both Gini and percentage of rural population have the right signs but not the statistical significance. When the GDP per worker variable is excluded the picture does not change significantly in respect of sign but the percentage of rural population emerges as the most significant variable.

Table 6.2. Explaining $1 a day and $2 a day Sala-i-Martin poverty incidence: 1970

A: Including log of GDP per worker

VARIABLE	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	3.181	.358	8.023	.907
Log of */**	.844	1.560	.569	.927
Log %Rural population	1.625	1.298	1.092	.882
Log of Gini coefficient	.056	2.206	.059	2.098
Log GDP/worker	-1.866	-3.208	-1.490	-2.875
Polity indicator	.015	.396	.027	.666
R-squared		0.632		0.609
R-squared adjusted		0.556		0.527
$2/day				
Constant	6.923	.983	6.217	1.044
Log of */**	-.066	-.148	-.144	-.262
Log %Rural population	.826	.862	.886	1.113
Log of Gini coefficient	.024	1.030	.022	.874
Log GDP/worker	-.904	-2.142	-.904	-2.290
Polity indicator	.037	1.118	.034	.952
R-squared		0.533		0.534
R-squared adjusted		0.447		0.448

B: Excluding log of GDP per worker

VARIABLE	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	-13.076	-1.529	-14.822	-3.352
Log of */**	-.109	-.207	.120	.177
Log %Rural population	3.544	2.752	3.796	4.152
Log of Gini coefficient	.022	.818	.024	.822
Polity indicator	-.018	-.424	-.018	-.412
R-squared		0.474		0.474
R-squared adjusted		0.390		0.390
$2/day				
Constant	.171	.026	-5.816	-1.931
Log of */**	-.481	-1.119	-.480	-.842
Log %Rural population	1.476	1.530	2.148	3.487
Log of Gini coefficient	.002	.098	-.005	-.221
Polity indicator	.022	.637	.009	.237
R-squared		0.454		0.443
R-squared adjusted		0.376		0.364

Table 6.3 presents regression results for 1980. Overall fit in terms of explanatory power is highly satisfactory. For the $1 a day poverty incidence, productivity measures have the right signs but only TFP and GDP per worker are significant factors. The polity indicator is also significant and has the expected sign. The same applies to the percentage of rural population variable. The picture does not change much if the GDP per worker variable is

excluded. Both the partial productivity and TFP measures exert a significant poverty-ameliorating effect. The polity variable assumes much greater significance in 1980 than in 1970. For the $2 a day incidence of poverty, when the GDP per worker variable is included, other productivity factors do not turn out to be significant even though they display the expected sign. The polity variable is not statistically significant in either equation for the $2 a day incidence of poverty. In the bottom panel of Table 6.3 the partial productivity measure is statistically significant but not the TFP measure, although both have the expected signs.

Table 6.3. Explaining $1 and $2 Sala-i-Martin poverty incidence: 1980

A: Including Log of GDP per Worker

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	7.014	1.513	3.816	.823
Log of */**	-.066	-.169	-.727	-1.726
Log %Rural population	1.083	1.680	1.193	2.086
Log of Gini coefficient	.012	.647	-.001	-.045
Log GDP/worker	-1.136	-2.706	-.871	-2.751
Polity indicator	-.034	-1.614	-.034	-1.701
R-squared		0.819		0.840
R-squared adjusted		0.780		0.804
$2/day				
Constant	1.203	.335	.201	.051
Log of */**	-.186	-.620	-.067	-.176
Log %Rural population	1.377	2.947	1.535	3.645
Log of Gini coefficient	.018	1.177	.018	1.088
Log GDP/worker	-.382	-1.217	-.486	-1.701
Polity indicator	-.011	-.589	-.009	-.517
R-squared		0.769		0.766
R-squared adjusted		0.726		0.722

B: Excluding log of GDP per worker

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	1.648	.350	-7.605	-3.262
Log of */**	-.872	-3.052	-1.404	-3.644
Log %Rural population	1.438	2.027	2.229	4.591
Log of Gini coefficient	-.004	-.195	-.023	-1.161
Polity indicator	-.048	-2.078	-.047	-2.192
R-squared		0.761		0.787
R-squared adjusted		0.722		0.751
$2/day				
Constant	-.707	-.217	-6.105	-4.274
Log of */**	-.436	-1.975	-.448	-1.413
Log %Rural population	1.471	3.166	2.073	7.197
Log of Gini coefficient	.014	.940	.008	.491
Polity indicator	-.017	-1.019	-.018	-1.033
R-squared		0.756		0.741
R-squared adjusted		0.721		0.704

Table 6.4 presents the regression results for 1990 with and without the GDP per worker variable. In terms of explanatory power, the equations that range between 63 and 77 per cent are quite satisfactory. With the inclusion of this variable, both the productivity measures display perverse signs even though they are not statistically significant. When GDP per worker is excluded the coefficients show the expected sign but only the TFP variable is statistically significant. Percentage of rural population performs consistently well. The scenarios seem similar in respect of both the $1 and $2 incidence of poverty. However, for the latter case the polity variable is statistically significant and displays the expected sign.

Table 6.4. Explaining $1 and $2 Sala-i-Martin poverty incidence: 1990

A: Including log of GDP per worker				
Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	3.156	.545	4.556	.823
Log of */**	.275	.701	.246	.643
Log %Rural population	1.405	1.989	1.228	1.931
Log of Gini coefficient	.048	2.121	.051	2.202
Log GDP/worker	-1.274	-2.650	-1.136	-2.715
Polity indicator	-.043	-1.041	-.046	-1.123
R-squared		0.774		0.773
R-squared adjusted		0.730		0.729
$2/day				
Constant	5.723	2.376	5.636	2.638
Log of */**	-.048	-.261	.202	1.097
Log %Rural population	.697	2.317	.774	3.278
Log of Gini coefficient	.029	2.812	.031	3.010
Log GDP/worker	-.728	-3.634	-.781	-4.640
Polity indicator	.012	.648	.009	.469
R-squared		0.801		0.808
R-squared adjusted		0.768		0.777
B: Excluding log of GDP per worker				
Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	-5.617	-1.068	-8.663	-2.955
Log of */**	-.250	-.669	.121	.285
Log %Rural population	1.848	2.436	2.229	3.869
Log of Gini coefficient	.039	1.553	.038	1.510
Polity indicator	-.101	-2.634	-.113	-3.034
R-squared		0.713		0.709
R-squared adjusted		0.670		0.665
$2/day				
Constant	1.889	.739	-3.032	-2.269
Log of */**	-.403	-2.184	.083	.354
Log %Rural population	.726	2.046	1.315	4.971
Log of Gini coefficient	.025	2.033	.024	1.832
Polity indicator	-.020	-1.061	-.037	-1.846
R-squared		0.714		0.671
R-squared adjusted		0.677		0.629

Table 6.5 sets out the regression results for 2000. Note that data on the polity variable are not available and the corruption scores are used instead. With the inclusion of the GDP per worker variable, neither the TFP nor the agricultural output variable is significant for $1 a day but the TFP is significant for the $2 a day incidence of poverty. Percentage of rural population is significant for the $2 a day case but not in the $1 a day case; in both cases the expected sign is present. Except for the $1 a day incidence, the Gini coefficient is without the GDP per worker variable in all cases. Results with TFP seem to be mixed in respect of significance but the sign is consistent. The percentage of rural population is the consistently significant variable.

Table 6.5. Explaining $1 and $2 Sala-i-Martin poverty incidence: 2000

A: Including log of GDP per worker				
Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	7.799	1.122	8.258	1.431
Log of */**	.050	.105	.077	.123
Log %Rural population	1.244	1.329	1.204	1.622
Log of Gini coefficient	.078	2.548	.080	2.387
Log GDP/worker	-1.626	-3.686	-1.624	-3.815
Corruption indicator	-.302	-1.070	-.306	-1.061
R-squared		0.756		0.756
R-squared adjusted		0.688		0.688
$2/day				
Constant	6.147	1.586	6.678	2.356
Log of */**	-.023	-.072	.760	2.164
Log %Rural population	.954	1.893	1.168	3.553
Log of Gini coefficient	.062	3.460	.065	3.968
Log GDP/worker	-1.085	-4.243	-1.199	-5.678
Corruption indicator	-.068	-.379	-.128	-.789
R-squared		0.778		0.813
R-squared adjusted		0.734		0.776
B: Excluding log of GDP per worker				
Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
$1/day				
Constant	-3.228	-.399	-10.082	-2.410
Log of */**	-.639	-1.131	-.645	-.826
Log %Rural population	1.965	1.665	2.690	3.250
Log of Gini coefficient	.064	1.631	.049	1.167
Corruption indicator	-.439	-1.218	-.453	-1.211
R-squared		0.572		0.559
R-squared adjusted		0.482		0.466
$2/day				
Constant	1.317	.276	-6.970	-3.126
Log of */**	-.678	-1.885	.303	.597
Log %Rural population	1.003	1.547	2.149	5.176
Log of Gini coefficient	.062	2.686	.061	2.488
Corruption indicator	-.190	-.830	-.377	-1.620
R-squared		0.619		0.573
R-squared adjusted		0.560		0.507

6.4. Explaining the percentage of rural population

What factors explain variations in the percentage of rural population? This question is addressed by estimating regression equations for 1970, 1980, 1990 and 2000. Tables 6.6 to 6.9 give the results of relevant regressions. As previously, the explanatory variables included are measures of productivity, agricultural value added as a percentage of GDP and government expenditure as a percentage of GDP. Note that data on government expenditure as a percentage of GDP are available only for 1980 and 2000. All variables are in natural logarithmic form.

Table 6.6 shows that all productivity variables are significant for 1970. As expected, higher productivity in agriculture or higher GDP per worker would leave a lower percentage of population in the rural sector. Furthermore, the higher the share of agriculture in GDP the lower is the percentage of rural population. All the coefficients are statistically significant at various levels.

Table 6.6. Explaining log of percentage of rural population: 1970

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
Constant	5.741	8.475	5.183	6.073
Log of */**	-.222	-3.813	-.151	-1.643
Log of agric. output/GDP	.171	2.182	.246	2.583
Log GDP/worker	-.082	-1.152	-.227	-3.511
R-squared		0.798		0.733
R-squared adjusted		0.781		0.710

For 1980 (Table 6.7) the partial measure of productivity seems to perform better in terms of statistical quality of the estimates than the TFP variable. When GDP per worker and agricultural output per labour are included in the same equation, the GDP per worker variable does not turn out to be significant. With government expenditure included in the equations (see bottom panel of Table 6.7), it is clear that all the productivity variables are statistically significant. As expected, agricultural value added as a percentage of GDP is highly significant with the expected sign. Government expenditure is not significant.

Table 6.7. Explaining log of percentage of rural population: 1980

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
With GDP/worker				
Constant	4.519	5.063	4.998	4.474
Log of */**	-.279	-3.348	-.065	-.653
Log of agric. output/GDP	.308	3.077	.301	2.510
Log GDP/worker	.049	.441	-.220	-2.549
R-squared		0.761		0.688
R-squared adjusted		0.741		0.662
With Government expenditure				
Constant	4.480	6.577	1.911	3.827
Log of */**	-.245	-4.756	-.163	-1.588
Log of agric. output/GDP	.305	3.419	.567	6.820
Log Gov. expenditure	.102	.808	.105	.663
R-squared		0.759		0.626
R-squared adjusted		0.738		0.593

For 1990 (Table 6.8) agricultural output per labour is significant but not the TFP variable even though both have the expected signs. GDP per worker when included with agricultural output/worker in the same equation shows a perverse sign but is not statistically significant. The sign of the coefficient of this variable changes when the TFP variable is used instead. However, the TFP variable is not significant but has the expected sign.

Table 6.8. Explaining log of percentage of rural population: 1990

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
Constant	3.574	3.360	3.629	2.559
Log of */**	-.346	-4.744	-.162	-1.381
Log of agric. output/GDP	.411	3.408	.436	2.878
Log GDP/worker	.168	1.505	-.126	-1.129
R-squared		0.771		0.655
R-squared adjusted		0.753		0.629

The results for 2000 are set out in Table 6.9. The agricultural output per worker variable is highly significant and has the right sign, while the GDP per worker is neither significant nor has the right sign. The TFP variable is not statistically significant but has the appropriate sign. Government expenditure is not significant.

Table 6.9. Explaining log of percentage of rural population: 2000

Variables	Agriculture output/labour *		TFP level **	
	Coeff.	t-ratio	Coeff.	t-ratio
With GDP/worker				
Constant	4.353	3.384	2.865	1.778
Log of */**	-.360	-4.797	-.078	-.544
Log of agric. output/GDP	.313	2.137	.533	3.039
Log GDP/worker	.124	1.122	-.063	-.477
R-squared		0.761		0.619
R-squared adjusted		0.742		0.589
With Government expenditure				
Constant	5.463	6.677	2.216	4.641
Log of */**	-.332	-4.547	-.093	-.649
Log of agric. output/GDP	.202	1.748	.599	6.215
Log Gov. expenditure	.040	.304	-.043	-.260
R-squared		0.750		0.615
R-squared adjusted		0.730		0.584

6.5 Discussion of results

The above analysis has significant implications, as listed below.

- One of the salient features of the results of the regression analysis is that the productivity variable, be it in the form of agricultural output per worker or real GDP per worker or total factor productivity, exerts a significant ameliorating influence on the incidence of poverty. Therefore, any noticeable reduction in the incidence or even intensity of poverty requires significant and sustained productivity growth. However, sustained productivity growth requires considerable investment in R&D. This would entail investing in education, given that illiteracy hinders productivity growth (as confirmed by the findings of Thirtle et al., 2002).
- Furthermore, the percentage of rural population consistently impacts significantly on poverty incidence.
- Institutional factors such as polity and corruption seem to exert significant influence on the incidence of poverty. This may be because conceptual difficulties and statistical pitfalls

surround the derivation and use of the data relating to these variables. The inequality measure such as the Gini coefficient does not exert a consistent influence on poverty incidence. The sporadic nature of the data generates problematic and misleading results.

The factors that explain the percentage of rural population behave consistently. Again the productivity-related variables show consistent results. The same is the case for the share of agricultural value added in GDP. Government expenditure does not seem to have any perceptible influence as a determinant of the percentage of rural population. Here, sociological factors might also be at work. For example, in many parts of the developing world, clans or tribal people develop a cultural affinity with their land and are reluctant to move, particularly in some parts of Asia and sub-Saharan Africa.

The above analysis also shows that the relationship between the incidence of poverty and its likely determinants seems to change over time. Thus, the regression results show considerable variability over time. For example, the factors that are significant determinants of poverty incidence in 1970 are not the same as those for 2000; nor are they similar (let alone identical) in importance. This may be attributable to the dynamics of time, bringing with it other changes that cannot be adequately quantified. Even if quantification were possible, consistent and reliable data are not available. This is particularly true for environmental quality factors. Land quality data were available for 1980 but did not turn out to be significant. For 2000, land quality data were available from a different source, which used completely different definitions and were not comparable to the 1980 data. Thus, the dynamics of the influence of this most important variable could not be captured.

Bibliography

Alauddin, M. and Hossain, M., 2001. *Environment and agriculture in a developing economy: Problems and prospects for Bangladesh*, Cheltenham and Northampton: Edward Elgar.

— and Tisdell, C.A., 1991. *The Green Revolution and economic development: The process and its impact in Bangladesh*, London: Macmillan.

Ark, B. van, 2000. "Measuring productivity in the 'New Economy': Towards a European perspective", in *De Economist* (Quarterly Review of the Royal Netherlands Economic Association),Vol. 148, No. 1, pp. 87-105.

Arnade, C. (1998), "Using a programming approach to measure international agricultural efficiency and productivity", in *Journal of Agricultural Economics*, Vol. 49, pp. 67-84.

Ball, V. Eldon, Bureau, J.C., Butault, J.P., Nehring, R., 2001. "Levels of farm sector productivity: An international comparison", in *Journal of Productivity Analysis,* Vol. 15, pp. 5-29.

Barro, R. and X. Sala-i-Martin, 1991. "Convergence across states and regions", *Brookings Paper on Economic Activity*, pp. 107-82.

Bernstein, H. , 1992. "Poverty and the Poor", in Bernstein, H., Crow, B. and Johnson, H. (eds.), *Rural livelihoods: Crises and responses*, London: Oxford University Press, pp. 13–26.

Black, C.E., 1966. *The dynamics of modernization: A study in comparative history*, New York: Harper and Row.

Bureau, C., R. Färe and S. Grosskopf, 1995. "A comparison of three nonparametric measures of productivity growth in European and United States agriculture", in *Journal of Agricultural Economics*, Vol. 46, pp. 309-26.

Capalbo, Susan M., and J.M. Antle (eds.), 1988. *Agricultural productivity: Measurement and explanation*, Washington DC, Resources for the Future.

Chambers, R.G., 1988. *Poverty in India: Concepts, research and reality*, Discussion Paper 241, Institute of Development Studies, Sussex: University of Sussex.

Charnes, A. W.W. Cooper and E. Rhodes, 1981. "Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through", in *Management Science*, Vol. 27, pp. 668-97.

Chavas, J.P., 2001. "An international analysis of agricultural productivity", in L. Zepeda, (ed.) *Agricultural Investment and Productivity in Developing Countries*, FAO, Rome.

Coelli, T.J., 1996. "A Guide to DEAP Version 2.1: A data envelopment analysis (computer) program", CEPA Working Paper 96/8, Department of Econometrics, University of New England, Armidale, Australia.

— , D.S.Prasada Rao and G.E. Battese, 1998. *An introduction to efficiency and productivity analysis*, Boston: Kluwer Academic Publishers.

— and D.S.Prasada Rao, 2001. "Implicit value shares in Malmquist TFP Index numbers", CEPA Working Paper no. 4/2001, School of Economics, University of New England, Armidale.

Craig, B.J., Pardey, P.G. and Roseboom, J., 1997. "International productivity patterns: Accounting for input quality, infrastructure, and research", in *American Journal of Agricultural Economics*, Vol. 79, pp. 1064-77.

Datt, G. and Ravallion, M., 1999. "When is growth pro-poor? Evidence from the diverse experiences of India's States", Working Papers – Poverty. Income distribution, safety nets, micro-credit. No. 2263, World Bank.

Fan, S., Hazell, P. and Thorat, S., 1999. *Linkages between government spending, growth and poverty in rural India*, IFPRI Research Report 110, Washington, DC.

Färe, R., S. Grosskopf, M. Norris and Z. Zhang, 1994. "Productivity growth, technical progress and efficiency changes in industrialised countries," in *American Economic Review*, Vol. 84, pp. 66-83.

Fulginiti, L.E. and R. K. Perrin, 1993. "Prices and productivity in agriculture", in *Review of Economics and Statistics,* Vol. 75, pp. 471-82.

—, 1997. "LDC agriculture: Nonparametric Malmquist productivity indexes", in *Journal of Development Economics*, Vol. 53, pp. 373-90.

—, 1999. “Have price policies damaged LDC agricultural productivity?”, in *Contemporary Economic Policy,* Vol. 17, pp. 469-75.

—, 1998. “Agricultural productivity in developing countries”, in *Journal of Agricultural Economics*, Vol. 19, pp. 45-51.

Gallup, J., Radelet, S. and Warner, A., 1997. *Economic growth and the income of the poor,* Harvard Institute for International Development, CAER II Discussion Paper No. 36.

Goulet, D., 1971. *The cruel choice: A new concept in the theory of development*, New York: Atheneum.

Grifell-Tatjé, E. and C.A.K. Lovell, 1995. “A note on the Malmquist Productivity Index”, *Economics Letters*, Vol. 47, pp. 169-75.

Hayami, Y. and Herdt, R.W., (1977). “Market price effects of technological change on income distribution in semi-subsistence agriculture”, in *American Journal of Agricultural Economics*, May, pp. 245-256.

Hayami, Y. and V. W. Ruttan, 1970. “Agricultural productivity differences among countries”, in *American Economic Review*, Vol. 40, pp. 895-911.

—, 1985. *Agricultural development: An international perspective*, Balimtore: Johns Hopkins University Press.

Headey, D., 2003. “The conditions of effective aid: When and where will aid promote growth?”, Honour Thesis, University of Queensland.

Janvry de, A. and Sadoulet, E., 2000. “Rural poverty in Latin America: Determinants and exit paths”, in *Food Policy*, Vol. 25, pp. 389-409.

Jodha, N.S., 1988. “Poverty debate in India: A minority view”, in *Economic and Political Weekly*, Vol. 23, Nos.45-47, pp. 2421-28.

Johnston, B.F. and Mellor, J.W., 1961. “The role of agriculture in economic development”, in *American Economic Review*, Vl. 51, No. 4, pp. 566-93.

Kawagoe, T. and Y. Hayami., 1983. “The production structure of world agriculture: An intercountry cross-section analysis”, in *Developing Economies*, Vol. 21, pp. 189-206.

—, 1985. “An intercountry comparison of agricultural production efficiency”, in *American Journal of Agricultural Economics*, Vol. 67, pp. 87-92.

— and V. Ruttan, 1985. “The intercountry agricultural production function and productivity differences among countries”, in *Journal of Development Economics*, Vol. 19, pp. 113-32.

Knack, S. and P. Keefer, 1995. “Institutions and economic performance: Cross-country tests using alternative institutional measures”, in *Economics and Politics*, Vol. 7, No. 3, pp. 207-227.

Lau, L. and P. Yotopoulos, 1989. “The meta-production function approach to technological change in world agriculture”, in *Journal of Development Economics*, Vol. 31, pp. 241-69.

Lewis, W. A., 1966. *The theory of economic growth*, London: Allen and Unwin.

Limão, N. and Venables, A. J., 2001. “Infrastructure, geographical disadvantage, transport costs and trade”, in *World Bank Economic Review*, Vol. 15, No. 3, pp. 451-479.

Lipton, M., 1977. *Why poor people stay poor*: *Urban bias in world development*, Cambridge Mass.: Harvard University Press.

Lundberg, M. and Squire, L., 2003. “The simultaneous evolution of growth and inequality”, in *Economic Journal*, Vol. 113, pp. 326-44.

Lusigi, A. and Thirtle, C., 1997. “Total factor productivity and the effects of R&D in African agriculture”, in *Journal of International Development*, Vol. 9, pp. 529-38.

—., 2001. “Productivity growth and convergence in Asian and African agriculture”, in *Asia and Africa in Comparative Economic Perspective*, P. Lawrence and C. Thirtle, eds. London: Palgrave, pp. 258-74.

Maddison, A., 1995. *Monitoring the world economy: 1820-1992*, OECD, Paris.

—, 1997. *Chinese economic performance in the long run*, OECD, Paris.

—, 2001. *The world economy: A millennial perspective*, OECD Development Centre, Paris (also in French).

Marshall, M. and Jaggers, K., 2003. *Political regime characteristics and transitions, 1800-1999.* Dataset Users' Manual, Center for International Development and Conflict Management, Maryland.

Martin, W. and Mitra, D., 1999. "Productivity growth and convergence in agriculture and manufacturing", *Agriculture Policy Research Working Papers*, no. 2171, World Bank, Washington DC.

Meier, G.M., 1984. *Leading issues in economic development*, 4th ed., New York: Oxford University Press.

Mellor, J.W., 1976. *The new economics of growth*, New York: Cornell University Press.

—, 2001. "Faster, more equitable growth", Agriculture, Employment Multipliers and Poverty Reduction, Paper prepared for USADD/GEGAD.

Myrdal, G., 1968, *Asian drama: An inquiry into the poverty of nations*, London: Penguin.

—, 1971. *The challenge of world poverty*, Harmondsworth, U.K.: Penguin.

Nin, A., Arndt, C. and Preckel, P.V., 2003. "Is agricultural productivity in developing countries really shrinking? New evidence using a modified nonparametric approach", in *Journal of Development Economics*, Vol. 71, pp. 395-415.

Pardey, P.G., Roseboom, H. and Bientema, N., 1997. "Investments in African agricultural research", in *World Development*, Vol. 25**,** pp. 409-23.

Peterson, W., 1987. "International Land Quality Indexes", Staff Paper P-87-10, Department of Agricultural Economics and Applied Economics, University of Minnesota.

Rao, D.S.Prasada, 1993. *Intercountry comparisons of agricultural output and productivity*, FAO, Rome.

— and Coelli, T.J. (1998), "Catch-up and convergence in global agricultural productivity, 1980-1995", CEPA Working Paper no. 4/98, Department of Econometrics, University of New England, Armidale.

—, G. Ypma and B. van Ark, 2004. "Purchasing power parities and global agricultural output and productivity, 1995", School of Economics, University of Queensland, Brisbane (mimeo).

Ruttan, V.W., 2002. "Productivity growth in world agriculture: Sources and constraints", in *Journal of Economic Perspectives,*Vol. 16, pp. 161-84.

Sachs, J. and P. Malaney, 2002. "The economic and social burden of malaria", in *Nature*, Vol. 415, No. 6872.

Sen, A., 1981. *Poverty and famines: An essay on entitlement and deprivation*, Oxford: Clarendon Press.

—, 1983. "Poor – Relatively speaking", in *Oxford Economic Papers*, Vol. 35, pp. 153-69.

—, 1999. "Assessing human development" in UNDP, *Human Development Report*, New York: Oxford University Press, p.2.

—, 2000. "Will there be any hope for the poor?", in *Time Europe*, Vol. No. 21.

Sharpe, A., 2003. "Productivity growth and poverty reduction in developing countries", Ottawa: Centre for the Study of Living Standards.

Strand, H., Wilhelmsen L. and Gleditsch, N.P., 2003. *Armed Conflict Dataset Codebook, Version 1.2.* Oslo: International Peace Research Institute.

Suhariyanto, K., Lusigi, A. and Thirtle, C. 2001. "Productivity growth and convergence in Asian and African agriculture", *in Asia and Africa in Comparative Economic* Perspective, P. Lawrence and C. Thirtle (eds.) London: Palgrave, pp. 258-274.

Taha, H.A., 1987. *Operations research: An* introduction, 4th ed., New York: Macmillan.

Thirtle, C., 2001. "Asian agricultural productivity and convergence", in *Journal of Agricultural Economics*, Vol. 52, pp. 96-110.

—, Lin, L. and Piesse J., 2002. "The impact of research-led agricultural productivity growth on poverty reduction in Africa and Latin America", Research paper no. 016 King's College, Management Research Centre, University of London.

—, Piesse, J., Lusigi, A. and Suhariyanto, K., 2003. "Multi-factor agricultural productivity, efficiency and convergence in Botswana, 1981-1996", in *Journal of Development Economics*, Vol. 71, pp. 605-24.

Tisdell, C. A., 1999. "Socio-economic policy and change in South Asia: A review concentrating on Bangladesh", in M. Alauddin and S. Hasan (eds.), *Development, governance and the environment in South Asia: A focus on Bangladesh*, London: Macmillan, pp. 17-33.

Todaro, M.P., 1992. *Economics for a Developing World*, New York: Longman.

Townsend, P., 1979. *Poverty in the United Kingdom*, Harmondsworth: Penguin.

Trueblood, M.A. and Coggins, J., 2003. *Intercountry agricultural efficiency and productivity: A Malmquist Index approach*, World Bank, Washington DC (mimeo).

Warr, P., 2001. "Poverty reduction and sectoral growth: Evidence from Southeast Asia", paper presented at the WIDER Development Conference on Growth and Poverty, Helsinki.

Wiebe, K., Soule, M., Narrod C., and Breneman, V., 2000. "Resource quality and agricultural productivity: A multi-country comparison", USDA, Washington DC (mimeo).

World Bank, 1990. *World Development Report 1990*, New York: Oxford University Press.

—, 2003. *World Development Indicators 2003*, New York: Oxford University Press.

Appendices

Table A4.1. Average output and productivity growth for all the countries for sub-periods

	Growth rate (%) , Level 1970-1980						Growth rate (%) , Level 1980-1990						Growth rate (%) , Level 1990-2000					
				Productivity						Productivity						Productivity		
Country	Output	Land	Labour	TFP	Land	Labour	Output	Land	Labour	TFP	Land	Labour	Output	Land	Labour	TFP	Land	Labour
Algeria	0.819	-0.088	-1.136	0.784	0.908	1.977	2.970	-1.233	0.510	1.578	4.255	2.447	3.691	0.250	3.325	1.558	3.433	0.354
Angola	-3.759	0.000	1.592	0.617	-3.759	-5.267	-0.186	0.001	1.906	1.026	-0.186	-2.053	5.449	-0.018	2.896	2.120	5.469	2.482
Burundi	0.568	1.445	1.404	0.214	-0.865	-0.824	2.794	0.046	2.527	1.468	2.747	0.260	-1.208	0.069	1.122	1.744	-1.276	-2.304
Cameroon	2.035	1.134	0.334	0.884	0.891	1.695	1.726	0.087	1.993	1.134	1.638	-0.262	3.752	0.167	1.173	1.164	3.578	2.549
Chad	2.336	0.052	1.486	0.885	2.283	0.838	0.318	0.011	1.357	0.931	0.307	-1.024	4.834	0.071	1.930	1.151	4.760	2.849
Egypt	1.996	-1.497	1.444	1.095	3.546	0.544	3.157	0.801	-0.998	1.231	2.338	4.197	4.992	2.198	0.814	1.025	2.735	4.145
Ethiopia PDR	0.779	0.022	1.705	0.636	0.757	-0.910	1.183	-0.076	2.307	0.880	1.260	-1.099	1.499	-6.202	0.780	1.196	8.211	0.713
Ghana	-1.065	0.253	2.658	0.541	-1.315	-3.626	1.715	0.332	2.802	1.040	1.378	-1.057	7.605	1.331	2.673	1.894	6.192	4.804
Guinea	1.972	-0.343	0.886	1.579	2.323	1.077	0.322	0.100	1.668	0.564	0.222	-1.324	5.389	0.566	3.272	0.858	4.796	2.050
Côte d'Ivoire	4.366	-0.065	1.954	0.942	4.434	2.366	3.626	0.364	2.068	1.260	3.251	1.526	3.564	2.002	2.098	1.042	1.531	1.436
Kenya	3.280	0.132	3.154	1.089	3.144	0.122	4.293	0.086	3.326	1.011	4.204	0.936	1.576	0.008	2.944	0.896	1.568	-1.329
Madagascar	1.373	0.236	2.224	1.033	1.134	-0.832	1.474	0.038	2.511	0.956	1.436	-1.011	0.835	0.146	1.889	1.004	0.688	-1.035
Malawi	3.824	0.101	2.323	0.993	3.719	1.467	1.812	1.018	3.902	0.972	0.786	-2.011	5.993	1.541	1.260	1.715	4.385	4.675
Mali	2.147	0.094	1.594	1.006	2.051	0.544	2.721	0.013	2.367	0.929	2.707	0.345	2.335	0.777	1.251	0.998	1.547	1.071
Morocco	1.788	1.180	1.674	0.898	0.601	0.112	4.780	0.507	0.331	1.392	4.252	4.435	0.622	0.108	0.525	1.018	0.513	0.096
Mozambique	-0.746	0.015	2.392	0.578	-0.761	-3.064	0.086	0.011	0.996	2.306	0.075	-0.901	1.635	0.211	2.184	0.633	1.421	-0.536
Niger	3.727	0.168	2.873	0.382	3.553	0.830	-1.448	0.609	2.868	0.590	-2.044	-4.195	5.506	1.623	2.650	1.703	3.822	2.782
Nigeria	-0.879	0.069	1.088	0.495	-0.948	-1.946	5.278	0.237	0.251	1.306	5.029	5.014	5.601	-0.284	-0.948	1.629	5.902	6.611
Rwanda	3.294	2.021	2.863	1.720	1.248	0.419	1.661	0.755	3.116	0.243	0.900	-1.410	0.348	-0.866	1.161	2.042	1.224	-0.804
Senegal	-0.249	0.000	2.191	0.753	-0.249	-2.388	4.846	0.055	2.127	1.468	4.789	2.663	3.520	-0.054	2.079	1.014	3.576	1.411
South Africa	3.389	-0.158	-2.963	1.238	3.553	6.547	0.662	0.106	0.241	1.246	0.556	0.420	1.026	0.407	-1.140	1.741	0.617	2.192
Sudan	2.779	0.061	1.484	0.730	2.717	1.276	-0.622	1.077	2.092	0.958	-1.681	-2.659	6.052	0.839	2.077	1.679	5.170	3.895
Tanzania	2.984	-0.029	2.098	1.115	3.014	0.869	2.668	0.206	3.130	0.956	2.458	-0.448	1.233	0.340	2.744	1.120	0.890	-1.470
Tunisia	5.434	0.096	1.299	1.288	5.333	4.082	3.017	0.204	-0.623	1.168	2.807	3.663	5.036	1.007	1.559	1.217	3.989	3.424
Uganda	-2.994	-2.842	2.730	1.270	-0.156	-5.572	3.960	1.298	1.890	2.086	2.627	2.031	3.058	0.290	2.518	0.361	2.760	0.527
Burkina Faso	0.667	0.647	2.464	0.529	0.019	-1.755	5.365	0.820	2.191	0.659	4.508	3.106	4.419	0.328	1.092	1.042	4.078	3.291
Zimbabwe	3.243	0.066	2.489	1.170	3.174	0.735	2.496	0.171	2.981	1.089	2.321	-0.471	2.678	0.270	1.250	1.226	2.401	1.410
Canada	1.430	1.051	1.641	0.827	0.375	-0.208	2.456	0.027	-4.810	1.677	2.428	7.632	2.808	0.128	-2.376	1.411	2.676	5.310
Costa Rica	4.337	3.089	2.056	1.289	1.210	2.235	3.446	1.286	0.801	1.267	2.132	2.624	3.763	-0.049	0.896	1.411	3.814	2.841

Cuba	-0.141	1.688	0.360	0.741	-1.799	-0.499	1.858	0.638	-0.080	1.128	1.212	1.939	-3.854	0.522	-1.046	1.496	-4.353	-2.838
Dominican Rep.	4.124	0.850	-0.430	1.588	3.247	4.574	1.303	0.220	0.417	0.892	1.081	0.882	1.631	0.291	-1.585	1.417	1.336	3.268
El Salvador	5.073	0.782	-0.105	1.807	4.259	5.183	-0.965	0.060	-0.045	0.881	-1.024	-0.921	1.325	1.792	1.703	1.181	-0.458	-0.372
Guatemala	3.317	1.022	1.440	1.045	2.271	1.850	1.422	3.697	2.697	1.039	-2.194	-1.241	2.552	0.286	1.377	1.124	2.260	1.160
Haiti	1.828	-1.959	0.220	1.047	3.862	1.605	-0.713	0.021	0.887	0.758	-0.735	-1.587	3.244	-0.014	1.086	0.565	3.258	2.134
Honduras	3.992	0.692	1.663	1.256	3.278	2.291	1.447	0.192	0.145	1.302	1.253	1.300	3.156	-1.225	0.939	0.772	4.435	2.196
Mexico	4.351	0.142	2.171	1.269	4.203	2.133	1.606	0.317	0.626	0.967	1.285	0.974	3.128	0.487	0.128	1.389	2.628	2.996
Nicaragua	-0.624	1.013	0.719	0.568	-1.620	-1.333	-0.316	1.355	-0.771	1.066	-1.649	0.458	3.757	0.732	1.301	1.658	3.002	2.425
United States	1.926	-0.145	0.057	1.220	2.073	1.867	1.228	-0.028	-0.653	1.265	1.256	1.893	2.007	-0.206	-1.770	1.341	2.217	3.846
Argentina	1.942	-0.352	-0.761	1.053	2.301	2.724	1.206	-0.059	0.686	0.810	1.265	0.516	3.610	-0.012	-0.136	0.694	3.623	3.751
Bolivia	4.546	-0.398	2.000	1.159	4.964	2.495	2.881	-0.066	1.429	1.046	2.949	1.432	4.986	2.224	2.032	1.161	2.702	2.895
Brazil	4.398	1.217	0.914	0.925	3.143	3.452	2.725	0.884	-1.407	1.301	1.826	4.191	3.907	0.384	-1.429	1.224	3.510	5.413
Chile	1.725	1.331	1.092	1.097	0.389	0.627	3.461	0.263	1.610	1.189	3.190	1.822	3.295	-1.486	0.461	1.054	4.853	2.821
Colombia	3.649	0.515	1.462	1.087	3.118	2.156	2.651	0.106	-0.147	1.157	2.542	2.802	1.465	-0.070	0.578	1.249	1.536	0.883
Ecuador	1.263	2.926	0.159	0.887	-1.616	1.102	2.620	1.934	1.717	1.067	0.673	0.888	4.672	0.329	0.631	1.162	4.329	4.016
Paraguay	3.824	1.296	2.450	1.137	2.496	1.341	6.001	2.883	1.590	0.979	3.031	4.343	0.575	0.329	1.572	0.573	0.244	-0.982
Peru	-0.259	0.234	1.337	0.956	-0.492	-1.575	2.454	0.068	1.904	1.170	2.384	0.539	5.479	0.148	1.058	1.162	5.323	4.375
Uruguay	-1.352	0.016	-0.749	0.841	-1.368	-0.607	1.576	-0.172	0.104	1.163	1.751	1.471	1.997	0.040	-0.208	1.015	1.957	2.210
Venezuela	3.552	0.528	-0.983	0.943	3.008	4.580	2.129	0.528	1.528	0.994	1.593	0.591	2.563	-0.230	-0.868	1.364	2.800	3.461
Bangladesh	1.273	0.063	1.020	0.886	1.209	0.250	2.138	0.626	1.487	1.101	1.503	0.641	3.475	-1.331	1.022	1.458	4.871	2.428
Myanmar	3.960	-0.392	2.039	1.013	4.370	1.883	1.183	0.041	1.733	1.182	1.141	-0.540	5.174	0.361	1.573	1.216	4.795	3.545
Sri Lanka	2.333	-0.090	1.373	1.107	2.426	0.947	0.468	0.116	1.591	0.921	0.352	-1.105	1.504	0.047	1.602	1.140	1.456	-0.097
China	3.469	1.463	1.952	0.803	1.977	1.488	5.387	1.351	1.957	1.647	3.983	3.365	6.019	0.759	0.330	1.972	5.221	5.670
India	1.793	0.129	1.708	0.822	1.662	0.084	3.991	0.038	1.047	1.188	3.952	2.914	2.821	-0.024	1.302	1.116	2.846	1.499
Indonesia	3.789	-0.105	1.283	1.275	3.898	2.474	4.466	1.724	2.540	0.789	2.696	1.878	2.303	-0.080	1.136	0.872	2.385	1.154
Iran	3.591	-0.338	2.232	0.752	3.942	1.329	5.936	0.641	2.217	1.051	5.261	3.638	4.484	-0.196	-0.429	1.422	4.689	4.934
Iraq	2.166	0.485	-3.316	0.928	1.673	5.670	3.932	0.012	-2.975	1.280	3.920	7.119	-6.966	0.095	-1.466	0.484	-7.054	-5.582
Israel	3.703	0.151	-1.450	1.158	3.546	5.229	1.854	0.918	-1.567	1.081	0.928	3.475	0.188	-0.454	-0.819	1.005	0.645	1.015
Japan	1.262	-2.018	-4.991	1.331	3.348	6.582	0.681	-0.407	-2.904	1.082	1.092	3.692	-1.190	-0.015	-5.090	0.959	-1.175	4.109
Cambodia	-7.075	-2.516	-1.142	1.017	-4.677	-6.002	5.163	7.236	2.619	2.704	-1.933	2.479	4.214	-0.041	3.321	1.118	4.257	0.864
Rep.of Korea	4.203	-0.336	0.285	0.483	4.555	3.906	3.474	-0.225	-4.723	0.758	3.707	8.603	2.692	-1.070	-3.909	1.203	3.802	6.869
Laos	1.940	0.088	1.419	0.895	1.851	0.513	3.970	1.086	2.157	1.945	2.852	1.775	4.770	1.013	2.109	1.005	3.720	2.606
Malaysia	4.006	0.805	0.732	1.029	3.175	3.250	3.834	3.558	-1.192	0.985	0.267	5.087	2.128	0.953	-0.840	1.097	1.164	2.994
Mongolia	1.568	-1.208	0.925	0.539	2.809	0.637	1.365	-0.097	0.846	0.897	1.464	0.515	0.741	0.560	-0.616	2.490	0.180	1.365
Nepal	1.846	1.352	1.048	0.793	0.487	0.789	4.324	-0.143	2.383	1.080	4.474	1.896	2.628	1.308	2.047	1.134	1.302	0.569
Pakistan	2.858	0.391	2.013	0.873	2.458	0.829	4.718	0.250	1.769	1.084	4.457	2.898	4.664	0.386	1.304	1.464	4.261	3.317
Philippines	4.540	1.573	2.255	1.156	2.921	2.235	1.903	0.675	1.270	1.059	1.220	0.626	2.037	0.870	1.031	1.105	1.158	0.996
Saudi Arabia	6.065	0.063	1.916	1.121	5.999	4.071	13.105	3.568	-1.699	2.063	9.208	15.060	1.358	3.476	-5.334	1.095	-2.047	7.069

Syria	9.238	0.439	-0.586	1.407	8.760	9.882	0.711	-0.031	1.746	0.576	0.742	-1.017	4.660	-0.221	2.330	1.377	4.892	2.277
Thailand	4.663	2.886	1.897	0.888	1.726	2.715	1.816	1.222	1.628	0.749	0.587	0.185	2.954	-1.279	0.388	1.202	4.288	2.556
Turkey	3.431	0.105	-0.058	0.853	3.323	3.491	2.806	0.281	1.677	1.076	2.517	1.110	1.844	-0.159	0.786	1.133	2.006	1.049
Viet Nam	2.967	0.667	1.778	0.876	2.285	1.168	4.562	-0.194	2.558	1.623	4.766	1.954	6.140	1.740	1.328	0.938	4.325	4.749
Austria	1.395	-0.582	-3.155	1.161	1.989	4.699	0.371	-0.487	-1.948	1.320	0.862	2.365	0.147	-0.319	-3.614	1.374	0.468	3.903
Belgium-Lux	0.729	-1.736	-3.845	1.455	2.508	4.756	0.973	-0.351	-1.092	1.234	1.328	2.088	2.696	0.260	-3.189	1.647	2.429	6.078
Bulgaria	1.409	0.281	-4.887	1.180	1.125	6.620	0.144	-0.036	-4.305	1.266	0.180	4.649	-5.507	0.148	-6.966	1.161	-5.647	1.568
Czechoslovakia	2.392	-0.347	-1.523	1.230	2.748	3.975	1.500	-0.169	-1.051	1.151	1.672	2.578						
Denmark	1.724	-0.238	-3.309	1.382	1.966	5.205	1.845	-0.410	-1.582	1.455	2.265	3.482	0.763	-0.518	-3.710	1.291	1.288	4.646
Finland	0.875	0.011	-3.874	1.264	0.864	4.940	0.512	-0.226	-2.936	1.246	0.739	3.553	-1.592	-1.850	-4.040	1.179	0.263	2.552
France	1.838	-0.240	-3.944	1.599	2.083	6.020	0.629	-0.369	-3.656	1.526	1.002	4.448	0.747	-0.286	-4.027	1.446	1.036	4.974
Germany	1.210	-0.268	-1.756	1.184	1.482	3.019	0.579	-0.266	-4.817	1.202	0.847	5.669	-0.785	-0.548	-4.390	1.293	-0.238	3.770
Greece	3.238	0.027	-2.035	0.929	3.210	5.383	-0.176	-0.022	-1.850	0.860	-0.154	1.706	2.351	-0.711	-2.260	1.640	3.084	4.717
Hungary	4.088	-0.367	-3.722	1.670	4.471	8.112	0.091	-0.233	-2.649	1.338	0.325	2.814	-3.207	-1.002	-3.403	0.682	-2.228	0.203
Ireland	3.860	0.105	-2.323	1.174	3.750	6.330	1.268	-1.056	-2.165	1.303	2.349	3.509	1.115	-1.555	-1.417	1.160	2.712	2.568
Italy	1.734	-1.380	-3.268	0.841	3.158	5.172	-0.741	-0.419	-2.955	0.928	-0.323	2.281	1.182	-0.973	-4.340	1.389	2.176	5.772
Netherlands	3.414	-0.818	-0.435	1.264	4.267	3.866	1.590	-0.070	0.032	1.271	1.660	1.558	0.359	-0.252	-2.363	1.239	0.612	2.788
Norway	1.429	-0.190	-1.652	1.131	1.623	3.133	0.792	0.419	-1.758	1.080	0.371	2.595	-0.943	0.637	-2.317	1.038	-1.570	1.406
Poland	-0.171	-0.278	-1.982	0.647	0.107	1.848	2.045	-0.113	-0.696	1.380	2.161	2.760	-2.524	-0.204	-1.709	0.991	-2.325	-0.829
Portugal	-0.337	0.127	1.051	0.546	-0.463	-1.374	2.552	0.080	-3.336	1.303	2.470	6.091	1.038	0.322	-2.693	1.277	0.714	3.834
Romania	4.857	0.023	-3.356	1.410	4.833	8.498	-1.321	-0.131	-3.902	0.998	-1.192	2.685	-1.937	0.027	-4.427	1.589	-1.964	2.605
Spain	4.181	-0.278	-3.512	0.999	4.471	7.973	1.594	-0.248	-3.047	1.026	1.846	4.787	1.811	-0.267	-3.761	1.152	2.084	5.789
Sweden	1.332	-0.142	-1.813	1.212	1.476	3.203	0.689	-0.815	-2.359	1.154	1.517	3.122	-1.659	-0.789	-2.964	1.081	-0.877	1.344
Switzerland	1.671	-0.732	-1.728	1.066	2.421	3.460	0.180	0.005	0.567	1.070	0.175	-0.385	-0.589	-2.425	-2.207	1.645	1.882	1.655
Ukraine	1.781	-0.203	-0.265	1.199	1.988	2.051	0.709	-0.330	-1.178	1.190	1.042	1.909	-0.158	-0.520	-1.553	1.087	0.365	1.418
Yugoslavia	2.973	-0.236	-3.411	0.773	3.216	6.609	-0.287	-0.142	-3.225	1.003	-0.146	3.036						
Australia	1.256	0.024	-0.069	1.073	1.232	1.326	2.103	-0.389	0.649	1.256	2.501	1.444	2.832	-0.195	-0.351	1.329	3.033	3.195
New Zealand	1.203	0.876	1.305	1.114	0.325	-0.101	0.212	-0.172	1.276	1.180	0.384	-1.050	2.520	-0.456	0.118	0.970	2.989	2.399
Papua NG	2.771	-3.014	2.147	1.044	5.965	0.610	1.302	0.272	1.719	0.874	1.027	-0.409	2.346	7.823	1.431	0.887	-5.080	0.902
USSR	0.738	0.103	0.085	0.887	0.635	0.653	1.936	0.052	-1.113	1.259	1.882	3.083						
Belarus													-0.696	-0.094	-2.029	1.235	-0.603	1.361
Czech Rep.													-0.085	-0.005	-1.282	1.027	-0.080	1.212
Georgia													-1.818	-0.159	-1.371	0.770	-1.662	-0.453
Kazakhstan													-0.590	-0.353	-1.160	1.689	-0.238	0.576
Kyrgyzstan													3.507	0.272	-0.072	1.250	3.227	3.581
Latvia													-2.245	-0.227	-1.714	0.515	-2.023	-0.541
Lithuania													0.747	-0.054	-1.998	0.932	0.802	2.801
Russian Fed.													-0.783	0.035	-1.369	1.156	-0.818	0.595

Slovakia													-2.626	-0.020	-0.989	0.919	-2.606	-1.653
Slovenia													0.387	-0.378	-5.168	1.234	0.768	5.858
Tajikistan													-1.334	0.133	0.124	2.073	-1.465	-1.457
Turkmenistan													-1.022	0.039	0.924	1.166	-1.061	-1.928
Ukraine													-2.343	-0.107	-1.932	1.353	-2.238	-0.419
Uzbekistan													-0.496	-0.007	0.149	0.785	-0.489	-0.644

Table A4.2. Total factor productivity, labour productivity, and land productivity levels in agriculture by regions (USA=1.00)

Year Level	1970			1975			1980			1985		
Region	TFP	Lab Prod	Land Prod	TFP	Lab Prod	Land Prod	TFP	Lab Prod	Land Prod	TFP	Lab Prod	Land Prod
North Africa and the Middle East	0.410	0.032	0.971	0.445	0.035	0.967	0.314	0.037	1.059	0.328	0.035	1.024
Sub-Saharan Africa	0.456	0.020	0.306	0.531	0.019	0.291	0.327	0.018	0.273	0.365	0.015	0.279
North America, Australia and New Zealand	0.936	0.998	0.798	0.952	0.977	0.788	0.920	0.968	0.784	0.934	0.975	0.788
Latin America	0.589	0.095	0.521	0.670	0.088	0.496	0.491	0.093	0.543	0.500	0.089	0.541
Asia	0.408	0.016	1.908	0.447	0.016	1.861	0.295	0.016	1.962	0.301	0.015	2.041
China	0.290	0.008	0.837	0.298	0.008	0.819	0.186	0.008	0.829	0.240	0.008	0.929
Europe	0.744	0.263	3.404	0.807	0.283	3.328	0.745	0.345	3.501	0.696	0.360	3.360
Transition countries	0.496	0.093	0.935	0.487	0.092	0.924	0.386	0.093	0.879	0.366	0.093	0.849
Mean	0.549	0.086	1.120	0.578	0.083	1.090	0.443	0.084	1.117	0.445	0.075	1.119

Year Level	1990			1995			2000		
Region	TFP	Lab Prod	Land Prod	TFP	Lab Prod	Land Prod	TFP	Lab Prod	Land Prod
North Africa and the Middle East	0.344	0.039	1.127	0.423	0.038	1.123	0.404	0.033	1.241
Sub-Saharan Africa	0.395	0.015	0.322	0.548	0.015	0.366	0.487	0.013	0.374
North America, Australia and New Zealand	0.953	0.995	0.783	0.974	1.042	0.785	0.933	0.996	0.783
Latin America	0.529	0.094	0.559	0.635	0.107	0.592	0.553	0.094	0.599
Asia	0.292	0.016	2.218	0.347	0.016	2.405	0.339	0.013	2.296

China	0.258	0.009	1.082	0.427	0.012	1.442	0.450	0.011	1.445
Europe	0.751	0.409	3.388	0.845	0.459	3.306	0.850	0.424	3.047
Transition countries	0.414	0.105	0.877	0.560	0.088	0.793	0.505	0.068	0.602
Mean	**0.452**	**0.073**	**1.181**	**0.550**	**0.066**	**1.273**	**0.528**	**0.055**	**1.228**

Table A4.3. Total factor productivity, labour productivity, and land productivity levels in agriculture for selected countries (USA=1.00)

Year level	**1970**			**1975**			**1980**			**1985**		
Country	**TFP**	**Lab prod**	**Land prod**	**TFP**	**Lab prod**	**Land prod**	**TFP**	**Lab prod**	**Land prod**	**TFP**	**Lab prod**	**Land prod**
Netherlands	1.270	0.621	10.496	1.321	0.655	11.299	1.190	0.754	12.983	1.081	0.716	13.245
Poland	0.583	0.076	2.970	0.572	0.085	3.010	0.365	0.076	2.445	0.365	0.075	2.517
China	0.290	0.008	0.837	0.298	0.008	0.819	0.186	0.008	0.829	0.240	0.008	0.929
India	0.316	0.012	1.397	0.328	0.011	1.349	0.205	0.010	1.342	0.213	0.010	1.501
Syria	0.429	0.039	0.335	0.591	0.057	0.454	0.529	0.084	0.631	0.440	0.067	0.586
Brazil	0.441	0.055	0.509	0.443	0.057	0.498	0.328	0.064	0.565	0.370	0.068	0.592
Egypt	0.583	0.024	7.286	0.635	0.022	7.004	0.428	0.021	8.409	0.534	0.021	8.388
Nigeria	0.767	0.020	0.462	0.637	0.016	0.372	0.355	0.013	0.342	0.409	0.013	0.365

Year Level	**1990**			**1995**			**2000**		
Country	**TFP**	**Lab prod**	**Land prod**	**TFP**	**Lab prod**	**Land prod**	**TFP**	**Lab prod**	**Land prod**
Netherlands	1.245	0.729	13.511	1.368	0.719	13.134	1.394	0.658	11.533
Poland	0.433	0.083	2.672	0.433	0.066	2.089	0.391	0.052	1.696
China	0.258	0.009	1.082	0.427	0.012	1.442	0.450	0.011	1.445
India	0.212	0.012	1.745	0.256	0.012	1.914	0.250	0.009	1.856
Syria	0.383	0.063	0.600	0.454	0.064	0.691	0.467	0.054	0.777
Brazil	0.411	0.080	0.597	0.510	0.103	0.663	0.462	0.093	0.677
Egypt	0.618	0.026	9.351	0.816	0.031	8.417	0.639	0.027	9.835
Nigeria	0.431	0.018	0.493	0.750	0.023	0.624	0.663	0.024	0.703

Table A4.4. Mean technical efficiency change, technical Change and TFP change by countries, 1970-2001

No	Country	Region	Efficiency change	Technical change	TFP change
1	Algeria	1	1.006	1.017	1.023
2	Angola	2	1.025	0.985	1.009
3	Burundi	2	1.000	0.984	0.984
4	Cameroon	2	1.000	1.004	1.003
5	Chad	2	1.006	0.998	1.004
6	Egypt	1	1.000	1.009	1.009
7	Ethiopia PDR	2	0.993	0.994	0.987
8	Ghana	2	1.000	1.004	1.004
9	Guinea	2	1.005	0.988	0.993
10	Côte d'Ivoire	2	1.000	1.009	1.009
11	Kenya	2	1.002	0.998	1.000
12	Madagascar	2	1.009	0.995	1.005
13	Malawi	2	1.006	1.010	1.016
14	Mali	2	0.996	1.004	1.000
15	Morocco	1	1.004	1.007	1.010
16	Mozambique	2	1.000	0.988	0.987
17	Niger	2	0.997	0.974	0.971
18	Nigeria	2	1.000	1.000	0.999
19	Rwanda	2	1.000	0.995	0.995
20	Senegal	2	0.998	1.005	1.002
21	South Africa	2	1.014	1.016	1.031
22	Sudan	2	1.005	0.996	1.000
23	Tanzania	2	1.013	0.993	1.006
24	Tunisia	1	1.010	1.005	1.015
25	Uganda	2	1.000	0.998	0.998
26	Burkina Faso	2	0.996	0.980	0.976
27	Zimbabwe	2	1.004	1.009	1.013
28	Canada	3	1.000	1.022	1.022
29	Costa Rica	4	1.004	1.025	1.029
30	Cuba	4	0.976	1.019	0.994
31	Dominican Rep.	4	1.000	1.023	1.023
32	El Salvador	4	0.997	1.021	1.018
33	Guatemala	4	0.997	1.010	1.007
34	Haiti	4	1.000	0.974	0.974
35	Hondurus	4	0.999	1.009	1.008
36	Mexico	4	0.998	1.016	1.014
37	Nicaragua	4	1.000	1.005	1.005
38	United States	3	1.000	1.023	1.023
39	Argentina	4	1.000	0.983	0.983
40	Bolivia	4	1.000	1.005	1.005
41	Brazil	4	1.004	1.010	1.014
42	Chile	4	1.000	1.013	1.013
43	Colombia	4	1.011	1.004	1.015
44	Ecuador	4	1.000	0.999	0.999
45	Paraguay	4	1.000	0.989	0.989
46	Peru	4	1.005	1.003	1.008
47	Uruguay	4	1.000	0.993	0.993
48	Venezuela	4	1.003	1.006	1.009
49	Bangladesh	5	1.000	1.011	1.011
50	Myanmar	5	1.009	1.007	1.016
51	Sri Lanka	5	1.000	1.003	1.003
52	China	6	1.016	1.013	1.030
53	India	5	0.993	1.009	1.003
54	Indonesia	5	0.990	1.006	0.995

55	Iran	1	0.996	1.007	1.003
56	Iraq	1	0.977	1.007	0.985
57	Israel	1	1.000	1.008	1.008
58	Japan	5	0.995	1.015	1.010
59	Cambodia	5	0.994	1.043	1.037
60	Korea, Rep. of	5	1.000	0.975	0.975
61	Laos	5	1.001	1.012	1.012
62	Malaysia	5	1.000	1.004	1.004
63	Mongolia	5	1.000	0.999	0.999
64	Nepal	5	0.993	1.005	0.999
65	Pakistan	5	0.996	1.015	1.011
66	Philippines	5	1.000	1.010	1.010
67	Saudi Arabia	1	1.018	1.014	1.031
68	Syria	1	1.003	1.006	1.009
69	Thailand	5	0.993	1.000	0.993
70	Turkey	1	1.002	1.000	1.001
71	Viet Nam	5	0.996	1.012	1.008
72	Austria	7	1.006	1.018	1.024
73	Belgium-Lux	7	1.000	1.035	1.035
74	Bulgaria	8	1.008	1.012	1.020
75	Czechoslovakia	8	1.017	1.024	1.041
76	Denmark	7	1.010	1.022	1.032
77	Finland	7	0.997	1.024	1.021
78	France	7	1.008	1.032	1.040
79	Germany	7	1.004	1.017	1.021
80	Greece	7	1.004	1.005	1.009
81	Hungary	8	1.004	1.020	1.024
82	Ireland	7	0.999	1.020	1.019
83	Italy	7	1.003	1.000	1.003
84	Netherlands	7	1.000	1.021	1.021
85	Norway	7	0.991	1.017	1.008
86	Poland	8	0.983	1.015	0.999
87	Portugal	7	0.993	1.003	0.996
88	Romania	8	1.017	1.015	1.033
89	Spain	7	1.011	0.994	1.005
90	Sweden	7	0.995	1.019	1.014
91	Switzerland	7	1.000	1.020	1.020
92	United Kingdom	7	0.988	1.026	1.013
93	Yugoslavia SFR	8	1.020	1.024	1.044
94	Australia	3	1.000	1.020	1.020
95	New Zealand	3	1.000	1.008	1.008
96	Papua New Guinea	5	1.000	0.991	0.991
97	USSR	8	1.145	1.099	1.258
98	Belarus	8	1.592	1.373	2.185
99	Czech Republic	8	0.878	1.038	0.913
100	Georgia	8	1.468	0.908	1.334
101	Kazakhstan	8	1.467	1.257	1.830
102	Kyrgyzstan	8	1.004	1.051	1.055
103	Latvia	8	1.281	0.913	1.171
104	Lithuania	8	0.795	0.908	0.723
105	Russian Federation	8	1.793	0.889	1.592
106	Slovakia	8	1.087	0.862	0.936
107	Slovenia	8	1.138	1.087	1.238
108	Tajikistan	8	1.103	1.035	1.141
109	Turkmenistan	8	0.898	1.162	1.044
110	Ukraine	8	1.318	0.902	1.189
111	Uzbekistan	8	0.939	1.024	0.963
		Mean	**1.001**	**1.007**	**1.008**

Table A4.5. Mean technical efficiency change, technical change and TFP change, 1970-2001 (sorted by region and TFP change)

Region	Country	Efficiency change	Technical change	TFP change
North Africa and Middle East	***Saudi Arabia***	***1.018***	***1.014***	***1.031***
	Algeria	1.006	1.017	1.023
	Tunisia	1.01	1.005	1.015
	Morocco	1.004	1.007	1.01
	Egypt	1	1.009	1.009
	Syria	1.003	1.006	1.009
	Israel	1	1.008	1.008
	Iran	0.996	1.007	1.003
	Turkey	1.002	1	1.001
Sub-Saharan Africa	Iraq	0.977	1.007	0.985
	South Africa	***1.014***	1.016	***1.031***
	Malawi	1.006	1.01	1.016
	Zimbabwe	1.004	1.009	1.013
	Angola	1.025	0.985	1.009
	Côte d'Ivoire	1	1.009	1.009
	Tanzania	1.013	0.993	1.006
	Madagascar	1.009	0.995	1.005
	Ghana	1	1.004	1.004
	Chad	1.006	0.998	1.004
	Cameroon	1	1.004	1.003
	Senegal	0.998	1.005	1.002
	Sudan	1.005	0.996	1
	Kenya	1.002	0.998	1
	Mali	0.996	1.004	1
	Nigeria	1	1	0.999
	Uganda	1	0.998	0.998
	Rwanda	1	0.995	0.995
	Guinea	1.005	0.988	0.993
	Mozambique	1	0.988	0.987
	Ethiopia PDR	0.993	0.994	0.987
	Burundi	1	0.984	0.984
North America and Australia and N.Z.	Burkina Faso	0.996	0.98	0.976
	Niger	0.997	0.974	0.971
Latin America	United States	***1***	***1.023***	***1.023***
	Canada	1	1.022	1.022
	Australia	1	1.02	1.02
	New Zealand	1	1.008	1.008
	Costa Rica	***1.004***	***1.025***	***1.029***
	Dominican Rep.	1	1.023	1.023
	El Salvador	0.997	1.021	1.018
	Colombia	1.011	1.004	1.015
	Mexico	0.998	1.016	1.014
	Brazil	1.004	1.01	1.014
	Chile	1	1.013	1.013
	Venezuela	1.003	1.006	1.009

	Honduras	0.999	1.009	1.008
	Peru	1.005	1.003	1.008
	Guatemala	0.997	1.01	1.007
	Bolivia	1	1.005	1.005
	Nicaragua	1	1.005	1.005
	Ecuador	1	0.999	0.999
	Cuba	0.976	1.019	0.994
Asia	Uruguay	1	0.993	0.993
	Paraguay	1	0.989	0.989
	Argentina	1	0.983	0.983
	Haiti	1	0.974	0.974
	Cambodia	***0.994***	***1.043***	***1.037***
	Myanmar	1.009	1.007	1.016
	Laos	1.001	1.012	1.012
	Bangladesh	1	1.011	1.011
	Pakistan	0.996	1.015	1.011
	Philippines	1	1.01	1.01
	Japan	0.995	1.015	1.01
	Viet Nam	0.996	1.012	1.008
	Malaysia	1	1.004	1.004
	Sri Lanka	1	1.003	1.003
	India	0.993	1.009	1.003
	Mongolia	1	0.999	0.999
	Nepal	0.993	1.005	0.999
China	Indonesia	0.99	1.006	0.995
Europe	Thailand	0.993	1	0.993
	Papua New Guin.	1	0.991	0.991
	Korea, Rep. of	1	0.975	0.975
	China	***1.016***	***1.013***	***1.03***
	France	***1.008***	***1.032***	***1.04***
	Bel-Lux	1	1.035	1.035
	Denmark	1.01	1.022	1.032
	Austria	1.006	1.018	1.024
	Finland	0.997	1.024	1.021
	Netherlands	1	1.021	1.021
	Germany	1.004	1.017	1.021
	Switzerland	1	1.02	1.02
	Ireland	0.999	1.02	1.019
	Sweden	0.995	1.019	1.014
	United Kingdom	0.988	1.026	1.013
	Greece	1.004	1.005	1.009
Transition Countries	Norway	0.991	1.017	1.008
	Spain	1.011	0.994	1.005
	Italy	1.003	1	1.003
	Portugal	0.993	1.003	0.996
	Belarus	***1.592***	***1.373***	***2.185***
	Kazakhstan	1.467	1.257	1.83
	Russian Fed.	1.793	0.889	1.592
	Georgia	1.468	0.908	1.334
	USSR	1.145	1.099	1.258
	Slovenia	1.138	1.087	1.238
	Ukraine	1.318	0.902	1.189
	Latvia	1.281	0.913	1.171

	Tajikistan	1.103	1.035	1.141
	Kyrgyzstan	1.004	1.051	1.055
	Turkmenistan	0.898	1.162	1.044
	Yugoslav SFR	1.02	1.024	1.044
	Czechoslovakia	1.017	1.024	1.041
	Romania	1.017	1.015	1.033
	Hungary	1.004	1.02	1.024
	Bulgaria	1.008	1.012	1.02
	Poland	0.983	1.015	0.999
	Uzbekistan	0.939	1.024	0.963
	Slovakia	1.087	0.862	0.936
	Czech Republic	0.878	1.038	0.913
	Lithuania	0.795	0.908	0.723

Table A4.6. Average output and productivity growth for all the countries for sub-periods

	Growth rate (%) , Level 1970-1980						Growth rate (%) , Level 1980-1990						Growth rate (%) , Level 1990-2000					
				Productivity						Productivity						Productivity		
Country	**Output**	**Land**	**Labour**	**TFP**	**Land**	**Labour**	**Output**	**Land**	**Labour**	**TFP**	**Land**	**Labour**	**Output**	**Land**	**Labour**	**TFP**	**Land**	**Labour**
Algeria	0.819	-0.088	-1.136	0.784	0.908	1.977	2.970	-1.233	0.510	1.578	4.255	2.447	3.691	0.250	3.325	1.558	3.433	0.354
Angola	-3.759	0.000	1.592	0.617	-3.759	-5.267	-0.186	0.001	1.906	1.026	-0.186	-2.053	5.449	-0.018	2.896	2.120	5.469	2.482
Burundi	0.568	1.445	1.404	0.214	-0.865	-0.824	2.794	0.046	2.527	1.468	2.747	0.260	-1.208	0.069	1.122	1.744	-1.276	-2.304
Cameroon	2.035	1.134	0.334	0.884	0.891	1.695	1.726	0.087	1.993	1.134	1.638	-0.262	3.752	0.167	1.173	1.164	3.578	2.549
Chad	2.336	0.052	1.486	0.885	2.283	0.838	0.318	0.011	1.357	0.931	0.307	-1.024	4.834	0.071	1.930	1.151	4.760	2.849
Egypt	1.996	-1.497	1.444	1.095	3.546	0.544	3.157	0.801	-0.998	1.231	2.338	4.197	4.992	2.198	0.814	1.025	2.735	4.145
Ethiopia PDR	0.779	0.022	1.705	0.636	0.757	-0.910	1.183	-0.076	2.307	0.880	1.260	-1.099	1.499	-6.202	0.780	1.196	8.211	0.713
Ghana	-1.065	0.253	2.658	0.541	-1.315	-3.626	1.715	0.332	2.802	1.040	1.378	-1.057	7.605	1.331	2.673	1.894	6.192	4.804
Guinea	1.972	-0.343	0.886	1.579	2.323	1.077	0.322	0.100	1.668	0.564	0.222	-1.324	5.389	0.566	3.272	0.858	4.796	2.050
Côte d'Ivoire	4.366	-0.065	1.954	0.942	4.434	2.366	3.626	0.364	2.068	1.260	3.251	1.526	3.564	2.002	2.098	1.042	1.531	1.436
Kenya	3.280	0.132	3.154	1.089	3.144	0.122	4.293	0.086	3.326	1.011	4.204	0.936	1.576	0.008	2.944	0.896	1.568	-1.329
Madagascar	1.373	0.236	2.224	1.033	1.134	-0.832	1.474	0.038	2.511	0.956	1.436	-1.011	0.835	0.146	1.889	1.004	0.688	-1.035
Malawi	3.824	0.101	2.323	0.993	3.719	1.467	1.812	1.018	3.902	0.972	0.786	-2.011	5.993	1.541	1.260	1.715	4.385	4.675
Mali	2.147	0.094	1.594	1.006	2.051	0.544	2.721	0.013	2.367	0.929	2.707	0.345	2.335	0.777	1.251	0.998	1.547	1.071
Morocco	1.788	1.180	1.674	0.898	0.601	0.112	4.780	0.507	0.331	1.392	4.252	4.435	0.622	0.108	0.525	1.018	0.513	0.096
Mozambique	-0.746	0.015	2.392	0.578	-0.761	-3.064	0.086	0.011	0.996	2.306	0.075	-0.901	1.635	0.211	2.184	0.633	1.421	-0.536
Niger	3.727	0.168	2.873	0.382	3.553	0.830	-1.448	0.609	2.868	0.590	-2.044	-4.195	5.506	1.623	2.650	1.703	3.822	2.782
Nigeria	-0.879	0.069	1.088	0.495	-0.948	-1.946	5.278	0.237	0.251	1.306	5.029	5.014	5.601	-0.284	-0.948	1.629	5.902	6.611
Rwanda	3.294	2.021	2.863	1.720	1.248	0.419	1.661	0.755	3.116	0.243	0.900	-1.410	0.348	-0.866	1.161	2.042	1.224	-0.804
Senegal	-0.249	0.000	2.191	0.753	-0.249	-2.388	4.846	0.055	2.127	1.468	4.789	2.663	3.520	-0.054	2.079	1.014	3.576	1.411
South Africa	3.389	-0.158	-2.963	1.238	3.553	6.547	0.662	0.106	0.241	1.246	0.556	0.420	1.026	0.407	-1.140	1.741	0.617	2.192
Sudan	2.779	0.061	1.484	0.730	2.717	1.276	-0.622	1.077	2.092	0.958	-1.681	-2.659	6.052	0.839	2.077	1.679	5.170	3.895
Tanzania	2.984	-0.029	2.098	1.115	3.014	0.869	2.668	0.206	3.130	0.956	2.458	-0.448	1.233	0.340	2.744	1.120	0.890	-1.470
Tunisia	5.434	0.096	1.299	1.288	5.333	4.082	3.017	0.204	-0.623	1.168	2.807	3.663	5.036	1.007	1.559	1.217	3.989	3.424
Uganda	-2.994	-2.842	2.730	1.270	-0.156	-5.572	3.960	1.298	1.890	2.086	2.627	2.031	3.058	0.290	2.518	0.361	2.760	0.527
Burkina Faso	0.667	0.647	2.464	0.529	0.019	-1.755	5.365	0.820	2.191	0.659	4.508	3.106	4.419	0.328	1.092	1.042	4.078	3.291
Zimbabwe	3.243	0.066	2.489	1.170	3.174	0.735	2.496	0.171	2.981	1.089	2.321	-0.471	2.678	0.270	1.250	1.226	2.401	1.410
Canada	1.430	1.051	1.641	0.827	0.375	-0.208	2.456	0.027	-4.810	1.677	2.428	7.632	2.808	0.128	-2.376	1.411	2.676	5.310
Costa Rica	4.337	3.089	2.056	1.289	1.210	2.235	3.446	1.286	0.801	1.267	2.132	2.624	3.763	-0.049	0.896	1.411	3.814	2.841

Cuba	-0.141	1.688	0.360	0.741	-1.799	-0.499	1.858	0.638	-0.080	1.128	1.212	1.939	-3.854	0.522	-1.046	1.496	-4.353	-2.838
Dominican	4.124	0.850	-0.430	1.588	3.247	4.574	1.303	0.220	0.417	0.892	1.081	0.882	1.631	0.291	-1.585	1.417	1.336	3.268
El Salvador	5.073	0.782	-0.105	1.807	4.259	5.183	-0.965	0.060	-0.045	0.881	-1.024	-0.921	1.325	1.792	1.703	1.181	-0.458	-0.372
Guatemala	3.317	1.022	1.440	1.045	2.271	1.850	1.422	3.697	2.697	1.039	-2.194	-1.241	2.552	0.286	1.377	1.124	2.260	1.160
Haiti	1.828	-1.959	0.220	1.047	3.862	1.605	-0.713	0.021	0.887	0.758	-0.735	-1.587	3.244	-0.014	1.086	0.565	3.258	2.134
Honduras	3.992	0.692	1.663	1.256	3.278	2.291	1.447	0.192	0.145	1.302	1.253	1.300	3.156	-1.225	0.939	0.772	4.435	2.196
Mexico	4.351	0.142	2.171	1.269	4.203	2.133	1.606	0.317	0.626	0.967	1.285	0.974	3.128	0.487	0.128	1.389	2.628	2.996
Nicaragua	-0.624	1.013	0.719	0.568	-1.620	-1.333	-0.316	1.355	-0.771	1.066	-1.649	0.458	3.757	0.732	1.301	1.658	3.002	2.425
United States	1.926	-0.145	0.057	1.220	2.073	1.867	1.228	-0.028	-0.653	1.265	1.256	1.893	2.007	-0.206	-1.770	1.341	2.217	3.846
Argentina	1.942	-0.352	-0.761	1.053	2.301	2.724	1.206	-0.059	0.686	0.810	1.265	0.516	3.610	-0.012	-0.136	0.694	3.623	3.751
Bolivia	4.546	-0.398	2.000	1.159	4.964	2.495	2.881	-0.066	1.429	1.046	2.949	1.432	4.986	2.224	2.032	1.161	2.702	2.895
Brazil	4.398	1.217	0.914	0.925	3.143	3.452	2.725	0.884	-1.407	1.301	1.826	4.191	3.907	0.384	-1.429	1.224	3.510	5.413
Chile	1.725	1.331	1.092	1.097	0.389	0.627	3.461	0.263	1.610	1.189	3.190	1.822	3.295	-1.486	0.461	1.054	4.853	2.821
Colombia	3.649	0.515	1.462	1.087	3.118	2.156	2.651	0.106	-0.147	1.157	2.542	2.802	1.465	-0.070	0.578	1.249	1.536	0.883
Ecuador	1.263	2.926	0.159	0.887	-1.616	1.102	2.620	1.934	1.717	1.067	0.673	0.888	4.672	0.329	0.631	1.162	4.329	4.016
Paraguay	3.824	1.296	2.450	1.137	2.496	1.341	6.001	2.883	1.590	0.979	3.031	4.343	0.575	0.329	1.572	0.573	0.244	-0.982
Peru	-0.259	0.234	1.337	0.956	-0.492	-1.575	2.454	0.068	1.904	1.170	2.384	0.539	5.479	0.148	1.058	1.162	5.323	4.375
Uruguay	-1.352	0.016	-0.749	0.841	-1.368	-0.607	1.576	-0.172	0.104	1.163	1.751	1.471	1.997	0.040	-0.208	1.015	1.957	2.210
Venezuela	3.552	0.528	-0.983	0.943	3.008	4.580	2.129	0.528	1.528	0.994	1.593	0.591	2.563	-0.230	-0.868	1.364	2.800	3.461
Bangladesh	1.273	0.063	1.020	0.886	1.209	0.250	2.138	0.626	1.487	1.101	1.503	0.641	3.475	-1.331	1.022	1.458	4.871	2.428
Myanmar	3.960	-0.392	2.039	1.013	4.370	1.883	1.183	0.041	1.733	1.182	1.141	-0.540	5.174	0.361	1.573	1.216	4.795	3.545
Sri Lanka	2.333	-0.090	1.373	1.107	2.426	0.947	0.468	0.116	1.591	0.921	0.352	-1.105	1.504	0.047	1.602	1.140	1.456	-0.097
China	3.469	1.463	1.952	0.803	1.977	1.488	5.387	1.351	1.957	1.647	3.983	3.365	6.019	0.759	0.330	1.972	5.221	5.670
India	1.793	0.129	1.708	0.822	1.662	0.084	3.991	0.038	1.047	1.188	3.952	2.914	2.821	-0.024	1.302	1.116	2.846	1.499
Indonesia	3.789	-0.105	1.283	1.275	3.898	2.474	4.466	1.724	2.540	0.789	2.696	1.878	2.303	-0.080	1.136	0.872	2.385	1.154
Iran	3.591	-0.338	2.232	0.752	3.942	1.329	5.936	0.641	2.217	1.051	5.261	3.638	4.484	-0.196	-0.429	1.422	4.689	4.934
Iraq	2.166	0.485	-3.316	0.928	1.673	5.670	3.932	0.012	-2.975	1.280	3.920	7.119	-6.966	0.095	-1.466	0.484	-7.054	-5.582
Israel	3.703	0.151	-1.450	1.158	3.546	5.229	1.854	0.918	-1.567	1.081	0.928	3.475	0.188	-0.454	-0.819	1.005	0.645	1.015
Japan	1.262	-2.018	-4.991	1.331	3.348	6.582	0.681	-0.407	-2.904	1.082	1.092	3.692	-1.190	-0.015	-5.090	0.959	-1.175	4.109
Cambodia	-7.075	-2.516	-1.142	1.017	-4.677	-6.002	5.163	7.236	2.619	2.704	-1.933	2.479	4.214	-0.041	3.321	1.118	4.257	0.864
Korea	4.203	-0.336	0.285	0.483	4.555	3.906	3.474	-0.225	-4.723	0.758	3.707	8.603	2.692	-1.070	-3.909	1.203	3.802	6.869
Laos	1.940	0.088	1.419	0.895	1.851	0.513	3.970	1.086	2.157	1.945	2.852	1.775	4.770	1.013	2.109	1.005	3.720	2.606
Malaysia	4.006	0.805	0.732	1.029	3.175	3.250	3.834	3.558	-1.192	0.985	0.267	5.087	2.128	0.953	-0.840	1.097	1.164	2.994
Mongolia	1.568	-1.208	0.925	0.539	2.809	0.637	1.365	-0.097	0.846	0.897	1.464	0.515	0.741	0.560	-0.616	2.490	0.180	1.365
Nepal	1.846	1.352	1.048	0.793	0.487	0.789	4.324	-0.143	2.383	1.080	4.474	1.896	2.628	1.308	2.047	1.134	1.302	0.569
Pakistan	2.858	0.391	2.013	0.873	2.458	0.829	4.718	0.250	1.769	1.084	4.457	2.898	4.664	0.386	1.304	1.464	4.261	3.317
Philippines	4.540	1.573	2.255	1.156	2.921	2.235	1.903	0.675	1.270	1.059	1.220	0.626	2.037	0.870	1.031	1.105	1.158	0.996
Saudi Arabia	6.065	0.063	1.916	1.121	5.999	4.071	13.105	3.568	-1.699	2.063	9.208	15.060	1.358	3.476	-5.334	1.095	-2.047	7.069

Syria	9.238	0.439	-0.586	1.407	8.760	9.882	0.711	-0.031	1.746	0.576	0.742	-1.017	4.660	-0.221	2.330	1.377	4.892	2.277
Thailand	4.663	2.886	1.897	0.888	1.726	2.715	1.816	1.222	1.628	0.749	0.587	0.185	2.954	-1.279	0.388	1.202	4.288	2.556
Turkey	3.431	0.105	-0.058	0.853	3.323	3.491	2.806	0.281	1.677	1.076	2.517	1.110	1.844	-0.159	0.786	1.133	2.006	1.049
Viet Nam	2.967	0.667	1.778	0.876	2.285	1.168	4.562	-0.194	2.558	1.623	4.766	1.954	6.140	1.740	1.328	0.938	4.325	4.749
Austria	1.395	-0.582	-3.155	1.161	1.989	4.699	0.371	-0.487	-1.948	1.320	0.862	2.365	0.147	-0.319	-3.614	1.374	0.468	3.903
Belgium-Lux	0.729	-1.736	-3.845	1.455	2.508	4.756	0.973	-0.351	-1.092	1.234	1.328	2.088	2.696	0.260	-3.189	1.647	2.429	6.078
Bulgaria	1.409	0.281	-4.887	1.180	1.125	6.620	0.144	-0.036	-4.305	1.266	0.180	4.649	-5.507	0.148	-6.966	1.161	-5.647	1.568
Czechoslovakia	2.392	-0.347	-1.523	1.230	2.748	3.975	1.500	-0.169	-1.051	1.151	1.672	2.578						
Denmark	1.724	-0.238	-3.309	1.382	1.966	5.205	1.845	-0.410	-1.582	1.455	2.265	3.482	0.763	-0.518	-3.710	1.291	1.288	4.646
Finland	0.875	0.011	-3.874	1.264	0.864	4.940	0.512	-0.226	-2.936	1.246	0.739	3.553	-1.592	-1.850	-4.040	1.179	0.263	2.552
France	1.838	-0.240	-3.944	1.599	2.083	6.020	0.629	-0.369	-3.656	1.526	1.002	4.448	0.747	-0.286	-4.027	1.446	1.036	4.974
Germany	1.210	-0.268	-1.756	1.184	1.482	3.019	0.579	-0.266	-4.817	1.202	0.847	5.669	-0.785	-0.548	-4.390	1.293	-0.238	3.770
Greece	3.238	0.027	-2.035	0.929	3.210	5.383	-0.176	-0.022	-1.850	0.860	-0.154	1.706	2.351	-0.711	-2.260	1.640	3.084	4.717
Hungary	4.088	-0.367	-3.722	1.670	4.471	8.112	0.091	-0.233	-2.649	1.338	0.325	2.814	-3.207	-1.002	-3.403	0.682	-2.228	0.203
Ireland	3.860	0.105	-2.323	1.174	3.750	6.330	1.268	-1.056	-2.165	1.303	2.349	3.509	1.115	-1.555	-1.417	1.160	2.712	2.568
Italy	1.734	-1.380	-3.268	0.841	3.158	5.172	-0.741	-0.419	-2.955	0.928	-0.323	2.281	1.182	-0.973	-4.340	1.389	2.176	5.772
Netherlands	3.414	-0.818	-0.435	1.264	4.267	3.866	1.590	-0.070	0.032	1.271	1.660	1.558	0.359	-0.252	-2.363	1.239	0.612	2.788
Norway	1.429	-0.190	-1.652	1.131	1.623	3.133	0.792	0.419	-1.758	1.080	0.371	2.595	-0.943	0.637	-2.317	1.038	-1.570	1.406
Poland	-0.171	-0.278	-1.982	0.647	0.107	1.848	2.045	-0.113	-0.696	1.380	2.161	2.760	-2.524	-0.204	-1.709	0.991	-2.325	-0.829
Portugal	-0.337	0.127	1.051	0.546	-0.463	-1.374	2.552	0.080	-3.336	1.303	2.470	6.091	1.038	0.322	-2.693	1.277	0.714	3.834
Romania	4.857	0.023	-3.356	1.410	4.833	8.498	-1.321	-0.131	-3.902	0.998	-1.192	2.685	-1.937	0.027	-4.427	1.589	-1.964	2.605
Spain	4.181	-0.278	-3.512	0.999	4.471	7.973	1.594	-0.248	-3.047	1.026	1.846	4.787	1.811	-0.267	-3.761	1.152	2.084	5.789
Sweden	1.332	-0.142	-1.813	1.212	1.476	3.203	0.689	-0.815	-2.359	1.154	1.517	3.122	-1.659	-0.789	-2.964	1.081	-0.877	1.344
Switzerland	1.671	-0.732	-1.728	1.066	2.421	3.460	0.180	0.005	0.567	1.070	0.175	-0.385	-0.589	-2.425	-2.207	1.645	1.882	1.655
Ukraine	1.781	-0.203	-0.265	1.199	1.988	2.051	0.709	-0.330	-1.178	1.190	1.042	1.909	-0.158	-0.520	-1.553	1.087	0.365	1.418
Yugoslavia	2.973	-0.236	-3.411	0.773	3.216	6.609	-0.287	-0.142	-3.225	1.003	-0.146	3.036						
Australia	1.256	0.024	-0.069	1.073	1.232	1.326	2.103	-0.389	0.649	1.256	2.501	1.444	2.832	-0.195	-0.351	1.329	3.033	3.195
New Zealand	1.203	0.876	1.305	1.114	0.325	-0.101	0.212	-0.172	1.276	1.180	0.384	-1.050	2.520	-0.456	0.118	0.970	2.989	2.399
Papua NG	2.771	-3.014	2.147	1.044	5.965	0.610	1.302	0.272	1.719	0.874	1.027	-0.409	2.346	7.823	1.431	0.887	-5.080	0.902
USSR	0.738	0.103	0.085	0.887	0.635	0.653	1.936	0.052	-1.113	1.259	1.882	3.083						
Belarus													-0.696	-0.094	-2.029	1.235	-0.603	1.361
Czech Rep.													-0.085	-0.005	-1.282	1.027	-0.080	1.212
Georgia													-1.818	-0.159	-1.371	0.770	-1.662	-0.453
Kazakhstan													-0.590	-0.353	-1.160	1.689	-0.238	0.576
Kyrgyzstan													3.507	0.272	-0.072	1.250	3.227	3.581
Latvia													-2.245	-0.227	-1.714	0.515	-2.023	-0.541
Lithuania													0.747	-0.054	-1.998	0.932	0.802	2.801
Russian Fed													-0.783	0.035	-1.369	1.156	-0.818	0.595

Slovakia													-2.626	-0.020	-0.989	0.919	-2.606	-1.653
Slovenia													0.387	-0.378	-5.168	1.234	0.768	5.858
Tajikistan													-1.334	0.133	0.124	2.073	-1.465	-1.457
Turkmenistan													-1.022	0.039	0.924	1.166	-1.061	-1.928
Ukraine													-2.343	-0.107	-1.932	1.353	-2.238	-0.419
Uzbekistan													-0.496	-0.007	0.149	0.785	-0.489	-0.644

Table A6.1. Determinants of poverty in the developing world: The data set (see Part 6 of this report)

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sala-i Martin $1 Poverty	Sala-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
Bangladesh	1970	0.391	0	198.75				54.56	35.00	75.43	92.39				28	59	3593	1105
Bangladesh	1980	0.346	0	203.77	6.141			30.76	34.00	71.07	85.12			-4	29	64	3418	973
Bangladesh	1990	0.381	0	217.22				29.42	32.90	65.78	80.23			-5	13	49	4404	1278
Bangladesh	2000	0.556	2	276.12	4.572			24.62	31.79	60.01	75.00	41.35	9.05		5	34	6648	1684
Bolivia	1970	0.476	1	722.96					42.00	42.49	60.22			-5	0.2	7.2	7643	2498
Bolivia	1980	0.552	1	925.04	13.842				42.00	31.32	54.55			-7	0	2.2	9785	3053
Bolivia	1990	0.577	2	1066.38				16.74	42.00	21.90	44.42			9	5.5	26.5	7841	2446
Bolivia	2000	0.670	3	1418.55	14.345	14.40	34.30	15.03	44.68	14.58	37.65	49.10	4.00		23.8	40.1	6829	2724
Brazil	1970	0.441		1326.43				12.35	57.60	31.60	43.49			-9	13.7	31	11006	3620
Brazil	1980	0.408	4	1862.44	9.198			11.01	57.00	23.96	33.19			-4	1.9	15.4	17477	6380
Brazil	1990	0.531	4	2808.04				8.10	57.00	17.97	25.24			8	2.2	16.5	16984	6218
Brazil	2000	0.650	3	4757.27	19.009	11.60	26.50	7.26	60.70	13.09	18.85	64.06	2.16		1	12.9	19220	7190
Burkina Faso	1970	0.534	4	136.67				35.44	51.72	93.02	94.25			-4	60.9	79	1181	669
Burkina Faso	1980	0.282	4	114.50	10.415			33.24	51.72	89.20	91.53			-7	53.4	76	1377	765
Burkina Faso	1990	0.186	4	155.46				32.33	51.72	83.65	86.44			-7	48.5	74	1750	845
Burkina Faso	2000	0.194	3	214.91	14.211			39.68	55.08	76.10	83.48	60.74	4.46		43.3	71	2017	957
Chile	1970	0.546	4	2632.10				6.91	46.00	12.38	24.77			6	0.6	10.5	15345	4794
Chile	1980	0.599	4	2801.81	12.451			7.25	46.00	8.60	18.76			-7	0.5	9.9	15988	5412
Chile	1990	0.712	3	3356.24				8.71	56.50	6.00	16.73			8	0.5	10.1	16799	6148
Chile	2000	0.751	4	4432.70	11.084	2.00	8.70	8.54	56.65	4.24	14.21	61.28	3.17		0	2.2	25084	9926

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Pop.ulation	Top 20 percent	Bottom 20 percent	Polity indicator	Sala-i Martin $1 Poverty	Sala-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
China	1970	0.290		200.88				35.22	12.66	47.13	82.60				27	74	1583	815
China	1980	0.233		232.86	14.587			30.09	21.20	32.94	80.36				20	56	1946	1069
China	1990	0.384		324.20				27.05	35.50	21.71	72.60				10	36	2954	1787
China	2000	0.757		562.77	13.087	18.80	52.60	15.89	40.30	14.81	64.21	46.64	5.86		3	19	6175	3747
Colombia	1970	0.496		1348.55				25.69	52.00	22.17	43.41			7	3.8	25.1	10544	3159
Colombia	1980	0.539		1669.23	10.069			19.91	45.00	15.97	37.39			8	1.8	16.3	13910	4312
Colombia	1990	0.624		2200.59				16.75	49.20	11.55	31.29			8	3	17.2	15114	4934
Colombia	2000	0.779		2402.75	21.753	19.70	36.00	13.42	51.30	8.37	25.03				3.5	17	11477	5383
Costa Rica	1970	0.537	5	2167.56				25.34	44.40	11.80	61.17			10	1.8	14.9	13639	4181
Costa Rica	1980	0.692	5	2703.84	18.221			20.17	42.00	8.31	53.12			10	0.4	8.3	15889	5419
Costa Rica	1990	0.877	5	3503.34				17.89	46.10	6.12	46.32			10	0.8	11.2	14150	4931
Costa Rica	2000	1.237	5	4635.96	13.268	12.60	26.00	9.55	48.07	4.44	41.00				0.50	9.20	14827	5870
Côte d'Ivoire	1970	0.464		793.48				31.87		78.98	72.60			-9	6.5	27	4823	2391
Côte d'Ivoire	1980	0.437		1002.55	16.857			25.88		70.52	65.26			-9	3	21	5825	2527
Côte d'Ivoire	1990	0.551		1166.52				32.50		61.49	60.15			-7	7	32	5383	2123
Côte d'Ivoire	2000	0.574		1345.31	8.792			24.17		51.37	56.39				4.9	29	4679	1869
Dominican R	1970	0.711		1086.38				23.24	52.36	32.81	59.73			-3	10.4	31.6	7488	2018
Dominican R	1980	1.129		1699.02	7.601			20.15	50.65	26.03	49.50			6	2.3	18.1	10329	2917
Dominican R	1990	1.007		1854.98				13.42	49.00	20.57	41.57			6	3.9	22.6	10063	3160
Dominican R	2000	1.426		2558.56	8.441			11.17	47.40	16.34	34.61	53.31	5.09		0.3	8.4	16173	5270
Ecuador	1970	0.917		1651.66				23.95	38.00	25.68	60.47			0	6.5	28.6	7389	2292
Ecuador	1980	0.814	4	1842.99	14.510			12.13	42.30	18.09	53.04			9	2	7.6	14116	4242
Ecuador	1990	0.868	3	2013.32				13.41	46.60	12.36	44.91			9	0.1	13.9	12373	3774
Ecuador	2000	1.009	4	2984.76	9.813			10.62	51.34	8.44	37.00				0.1	13.6	10903	3468

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
El Salvador	1970	0.461	2	743.39				40.44	40.00	42.05	60.60			0	0.5	12.5	12554	4141
El Salvador	1980	0.833	2	1232.21	13.989			37.96	40.00	34.16	55.94				1.1	15.2	12581	4159
El Salvador	1990	0.734	2	1123.37				17.10	44.80	27.58	50.77			6	4	21.6	11294	3525
El Salvador	2000	0.867	3	1082.27	9.922	21.00	44.50	9.78	52.17	21.32	39.69	56.43	3.27		2.5	16.8	13522	4435
Ethiopia	1970	0.450		243.16					32.40	87.12	91.40			-9	60.5	82	1293	608
Ethiopia	1980	0.286		221.92					32.40	80.12	89.52			-7	56.5	80	1406	641
Ethiopia	1990	0.252		198.69				49.32	44.80	71.40	87.28			-8	62.9	83	1318	574
Ethiopia	2000	0.301		213.33	23.238			52.33	57.20	60.90	84.48	60.76	2.45		61.1	82	1483	635
Ghana	1970	0.529	1	611.07				46.52	33.08	70.50	71.03			3	4.9	33	3210	1282
Ghana	1980	0.286	1	422.37	11.164			57.92	33.08	56.23	68.83			6	11	43	3200	1204
Ghana	1990	0.298	4	379.78				44.85	36.70	41.54	66.45			-7	20.2	53	2453	1181
Ghana	2000	0.564	3	607.14	15.306	44.80	78.50	35.30	40.71	28.40	63.93	46.63	5.56		20.2	50	2775	1351
Guatemala	1970	0.422	2	746.46				27.32	50.20	54.89	64.47			1	5.5	31.6	9885	2991
Guatemala	1980	0.441	2	896.66	7.958			24.84	50.20	46.99	62.60			-5	2.1	22.1	14256	4057
Guatemala	1990	0.458	2	791.38				25.88	58.70	38.98	61.90			3	8.6	28.5	12576	3598
Guatemala	2000	0.515	4	888.08	6.989	10.00	33.80	22.64	55.80	31.46	60.34	60.55	3.83		11.3	25.1	13274	3914
Guinea	1970	0.561		244.19					36.65		86.15				2.7	21	3890	2282
Guinea	1980	0.886		271.79	24.074				36.65		80.89			10	2.2	20	4532	2598
Guinea	1990	0.500		237.87				23.78	46.80		76.57			10	2.7	21	5060	2435
Guinea	2000	0.429		291.38				23.59	59.75		72.50				1.6	18	5932	2831
Honduras	1970	2.000	2					32.44	61.20	49.37	71.10			-1	0.2	10.3	6217	1861
Honduras	1980	2.000	2		12.666			23.67	62.00	40.08	65.13				0.5	13.1	7810	2280
Honduras	1990	2.000	2					22.44	59.10	31.90	58.19			6	13.3	36.7	7211	2224
Honduras	2000	2.000	2		12.704	24.30	45.10	14.98	56.30	25.02	47.26	60.98	2.01		30.1	47.2	6380	2050

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
India	1970	0.316		302.68				46.07	30.40	66.90	80.25			9	21	59	2659	1073
India	1980	0.260	3	305.23	10.081			38.86	42.00	58.97	76.94			8	17	54	3011	1159
India	1990	0.309	2	406.77				31.27	32.00	50.68	74.46			8	5	32	4287	1675
India	2000	0.344	3	472.04	13.111			24.95	33.80	42.76	72.34				1	14	6216	2479
Indonesia	1970	0.408	1	351.47				44.94	30.70	43.94	82.93			-7	37	69	2864	1087
Indonesia	1980	0.520	1	448.77	10.525			23.97	31.00	30.96	77.80			-7	7	36	5091	1896
Indonesia	1990	0.410	0	540.55				19.41	33.20	20.49	69.41			-7	0	10	7256	2851
Indonesia	2000	0.358	3	606.25	7.177	12.90	65.50	17.23	30.33	13.19	59.01	43.29	8.41		0	3	8944	3642
Kenya	1970	0.268	3	316.38				33.29	59.00	59.38	89.70			-7	50	74	1875	821
Kenya	1980	0.292	3	320.26	19.803			32.59	57.30	43.85	83.93			-6	33.8	62	2932	1239
Kenya	1990	0.295	3	351.52				29.14	57.50	29.24	75.99			-7	35.2	63	2732	1336
Kenya	2000	0.264	3	307.50	17.483			19.71	57.70	17.58	66.63				35	63	2476	1244
Korea, Rep.	1970	1.156		422.98				27.08	33.30	13.20	59.29				2	19	7596	2716
Korea, Rep.	1980	0.558		620.51	11.718			14.84	36.00	7.13	43.14				0	3	12395	4790
Korea, Rep.	1990	0.423		1416.35				8.51	33.60	4.11	26.15				0	0	23896	9952
Korea, Rep.	2000	0.509		2752.37	10.054			4.70	33.60	2.25	18.12	37.45	7.91		0	0	36850	15876
Madagascar	1970	0.438		488.19				24.43	38.11	61.51	85.90			-1	8.4	37	2590	1274
Madagascar	1980	0.453	4	449.06	12.107			30.05	38.11	52.45	81.48			-6	19	52	2307	1087
Madagascar	1990	0.433	4	405.67				28.58	43.40	42.04	76.43			-6	39.6	70	2084	901
Madagascar	2000	0.434	4	365.59	6.822	49.10	83.30	29.08	38.11	33.50	70.51	44.78	6.38		50.6	75	1917	836
Malaysia	1970	0.671	6	1229.54				29.44	50.00	41.94	66.55			1	14	32	8481	2884
Malaysia	1980	0.691	6	1692.93	15.993			22.61	48.00	28.84	57.96			4	1	14	12569	4876
Malaysia	1990	0.680	4	2780.41				15.22	44.50	19.32	50.18			4	0	5	15951	6525
Malaysia	2000	0.746	4	3734.31	10.589			8.69	48.40	12.61	42.58				0	1	27507	9919

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
Mali	1970	0.332	1	247.10				66.02		90.86	85.69			-7	55.5	76	2311	784
Mali	1980	0.334	1	260.89	11.551			48.31		86.58	81.54			-7	46.1	71	2890	944
Mali	1990	0.310	2	270.04				45.52		81.16	76.18			-7	53	75	1573	755
Mali	2000	0.310	3	300.39	12.820			41.19		74.36	69.81				51.4	74	2033	969
Mexico	1970	0.486	2	1487.87				12.73	58.00	26.52	40.98			-6	5.8	20.2	19509	5522
Mexico	1980	0.617	2	1837.57	10.039			9.00	50.00	18.67	33.65			-3	0.2	7.1	23885	7655
Mexico	1990	0.596	3	2024.57				7.85	50.30	12.65	27.54			0	0.1	4.5	21411	7334
Mexico	2000	0.828	2	2719.83	11.062	15.90	37.70	4.09	53.11	8.84	25.63	57.61	3.39		0	1.8	24588	8762
Mozambique	1970	0.245	4	241.14						83.40	94.21				3	22	2698	1571
Mozambique	1980	0.142	4	176.65	12.151			37.09		75.56	86.89			-8	16	46	1981	1129
Mozambique	1990	0.327	4	161.36				37.12		66.52	78.89			-7	27.1	60	1900	926
Mozambique	2000	0.207	4	152.91	10.225			22.27		55.98	67.89				26.8	60	2133	1037
Nepal	1970	0.414		176.23				67.29	52.49	83.64	96.09				27	72	1825	816
Nepal	1980	0.328		190.65	6.702			61.77	53.00	77.59	93.45				28	69	2055	860
Nepal	1990	0.354		230.04				51.63	56.76	69.56	91.05				20	57	2604	1087
Nepal	2000	0.402		243.48	9.112			40.68	51.85	58.30	88.15				15	49	3482	1459
Nicaragua	1970	0.744	3	1608.53				24.89	50.30	45.53	52.99			-8	0	0.1	13202	3980
Nicaragua	1980	0.423	3	1406.46	19.728			23.21	50.30	41.21	49.73				0	1.6	10194	3039
Nicaragua	1990	0.450	5	1472.27				31.05	50.30	37.26	46.94			6	6.9	28.8	7233	2250
Nicaragua	2000	0.747	4	1870.80					60.30	33.52	43.86	63.59	2.28		26.6	47.3	5427	1767

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
Niger	1970	0.797		241.61				64.88	36.10	94.25	91.49			-7	23.5	50	2653	1519
Niger	1980	0.304		262.44	10.377			43.06	36.10	92.05	87.40			-7	27.9	55	2099	1133
Niger	1990	0.179	4	170.96				35.25	36.10	88.60	83.90			-7	39.8	68	1958	948
Niger	2000	0.305	0	224.94	13.035			37.84	36.10	84.04	79.43				44.2	71	1823	875
Nigeria	1970	0.767	1	478.80				41.28	37.50	79.86	80.04			-7	8.5	45	2700	1113
Nigeria	1980	0.379	1	393.36	12.094			20.63	37.50	67.06	73.13			7	16.6	53	3047	1215
Nigeria	1990	0.496	2	641.61				32.71	37.50	51.34	64.96			-5	30.9	63	2291	1095
Nigeria	2000	0.807	2	1217.05	22.783			28.81	37.50	35.98	55.93				45.9	70	1479	707
Pakistan	1970	0.458		490.15				36.83	29.90	79.10	75.11				13	50	3206	943
Pakistan	1980	0.400	1	532.32	10.035			29.52	36.00	72.18	71.93			-7	11	45	3905	1152
Pakistan	1990	0.434	2	708.31				25.98	40.70	64.62	69.43			8	3	28	5814	1747
Pakistan	2000	0.635	3	981.62	11.173			26.68	46.01	56.79	66.90	42.29	8.75		2	23	7023	2008
Paraguay	1970	0.579	3	1980.90				32.07	55.00	20.21	62.93			-8	22.8	39	8868	2874
Paraguay	1980	0.659	3	2263.18	6.020			28.62	39.84	14.07	58.31			-8	15.4	24.4	13561	4487
Paraguay	1990	0.645	0	3462.07				27.78	55.26	9.68	50.49			2	13.6	22.8	14884	4962
Paraguay	2000	0.369	2	3136.60	10.479	19.50	49.30	20.36	57.70	6.73	41.62	60.66	1.91		12.8	22.3	10439	4684
Peru	1970	0.425	2	1013.23				18.68	55.00	28.53	42.59			-7	0.1	6.6	15997	4686
Peru	1980	0.406	2	864.46	10.522			10.23	31.00	20.57	35.43			7	0	2.9	15788	4901
Peru	1990	0.475	3	912.23				8.54	43.00	14.53	31.10			8	1.3	15.3	11218	3585
Peru	2000	0.552	3	1399.84	11.173			8.64	44.90	10.15	27.23				1	12.5	10095	4589
Philippines	1970	0.686		775.02				29.52	49.40	18.17	67.02			2	16.4	34	6548	2396
Philippines	1980	0.793	0	966.69	9.066			25.12	45.00	12.21	62.52			-9	4	32	9060	3289
Philippines	1990	0.840	2	1028.90				21.90	40.70	8.27	51.22			8	3	21	8166	3009
Philippines	2000	0.927	3	1136.06	12.769			15.90	46.09	5.07	41.45	52.28	5.38		1	17	8374	3425

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
Rwanda	1970	0.919		319.28				61.62	42.39	72.23	96.81				31.2	71	1676	887
Rwanda	1980	1.581		332.92	12.492			45.85	38.53	60.17	95.29				17.5	58	2117	1097
Rwanda	1990	0.385		288.85				32.55	28.90	46.72	94.67				19.5	61	2171	1066
Rwanda	2000	0.786		266.45	10.524			41.42	36.19	33.15	93.21				23.8	65	1786	895
Senegal	1970	0.422	3	301.73				23.77	49.00	85.32	66.58			-7	20.9	48	3414	1627
Senegal	1980	0.318	3	236.94	20.298			18.87	51.55	78.99	64.26			-2	22.3	50	3142	1462
Senegal	1990	0.467	3	308.16				19.88	54.10	71.65	59.97			-1	23	51	3152	1505
Senegal	2000	0.473	3	354.52	10.414			18.14	56.78	62.63	52.56				23.4	51	3389	1622
South Africa	1970	0.318		1821.93				7.13		30.29	52.20				5.9	20	18793	6878
South Africa	1980	0.394		3435.04	14.291			6.18		23.85	51.86				3.2	17	24053	7950
South Africa	1990	0.490		3582.16				4.63		18.79	51.17				3.8	18	23001	7786
South Africa	2000	0.854		4449.40	18.089			3.20		14.76	43.13				4.3	19	21998	7541
Sri Lanka	1970	0.286	3	595.34				28.30	31.20	19.54	78.13			8	14	41	3745	1557
Sri Lanka	1980	0.317	3	654.18	8.545			27.55	45.00	14.71	78.43			6	6	29	4303	1790
Sri Lanka	1990	0.292	3	585.39				26.32	30.10	11.28	78.70			5	1	16	6048	2515
Sri Lanka	2000	0.333	4	579.74	10.418			19.54	30.10	8.37	77.21				0	4	7646	3300
Tanzania	1970	0.223		269.11					39.00	64.36	93.31			-7	57.1	81	1061	565
Tanzania	1980	0.249	1	293.42					38.30	50.97	85.25			-7	52.8	79	1203	606
Tanzania	1990	0.238	4	280.55				45.96	59.00	37.05	78.30			-7	63.9	85	1041	494
Tanzania	2000	0.266	3	241.93	6.518			45.04	38.10	24.99	67.75				70.2	89	1014	482
Thailand	1970	0.522	4	397.51				25.92	49.90	19.83	86.71			2	19	38	3711	1822
Thailand	1980	0.464	4	519.60	12.292			23.24	47.00	12.51	82.96			2	9	26	5386	2730
Thailand	1990	0.347	3	529.32				12.50	43.80	7.62	81.29			3	0	9	9118	4833
Thailand	2000	0.417	3	681.30	11.386	2.00	28.20	10.26	43.15	4.52	80.17	50.00	6.06		0	5	12702	6857

Country	Year	Cumulative TFP Changes	Corruption Indicator	Agriculture output/labour	Government expenditure	WB $1 poverty	WB $2 poverty	Agriculture output/GDP	GINI coefficient	Illiteracy rate	Percentage of Rural Population	Top 20 percent	Bottom 20 percent	Polity indicator	Sa-la-i Martin $1 Poverty	Sa-la-i Martin $2 Poverty	Real GDP/Worker	Real GDP/Capita
Uganda	1970	0.719	1	602.47				53.78	33.00	63.62	92.04			-7	55.3	88	1255	608
Uganda	1980	0.913	1	339.59				72.03	33.00	54.13	91.20				73.2	93	943	443
Uganda	1990	1.905	3	415.22				56.58	33.00	43.85	88.84			-7	49.2	78	1415	686
Uganda	2000	0.687	2	437.62	11.996			37.34	40.80	32.97	85.84				37.9	69	1971	941
Uruguay	1970	0.657	3	9962.03				17.81	44.90	6.69	17.90			8	0	2	15502	6131
Uruguay	1980	0.553	3	9373.63	12.453			13.53	46.12	4.97	14.76			-7	0	0.4	20581	8027
Uruguay	1990	0.643	3	10847.24		2.00	6.60	9.21	41.79	3.49	11.03			10	0	0.9	18667	7263
Uruguay	2000	0.652	3	13497.27	13.196			6.21	46.62	2.44	8.09	50.35	4.48		0	0.1	21150	9622
Venezuela	1970	0.513	2	2175.04				6.11	47.70	23.73	28.43			9	0	1.4	36297	10528
Venezuela	1980	0.484	2	3403.74	11.786			4.80	49.00	16.10	20.58			9	0	1.3	24179	7967
Venezuela	1990	0.481	3	3610.48				5.40	44.40	11.11	16.02			9	0.1	4.2	20007	6952
Venezuela	2000	0.656	3	5073.90	7.227	23.00	47.00	5.00	49.53	7.46	13.07	53.17	3.01		0.1	4.8	17754	6420
Zambia	1970		1					11.63	61.60	52.35	69.83			0	19.2	43	3821	1335
Zambia	1980		1		25.512			15.07	56.00	41.43	60.19			-9	30.5	57	3660	1239
Zambia	1990		2					20.60	42.00	31.85	60.59			-9	40.4	67	3053	1021
Zambia	2000		3		9.533	63.70	87.40	22.30	52.60	21.81	60.39	56.60	3.28		51.6	75	2611	892
Zimbabwe	1970	0.150		375.38				16.98	62.90	42.42	83.08			4	17.5	44	5090	2155
Zimbabwe	1980	0.176	3	403.92	18.512			15.70	59.85	29.90	77.73			5	14.9	41	6511	2634
Zimbabwe	1990	0.191	3	385.29		36.00	64.20	16.48	56.80	19.30	71.62			-6	11.3	37	6008	2914
Zimbabwe	2000	0.234	3	443.21	24.229			18.49	53.91	11.33	64.69				10.5	36	5127	2486

Table A6.2. Determinants of poverty in the developing world: Descriptive statistics (see Part 6 of this report)

Variables	Mean	Median	Std.	Minimum	Maximum	N
Changes in US$1 poverty 1970-2000	-0.47	0.36	2.40	-9.00	1.00	40
Changes in US$1 poverty 1980-2000	0.14	0.22	0.73	-2.43	1.00	42
Changes in US$2 poverty 1970-2000	-0.02	0.18	1.07	-4.38	1.00	38
Changes in US$2 poverty 1980-2000	-0.03	-0.02	0.90	-3.31	1.00	43
Changes in Agriculture output/labour 1970-2000	0.69	0.47	1.00	-0.37	5.51	43
Changes in Agriculture output/labour 1980-2000	0.48	0.36	0.67	-0.20	3.44	43
TFP Level 1970	0.52	0.48	0.20	0.15	1.16	43
TFP Level 1980	0.51	0.44	0.27	0.14	1.58	43
TFP Level 1990	0.51	0.46	0.29	0.18	1.91	43
TFP Level 2000	0.59	0.56	0.27	0.19	1.43	43
Sala-i Martin $1 Poverty level 1970	17.37	13.00	18.32	0.00	60.90	45
Sala-i Martin $2 Poverty level 1970	39.12	34.00	24.95	0.10	88.00	45
Sala-i Martin $1 Poverty level 1980	14.67	7.00	18.11	0.00	73.20	45
Sala-i Martin $2 Poverty level 1980	34.84	29.00	25.82	0.40	93.00	45
Sala-i Martin $1 Poverty level 1990	15.49	6.90	18.67	0.00	63.90	45
Sala-i Martin $2 Poverty level 1990	35.63	28.50	25.28	0.00	85.00	45
Sala-i Martin $1 Poverty level 2000	16.61	4.90	20.15	0.00	70.20	45
Sala-i Martin $2 Poverty level 2000	33.72	23.00	27.44	0.00	89.00	45
Agriculture output level 1970	1012.22	595.34	1541.16	136.67	9962.03	43
Agriculture output level 1980	1164.82	532.32	1566.62	114.50	9373.63	43
Agriculture output level 1990	1377.06	641.61	1848.25	155.46	10847.24	43
Agriculture output level 2000	1774.86	888.08	2362.51	152.91	13497.27	43
Gini Coefficient 1970	44.45	45.45	11.00	12.66	62.90	42
Gini Coefficient 1980	43.73	43.65	9.06	21.20	62.00	42
Gini Coefficient 1990	45.03	44.65	8.84	28.90	59.10	42
Gini Coefficient 2000	47.09	47.74	8.94	30.10	60.70	42
% Rural population 1970	70.19	71.10	20.25	17.90	96.81	45
% Rural population 1980	64.94	65.26	21.32	14.76	95.29	45
% Rural population 1990	59.72	61.90	22.15	11.03	94.67	45
% Rural population 2000	54.20	59.01	22.58	8.09	93.21	45
Government expenditure 1980	12.82	12.10	4.49	6.02	25.51	42
Government expenditure 2000	12.32	11.17	4.58	4.57	24.23	43
Polity Indicator 1970	-1.56	-2.00	6.15	-9.00	10.00	36
Polity Indicator 1980	-1.28	-4.50	6.94	-9.00	10.00	36
Polity Indicator 1990	1.10	3.00	6.99	-9.00	10.00	40
Top 20 per cent	53.08	53.24	7.84	37.45	64.06	24
Bottom 20 per cent	4.67	4.23	2.20	1.91	9.05	24
Corruption indicator 1970	2.46	2.00	1.45	0.00	6.00	26
Corruption indicator 1980	2.47	2.50	1.46	0.00	6.00	34
Corruption indicator 1990	2.80	3.00	1.23	0.00	5.00	35
Corruption indicator 2000	3.03	3.00	0.89	0.00	5.00	35
GDP/worker 1970	7138.44	3890.00	6767.86	1061.00	36297.00	45
GDP/worker 1980	8370.96	5386.00	6849.61	943.00	24179.00	45
GDP/worker 1990	8370.36	6048.00	6645.32	1041.00	23896.00	45
GDP/worker 2000	9452.27	6648.00	8342.71	1014.00	36850.00	45

Variables	Mean	Median	Std.	Minimum	Maximum	N
WB $1 poverty 2000	21.49	18.80	16.46	2.00	63.70	17
WB $2 poverty 2000	46.14	44.50	21.71	8.70	87.40	17
Agriculture output/GDP 1970	31.84	28.87	16.28	6.11	67.29	40
Agriculture output/GDP 1980	26.76	23.97	15.05	4.80	72.03	41
Agriculture output/GDP 1990	24.61	23.78	13.09	4.63	56.58	45
Agriculture output/GDP 2000	20.83	19.02	12.64	3.20	52.33	44
Illiteracy rate 1970	49.88	46.33	26.26	6.69	94.25	44
Illiteracy rate 1980	41.85	37.12	25.96	4.97	92.05	44
Illiteracy rate 1990	34.39	28.41	24.75	3.49	88.60	44
Illiteracy rate 2000	27.61	19.45	22.85	2.25	84.04	44

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