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Abstract

This paper describes the world in terms of income and productivity, levels and growth. It shows that the world is becoming increasingly unequal, in terms of income per worker, TFP and technical efficiency. Although some developing countries have managed to catch up with the world technology frontier, countries that were poor in 1960 generally stayed poor in 2000. Growth analysis tends to confirm the bleak picture and shows little indication of a forthcoming reversal of income polarization and divergence. Taken together, it appears that in early stages of development, countries rely on factor accumulation for their growth, but as they advance, productivity growth starts to contribute to output growth.

Keywords: Growth patterns, total factor productivity, technological progress and technical efficiency

1. Introduction

It is puzzling and, at the same time, distressing that the riches of the world are so unequally shared amongst countries. Partly, it is because initial conditions differ greatly, with some countries in temperate zones, while others struggle in the tropics. Yet, some tropical countries are resource-rich and manage to translate these into rapid economic growth, while others end up as failed states. Some, if not many, of the differences in income per capita are man-made. That is, how society and its production are organized can significantly explain the observed income divergence since the industrial revolution.

The analysis of why some nations are rich and others poor can be addressed in many ways, as evidenced by an extensive literature on the topic.[1] An analysis of growth determinants is one popular route to take; another is the focus on sources of growth. From a policy viewpoint, it can be argued that the latter is preferable, as it pins down the relevant policy area. In particular, the discussion on whether an improvement in technology, measured as total factor productivity (TFP) growth or factor accumulation, contributes the most to differences in income per capita gained new currency with the publication of Mankiw, Romer and Weil (1992) and even led to a resurrection of neoclassical growth analysis after an important decade of endogenous growth.

Actually, the discussion of factor accumulation versus TFP might, in a sense, not be particularly interesting because TFP growth is unlikely to be achieved without investments in physical and human capital, which in part pave the way for new technologies. In addition, learning about new markets and organization of production is important (Nelson and Pack, 1997). For example, the East Asian Miracle cannot be explained solely in terms of TFP growth or factor accumulation (for example, Collins and Bosworth, 1996; Nelson and Pack, 1997; Young, 1995). Such instances as Taiwan, Province of China (henceforth Taiwan) and Hong Kong, SAR of China (henceforth Hong Kong) have enjoyed quite significant TFP growth rates, albeit

[1] This includes, inter alia, Bosworth, Collins and Chen (1995), Bosworth and Collins (2003), Klenow and Rodriguez-Clare (1997), Hall and Jones (1999), Baier, Dwyer Jr. and Tamura (2002), Caselli (2004), Islam (1995), Caselli, Esquivel and Lefort (1996), Aiyar and Dalgaard (2002), Shastry and Weil (2002) and Weil (2005).

coupled with very impressive investment rates, in both physical and human capital. Furthermore, as a part of measured factor accumulation is actually due to TFP growth, the distinction between the two is hardly clinical. While both sources are likely to be important, in the short *and* long run, productivity growth is what contributes to welfare improvement because it is the only way to produce more at the same cost or effort.[2]

The so-called Great Divergence may have its roots both in differences in technology and factor accumulation. When innovation is localized and takes place at high levels of capital intensity, implying that innovation occurs in industrialized countries, technology spills over into other countries but largely eludes those with an inadequate level of capital intensity. In Basu and Weil's (1998) words, this technology is 'inappropriate'. Hence, countries unable to exploit this spillover will fall behind. More importantly, while the power of productivity is undisputed, it has to be recognized that investment in physical and human capital is also necessary to stop the process of falling behind.

This paper presents a global picture, to the extent that it measures TFP growth for different country groups as well as for 112 individual countries over a 40-year period (1960-2000). The aim is to establish how productivity growth contributes to output growth. In addition, the role of capital deepening is investigated. Particular attention is paid to developing countries as a whole and, within that group, to least developed countries (LDCs) and an ad hoc group, termed dynamic developers.

The measure of TFP growth used here can be broken down into two parts: the first pertaining to technological change and the second concerning change in technical efficiency.[3] These are technical expressions, while terms more accessible are, for the former, innovation and, for the latter, catching up. Data for these three variables are

[2] Strictly speaking, this is true only in the case of constant returns to scale. When increasing returns to scale prevail, an increase of inputs leads to a more than proportionate increase in output and, as such, mimics the effect on productivity growth. As the issue here relates to aggregate level data only, the most logical assumption is constant returns to scale.

[3] For a better understanding of total factor productivity, its importance and the daunting task of measuring it, see "Understanding Productivity" and "Measuring Productivity", both by Isaksson (2006a, 2006b).

presented together with data on overall economic (GDP) growth and accumulation of labour and capital.

As a prelude to the discussion on TFP growth, this paper presents some startling facts on income and TFP levels. The former, also referred to as average labour productivity, appears more relevant for gauging standards of living purposes, while the latter is a better measure of productivity.[4] Although there is a tendency for labour productivity to be high in countries where TFP is high, it is shown that there are some important exceptions. Moreover, being efficient in the use of one production factor, such as, labour, does not automatically mean that a country is making efficient use of another, such as, capital. Furthermore, what may actually prove to be difficult for countries is to make efficient use of all production factors simultaneously. Here, TFP is used to measure this capability.

Next, what is in this paper termed the world technology frontier shows how much output (GDP) can be produced at different levels of capital intensity (capital per worker) or perhaps better stated, at different levels of development, since rich countries tend to have high capital intensities compared with relatively poor countries. The locations of all 112 countries are shown in the form of data points. The closer a country is to the frontier, the more efficiently it uses its resources (production factors). A series of such graphs focuses on different country groups for two sample years, 1960 and 2000. The difference between the graphs of 1960 and 2000 reveals what has occurred in the world over the 40-year period.

In the final section of the paper, growth patterns are discussed. However, since a Solow sources-of-growth analysis is not carried out, the extent to which GDP growth can be attributed to TFP growth, relative to factor accumulation, cannot be established.[5] Nevertheless, occasionally such an analysis is hinted at. In the case of industrialized countries, one observes that the role of TFP growth in explaining aggregate growth is significant, while for developing countries factor accumulation prevails. Attention is also given to how and how much the world technology frontier

[4] See, however, Nordhaus (2002), who argues for TFP also for such purposes.
[5] This amount will be understated because of failure to incorporate the effect TFP growth has on capital accumulation. The World Productivity Database (Isaksson, 2007), from which this paper obtains its information, provides for such an adjustment.

has moved. The range of such shifts at different development levels is discussed revealing that only small shifts have been recorded for the relatively poor, while for industrialized countries they are considerable. This provides further evidence of divergence and obstacles to technology transfer, while reinforcing the notion that technology is more local than global.

2. In search of the most productive country

In this section, two issues are examined: first, is a ranking of income per worker (adjusted for purchasing power parity (PPP)) to see which country in the world is the richest (based on this criterion). The ranking of 1960, the start-year, is compared with that of 2000, the sample's end-year, and the same exercise is then undertaken for TFP. Note that all the figures refer to percentage income relative to the U.S. For instance, the figure 75 indicates that this country's labour productivity is 75 per cent that of the U.S. Secondly, using an ad hoc criterion, namely, to find out which countries have, over the past 40 years, caught up, maintained the distance or fallen behind in terms of these two productivity measures.

Table 1 presents the ranking of countries according to income per worker for the sample of 112 countries.[6] Measured by this criterion, the most productive countries in the world in 1960 (left panel) were industrialized countries, with Switzerland topping the list followed by New Zealand and the U.S. in second and third place, respectively. The least productive industrialized country was Japan at position 41, with labour productivity at 25 per cent that of the U.S. The leading non-industrial country is oil-rich Venezuela in seventh place, while Argentina ranked eighteenth. Of the 112 countries, only 20 had a labour productivity level of at least 50 per cent that of the U.S. In 1960, Asian tigers, such as Hong Kong, Singapore, Republic of Korea (henceforth, Korea) and Taiwan, only managed rankings of 40, 50, 64 and 69, respectively. However, this was soon to change. At the lower level of the ranking, one tends to find countries from sub-Saharan Africa, many with income per worker of less than 10 per cent that of the U.S. Interestingly, this group also includes recent fast-growers, such as India (position 91) and China (position 103).

Some 40 years later (right column of table 1), one can observe several interesting changes. The former leader, Switzerland, has slipped to fifteenth position with the new leader, Luxembourg (previously in fifth position). The U.S. is still third, while the new second is the European comet, Ireland. Although labour productivity of Luxembourg is 160 per cent that of the U.S., this is to some extent illusory because a number of workers from Luxembourg reside in neighbouring countries and are therefore not included in its labour force. However, adjusting data for this phenomenon does not change the fact that Luxembourg leads the labour productivity league, albeit with a smaller margin. It is worth noting that, relative to the U.S., more countries have succeeded in attaining at least 50 per cent in terms of labour productivity as compared to 40 years ago (29 versus 20). This group of countries now includes Hong Kong (tenth position) at 80 per cent, Singapore (eleventh position) at 79 per cent, Taiwan (twenty-first position) at 66 per cent, while Korea (thirtieth position) is just outside at 48 per cent. Japan has climbed from forty-first to twenty-fifth position, while Venezuela has plummeted from seventh to forty-fifth position.

At the other end of the spectrum, the domination by sub-Saharan African countries is even more pronounced. The few non-African countries previously found at this level have slowly started their climb upward. Although China and India have improved, relative to the U.S., they still have a very long way to go (seventy-first and seventy-fourth positions, respectively). Whereas the relative labour productivity of less than 10 per cent included 36 countries in 1960, this figure has now increased to 41 countries, an indication of increased divergence.

Table 2 succinctly summarizes the countries that have caught up and those that have fallen behind. The ad hoc threshold has been set at ± 4 per cent, that is, a country that has increased/decreased its labour productivity relative to the U.S. by at least 5 per cent is placed in the grouping termed “catching up/falling behind”. Countries are ranked according to extent of change, where –5 is greater than –10. The catching-up group, led by Luxembourg, Ireland, Hong Kong and Taiwan, improved their relative labour productivity by more than 50 percentage points. Also high up are Korea and Japan, as well as former relatively weak EU-countries, namely, Cyprus, Spain, Greece and Portugal. The falling-behind group, starting with worst performers, includes

[6] Table A1 in the Appendix lists all the countries with country codes; the latter may be helpful when

Venezuela (already mentioned), which dropped 59 percentage points in 40 years. The second worst performer is New Zealand, followed by Switzerland.[7] Most of the other countries in this group, although they have indeed fallen behind, have more or less managed to keep pace with the U.S. Hence, the most alarming message of table 2 is that only a few countries have managed to catch up, which means that the vast majority of those that were poor in 1960 continue to remain poor 40 years later.

What happens if countries are ranked by another criterion, namely, TFP[8] (table 3) According to this criterion, the leader was the U.S. in 1960, with New Zealand second and Switzerland third. Venezuela still ranks among the top 10 countries, along with Equatorial Guinea. It seems that when labour and capital are simultaneously accounted for, resource-rich developing countries perform better, especially if they are small. As expected, however, industrialized countries dominate the top half of the ranking. One very important difference between labour productivity and TFP rankings is the marked contraction in the case of the latter. Nevertheless, using the former criterion, the world appeared much more unequal. For example, whereas in the case of TFP the 50-per cent mark lands in position 33 (Israel), for labour productivity 50-per cent instead occurs at 20 (Austria). Furthermore, in the case of TFP, only three countries have a relative productivity level that is less than 10 per cent that of the U.S., while the same figure was 36 with labour productivity. Although closer to the level of the U.S., India (ninety-eighth) and China (hundred-and-fifth) also performed poorly according to this criterion. Countries of sub-Saharan Africa again strongly figure at the bottom of the TFP table.

By 2000, Luxembourg had overtaken the U.S. as the most productive country in the world, with Ireland as runner-up, also with regard to labour productivity. Among the top 10 countries are Hong Kong (from sixty-second to fifth position) and Taiwan (from seventy-second to ninth), both close to the U.S. at 83 per cent. Singapore is in

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interpreting some of the graphical illustrations.

[7] It is important to emphasize that changes in relative levels are referred to here, but in the case of Switzerland it does not mean that it is suddenly a poor country. Switzerland is still in position 15 but instead of being ahead of the U.S., it now has a relative labour productivity level of 73 per cent that of the U.S. While New Zealand's fall is worse, it still occupies position 22, which is considerably better than, for example, Venezuela's forty-fifth position at only 24 per cent relative labour productivity.

twentieth position (forty-eighth in 1960) at 74 per cent, while Korea at 57 per cent ranks thirty-fourth (previously seventy-fifth). This represents a remarkable performance by these Asian countries in just 40 years! The two African fast-growers, Mauritius and Botswana, also perform equally well in terms of TFP (from thirty-fourth to twelfth and from fifty-third to twenty-ninth positions, respectively). In fact, they are both better than Japan (at 60 per cent). Again, Venezuela dropped to fiftieth position, while Equatorial Guinea fell even further to sixty-sixth position. The 50-per cent line now extends all the way down to fortieth place (33 in 1960), while the relative TFP level in only five countries is less than 10 per cent. One important finding is that, although there is some indication of convergence, it occurs only in the top half of table 3. In the bottom half, there are clear signs of divergence, and it appears that a bipolar situation has indeed developed over the past four decades.

Table 4 summarizes the prime TFP movers. Compared with labour productivity, there are now much greater movements in terms of percentage points. The best performers are, once again, Luxembourg, Taiwan, Ireland and Hong Kong, but several other countries have improved immensely going by this performance criterion. Apart from the EU-countries and Asian tigers mentioned previously, Mauritius and Botswana, well-known African successes, also figure along with oil-rich Gabon. Some countries that have undoubtedly grown rapidly in the past 20 years or so, most notably China and India, have not as yet caught up much in TFP because their growth is mainly explained by factor accumulation instead of productivity growth.

The list of countries falling behind is long, and compared to table 2 many countries have lost ground relative to the U.S. Moreover, the extent of change is greater for more countries. Most of the countries that have fallen behind are located either in sub-Saharan Africa or Central America and were, in the majority of cases, already performing poorly in 1960 – which can be interpreted as a clear sign of divergence (in TFP). What is particularly interesting is that some of the oil-rich developing countries, which ranked high in 1960, such as Equatorial Guinea and Venezuela, were unable to use this windfall in a productive way. Whatever the reason may be, although poor

[8] TFP has been calculated as GDP divided by an input index, where the respective weights of labour and capital are one-third and two-thirds, respectively. These weights largely reflect their respective income shares in GDP and are standard assumptions.

institutions stand out as a strong contender, the result has been a sharp drop in performance. Even if the resource-curse indeed seems to be a real phenomenon, it is likely to relate to institutional quality because there is evidence of countries, such as Botswana and Norway, apparently being able to stave off the effects of Dutch Disease and sheer rent-seeking.

Tables 1 and 3 both suggest divergence, although the former more blatantly so. Table 3 points to convergence (relative to the U.S.) among a restricted group of countries, but also reveals a clear tendency towards polarization. Before drawing too strong a conclusion, however, more information is needed. To this end, the world technology frontier, referred to in the next section, is used to learn more about the relative performance of countries.

3. The world technology frontier[9]

An explanation has already been provided on how the world technology frontier is constructed as well as how graphical illustrations should be interpreted. However, with the graphs at hand it might be worthwhile to briefly review the matter. Figure 1 shows the location of all 112 countries relative to the world technology frontier in 1960. Each point denotes a country combination of output and capital per worker. The technology frontier is obtained by connecting the points that envelop all other points.[10] The distance from each country point to the frontier provides a measure of technical (in)efficiency. In other words, it shows how much less is produced at a given capital intensity compared with actual potential.

From rich to poor, the frontier is made up of Switzerland, the U.S., El Salvador, Equatorial Guinea, Sierra Leone and Lesotho. This shows that technical efficiency and affluence do not go hand in hand, mainly because the latter is no guarantee for efficient use of production factors. Another important aspect is that technical efficiency does not predict productivity. In other words, the fact that El Salvador is on the frontier does not necessarily mean that it is a highly productive country.

[9] A better term for this frontier is ”best-practice”. In particular, the method of analysis is sample-specific, which means that one is not necessarily able to get a picture of the world technology frontier. In this case, with the exception of Germany, the dataset includes all reasonable frontier countries and therefore warrants a discussion on the world technology frontier.

Furthermore, data near the origin is relatively noisy. Hence, one should not over-emphasize the frontier at very low levels of income and capital intensity. The maximum level of the frontier is around US$32,000 per worker (1996 PPP), while the maximum capital per worker is close to US$54,000 (these are, of course, the Swiss coordinates).

The main cloud of country points is located near the origin at low capital intensity and low output per worker; clearly, higher the capital intensity, higher the output per worker. However it is interesting to note that, although it seems that output of Switzerland is almost as high as that of the U.S., capital per worker in Switzerland is much lower than that in the U.S. This could point to a need to adjust input data for utilization rates – in this case for labour utilization in particular, as the unemployment rate in Switzerland is low. Table 5 shows that the average distance to the technology frontier for the world as a whole was 0.56, which means that the average country produces at only 56 per cent of best practice.

A more in-depth study is conducted for three different sub-groups, namely, industrialized countries,[11] dynamic developers[12] (in principle, fast growers) and LDCs.[13] Figure 2 shows the location of industrialized countries in 1960. Most of the rich countries are found in the northeast part of the graph, with five exceptions: Japan, Ireland, Greece, Portugal and Spain, countries that are currently situated to the right as well. On average, this group of countries performs well in terms of efficiency, with an average score of 0.75. The highest capital intensity was reached by Luxembourg, while Switzerland, as already mentioned, produced the highest output per worker. The ("horizontal") distance between relatively poor industrialized countries to relatively rich ones is huge: in terms of capital intensity Japan had only 15 per cent of the level of Switzerland, while the difference in output per worker was more than 400 per cent! This, of course, could change with time.

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[10] Hence the method's name: Data Envelopment Analysis.

[11] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

[12] Botswana, Chile, China, Hong Kong (SAR of China), India, Indonesia, Republic of Korea, Malaysia, Mauritius, the Philippines, Singapore, Taiwan (Province of China) and Thailand.

[13] Angola, Bangladesh, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Haiti, Lesotho, Madagascar, Malawi, Mauritania, Mozambique, Nepal, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Togo, Uganda, United Republic of Tanzania, and Zambia.

In 1960, the dynamic developers (figure 3) tended to be very close to the origin, with Chile, Mauritius and Hong Kong being the main exceptions. It is striking to note how poor countries, such as Botswana, China, India and Indonesia, ranked 40 years ago. It is equally striking to see how far away these countries were from, say, Switzerland to make an extreme comparison. For example, the relative output per worker in Korea compared to Switzerland was only 14 per cent, while capital intensity was a mere 6 per cent. The average efficiency for this group of countries was 48 per cent, a figure that was subsequently subject to some major changes.

Although LDCs are located extremely close to the origin (figure 4), in terms of technical efficiency, they can be compared with the dynamic developers at 46 per cent. As is clear from the graph, the cluster of countries is so densely packed that it is practically impossible to distinguish between them.

Figures 5 to 9 replicate the 1960 exercise, but this time for 2000. Table 5 provides information on average technical efficiency. In 2000, the world technology frontier included new countries: Luxembourg, Ireland, Barbados, Egypt, Haiti and Uganda, with Luxembourg almost appearing as an outlier (figure 5). As mentioned earlier, one must be cautious against attaching too much importance to the frontier near the origin. While the average efficiency level increased somewhat (from 0.56 to 0.58), the difference is too negligible to be interpreted as an actual change. However, there are two major changes worth mentioning. First, where there was previously only one cluster, there now appears to be two: one made up of relatively poor countries and the other of relatively rich countries, thus fuelling the notion of convergence clubs. Secondly, the approximate average income and capital per worker, respectively – for both rich and poor countries – appear to have doubled in 40 years, thus widening the income gap in absolute terms. The level of the frontier is nearly three times that of 1960, while the maximum capital per worker is about two-and-a-half times greater.

To obtain a better picture of changes that have occurred since 1960, refer to figure 6, which shows the shift of the technology frontier with data points for the year 2000. The distance between the two frontiers measures the extent of technological progress. In the case of the 1960 frontier, the horizontal extension is traced out in order to better

illustrate its position vis-à-vis the 2000 frontier. It is distressing to note that, in 2000, many countries are still behind the 1960 frontier. This is prevalent among relatively poor countries, with only one such case among the rich countries. Even worse, the two frontiers cross at a capital intensity level of around US$30,000, suggesting that many poor countries have experienced technological regress.[14] At capital intensity levels above US$30,000, technological progress has been rapid.

The absolute level of technological progress has been greater at higher-income levels, thus explaining one possible reason for the aforementioned divergence between rich and poor countries (or the emergence of convergence clubs, if one so prefers, see Quah (1997)). This is hardly surprising, since factors behind technological progress generally require resources. If one wishes, this could be interpreted as supporting the predictions of endogenous growth models, where technological change is made endogenous and is explained, inter alia, by research and development, which takes place in relatively rich countries.

An additional interesting finding is that the production relation seems to have tilted so that the slope of the 2000 frontier is greater than in 1960. In other words, technological change has not been (Hicks-) neutral with respect to capital and labour; it has been labour saving, that is, technological change has been Harrod-neutral. One important implication of such a tilt is that the time of diminishing marginal returns to capital is postponed. One possible interpretation is again that of support for endogenous growth models. The conclusion drawn is that capital intensity has a strong bearing on technological change.

At this point, turning to figures 7 to 9, one can see what occurred in the various country groups over the past 40 years. The industrialized countries (figure 7) seem to

[14] Is this really possible if one interprets the technology frontier as knowledge? No, but since there is only access to real data, this means that what is measured is an actual outcome. This obviously implies that the frontier for 2000 could have segments inside the 1960 frontier (areas where technological regress has occurred). There are two reasons for accepting technological regress: First, technological advances are taking place at a high level of capital intensity, while technological regress is observed only at a very low level. Therefore, in terms of knowledge, the results are not greatly affected. Secondly, the main effect of preventing technological regress when measuring productivity growth is to change the allocation between technological change and change in technical efficiency; changes to TFP growth are negligible. Because TFP growth, the prime interest, is only marginally affected, there is no

have converged (note that Greece, Japan, Portugal and Spain are no longer near the origin but are in the group of industrialized countries). Apart from Luxembourg, the group of countries seems to have shaped its own world with very high relative levels of capital intensity, albeit at a somewhat greater distance from the technology frontier (from 75 to 68 per cent).[15]

A few newly industrializing countries have joined the group. Figure 8, on dynamic developers, shows that these additional data points represent Hong Kong, Korea, Singapore and Taiwan, truly reflecting a "miracle" in East Asia. Some of these countries have also moved closer to the technology frontier, for example, Botswana, Mauritius and the Philippines. The average efficiency score has increased from 48 per cent to 62 per cent, which amounts to an average increase of 30 per cent in 40 years. Although most dynamic developers are still, relatively speaking, in the low-income club, countries such as Malaysia, Thailand and Mauritius have seriously started moving northeastwards.

Figure 9 reveals some interesting changes with regard to LDCs. For example, Equatorial Guinea has taken a great horizontal leap, amounting to a nineteen-fold increase in capital intensity! At the same time, income per worker has only increased by 27 per cent. Uganda, where income per worker and capital intensity have increased by 78 per cent and 554 per cent, respectively, is a perfect example of why growth rates sometimes are best studied together with levels. These levels, nonetheless, amounts to only 55 per cent and 5 per cent of those of Lesotho which, in turn, recorded only 14 per cent and 32 per cent of Botswana's levels. The pattern that, even if capital intensity increases, the effect on income per worker is limited, seems typical for LDCs. Undoubtedly, had it been possible to adjust for capital utilization and unemployment, the situation might have turned out differently, but this lack of information is noteworthy for LDCs. Unfortunately, there are also cases of zero or negative change. In Senegal, for example, income per worker changed from US$3,245 to US$3,389 over the 40-year period. Although there was virtually no change, capital intensity doubled. In Angola, income per worker was US$14,134 in 1960 and, by

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correction for this. Interested readers may refer to Forstner and Isaksson (2002) where such a correction is made.

[15] As a reminder, a smaller figure implies greater technical inefficiency and thus greater distance from the frontier.

2000, had *decreased* to US$3,050. Finally, in Zambia a near doubling of capital intensity has been coupled with only a slight increase in income per worker. Average technical efficiency has, in principle, remained unchanged for LDCs.

4. Patterns of economic growth

This section describes the world as a whole, followed by groupings of countries according to geographic regions and stages of development, which reveals interesting growth patterns. Finally, some country results worth highlighting are reviewed.

Overall, economic growth can be described in terms of its sources, factor accumulation and TFP growth. Likewise, TFP growth can be broken down into two sources, technological progress and change in technical efficiency. A standard sources-of-growth analysis allows for 'measuring' the relative importance of factor accumulation and TFP growth. For example, one can say that 60 per cent of output growth is due to investment in capital, 25 per cent to labour accumulation, while the remaining 15 per cent stems from TFP growth. However, the TFP growth measure used here is not the residual emanating from growth accounting – it comes from DEA – and, as a consequence, relative roles of factor accumulation and TFP growth (and its sources) cannot be analysed as neatly as standard analysis would allow. This is an important point that has to be kept in mind throughout the ensuing discussion.[16]

Figure 10 shows the (weighted) TFP growth for the world as a whole. The central line running through the graph is simply a trend line. From this, it is immediately clear that world TFP growth has been stationary over the past 40 years. Apart from the well-known productivity dips related to the oil crises and a strong ensuing recovery, TFP growth has not fluctuated much.

The post-oil crisis recovery of productivity growth peaked at nearly 3 per cent in the mid-1980s. The slight downward trend towards the two oil crises might suggest that changes in productivity growth could precipitate a major event, such as a crisis. After

[16] Technically speaking, the conventional income shares (weights) used in standard sources-of-growth analysis and those implied by DEA are different, and this is the main reason for the discrepancy.

the recovery, another downward trend appears to set in, but expansion starts at the end of 1990s.

As already stated, productivity growth can be decomposed into change in technical efficiency and technological change. Figure 11 shows the former, again for the world as a whole. Interestingly and again with the exception of the oil crises, catching up featured strongly until the mid-1980s.

Thereafter, there is a strong downward shift in the curve, implying that the world as a whole is becoming less efficient/divergent. There are wide fluctuations, with several positive peaks at the 3-per cent mark, while troughs reach almost to –4 per cent. There is, in fact, a slight negative tendency over the 40-year period as a whole.

The graph on world technological progress (figure 12) appears to be the mirror image of figure 11, which, of course, it is not. It shows that the strong growth witnessed during the 1960s was not driven by innovation. The situation was quite the contrary. Innovation started having a very strong positive impact only from the late 1980s or early-1990s, although the trend break occurs just after the second oil crisis. Here, the IT-revolution could, in part, explain the surge in technological change. One trend that goes hand in hand with TFP growth seems to be that technological progress slowed down in the first half of the period and reached an all-time (for the sample period) low during the oil crises. It is possible that changes in innovative activity more accurately than TFP growth predict ensuing events, good or bad, because signals sent out by TFP growth can be mitigated by changes in technical efficiency.

The graphs discussed so far describe the evolution of technical efficiency, technological change and TFP growth for the world as a whole. They may, however, mask important variations across, for example, regions. Table 6 shows the evolution of output and inputs and, separately, that of TFP and its decomposition. The grouping of countries is more of a “political” nature in that it does not consider geographic location. Industrialized countries, developing countries[17] (excluding LDCs) and LDCs are shown as three separate groups. Below the broken line, the dynamic developers are shown separately. Finally, both unweighted and weighted world means are

presented. Table 7 employs geographic distinctions, with the exception of industrialized countries, and compares those with Asia and the Pacific, Latin America and the Caribbean, Middle East and North Africa (MENA) and sub-Saharan Africa. The Asian tigers are singled out and the impact of South Africa on sub-Saharan Africa is also shown. The world means are obviously identical to those presented in table 6.

Considering first table 6, between 1960 and 2000 worldwide output growth recorded a remarkable 4.3 per cent on average annually. TFP growth was slow at 0.3 per cent per year, with its main contribution coming from technological progress. There is evidence of technological progress as well as catching up, although the latter effect appears negligible. This, however, does not mean that technological differences between countries are not the main explanatory factor behind differences in income levels. Before drawing such conclusions, it might be necessary to study sub-groups of countries rather than the world mean.

Since these figures are weighted by real GDP, industrialized countries figure very prominently. Unweighted means, that is, treating all countries with equal weight, suggest that output growth has been slower and the contribution of TFP to output growth is negative – the latter due to technological regress. Because relatively poorer countries in this context carry a larger weight compared with the case of weighted means, the effect of catching up is greater (since industrialized countries are leaders rather than followers).

Turning to country subgroups, TFP growth appears to be a more important source of output growth in industrialized countries than in developing countries, with innovation the prime driver. For LDCs, TFP growth contributed negatively to output growth. Interestingly, the catching-up component is slightly negative, suggesting that some industrialized countries have in fact started lagging behind. This may also indicate that the most innovative countries in the developed world are moving ahead of other rich (industrialized) countries. Another interpretation, however, is that Luxembourg is the driving force. This issue is discussed in some detail later when the sole focus is on industrialized countries.

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[17] Developing countries is a residual group and is thus highly heterogeneous.

In the developing-countries group, there is evidence of technological regress coupled with strong catching-up. High output growth is derived from factor accumulation. This disparate group of countries includes dynamic developers, which are likely to drive the growth process. This group's results will be analysed in further depth later with comments on geographic location and on individual countries. In LDCs, the catching-up process is slow, but positive. As expected, technological regress clearly leads to very negative TFP growth. Distressingly, LDCs are clearly falling even further behind due to an extraordinarily poor productivity performance in terms of both level and growth. This situation persists, despite their capital accumulation being on par with that of industrialized countries – albeit with slower capital deepening due to faster labour accumulation – and a somewhat improved resource utilization.

If dynamic developers are singled out, output growth for this group can be viewed as very strong. Behind this rapid growth lies solid factor accumulation, in particular that of capital, while the contribution of TFP growth does not appear particularly important. Hence, one may be tempted to agree with Krugman (1994) and Young (1995) that the East Asian Miracle may not be so miraculous after all. However, because these average figures are weighted by real GDP, relatively late developers, such as China, play a bigger role than the tiger economies. Therefore, conclusions will have to be postponed until these economies have been studied in more detail. In nay case, TFP growth stems from increased technical efficiency, while innovative capacity appears to be lagging.

Table 7 mainly sets out the regional distribution of output and TFP growth. At 5.9 per cent output growth, Asia and the Pacific is the fastest-growing region in the world. Rapid factor (capital) accumulation seems to be the main reason behind such fast growth. TFP growth has not been particularly good (0.27 per cent per year) and can be attributed to the region's poor performance in terms of innovation. However, these countries have been able to reduce inefficiency, thereby mitigating the unfavourable innovation performance. In fact, the reduction of inefficiency has been an amazing feature, in that every year the region has closed in on the world technology frontier by 1.5 per cent. Capital deepening has been astonishingly fast, about 33 per cent faster than in industrialized countries. One would imagine that capital deepening and TFP growth would be somehow positively correlated, but this does not seem to be the case

in Asia when compared to industrialized countries (actually not in general either, as it turns out).

Returning to the issue of the East Asian Miracle, representing a set of four countries that have grown even faster than the region as a whole, two points on TFP growth are worth mentioning. First, TFP growth in this group of countries is higher than that of the industrialized group. Secondly, according to growth accounting (not shown here) TFP growth contributed more than 30 per cent to output growth. Judged by that yardstick, Krugman and Young thus may have been wrong. While capital deepening was swift in Asia as a whole, it reaches almost extreme levels in these countries – 44 per cent faster than in the region as a whole and 92 per cent faster than the industrialized countries group! The corresponding differences in output growth are 37 and 117 per cent, respectively. TFP growth is 46 per cent faster in these four countries compared with industrialized countries. Here innovation hovers around zero, while the catching-up process has occurred at a slower pace than for the region as a whole. This is to be expected because the tiger economies started out in 1960 much closer to the technology frontier and, the closer a country gets to the frontier, the more demanding it is to sustain catching up.

The second best-performing region is the Middle East and North Africa (MENA), which mainly consists of oil-producing countries. Such countries are often characterized by rapid output growth and less impressive TFP growth. If these countries play their cards right, that is, avoid negative aspects, such as rent-seeking and Dutch Disease, they can quickly improve their economies. In this region, output growth was indeed rapid (5 per cent per year), while that of TFP was close to zero. Capital deepening has been as rapid as in industrialized countries, despite faster labour accumulation. While these countries have caught up somewhat, they have also experienced some technological regress.

Latin America has reasonable output growth (4.25 per cent annually), but slow capital deepening – due to low capital accumulation rather than very high labour accumulation. This may point to serious investment obstacles. TFP growth was at par with Asia but contributed less to output growth (growth accounting again). While other regions seem to have closed in on the technology frontier, Latin America, which

started fairly close to industrialized countries, has moved in the other direction. Technological change is positive, which is consistent with Latin America's status as a fairly advanced region.

Finally, sub-Saharan Africa is not surprisingly the slowest growing (3.1 per cent annually) group of countries and has the slowest rate of capital deepening (2.5 per cent per year). Technological regress plainly dominates TFP growth, which is why it is decisively negative. Owing to its very different economic structure, it is common to exclude South Africa from the rest of sub-Saharan Africa. This causes both output growth and, more significantly, TFP growth for the region to fall. By contrast, capital deepening increases by some 20 per cent. It thus seems that South Africa's main positive contribution is to TFP growth, which is a reflection of it being more industrialized. The implication of TFP development for economic growth in Africa is without doubt disastrous and unique across regions. An important explanation of why Africa appears to develop slower than other regions is believed to be to its dismal TFP performance. If a 1 per cent growth doubles the economy in 72 years, then it is clear how quickly a negative 1 per cent per year will have the opposite effect.

Turning briefly to some country figures, within industrialized countries (table 8), the growth champion over the 40-year period is Israel, at 5.8 per cent per year, closely followed by Cyprus and Japan (both at more than 5 per cent per year). The slowest growing countries are Switzerland (2.2 per cent), the United Kingdom (2.5 per cent), New Zealand (2.5 per cent), Sweden (2.6 per cent) and Denmark (2.7 per cent). The main reasons why industrialized countries as a whole displayed a negative change in technical efficiency are evident. Switzerland and New Zealand have both slipped back by more than 1 per cent per year, as clearly indicated in the labour and TFP tables analysed at the beginning of this paper. Several other countries have also slipped back slightly in terms of technical efficiency.

The clear winner in the catching-up process is Cyprus, which has gained 1.6 per cent per year relative to the technology frontier. Overall, there are in general small movements with respect to change in technical efficiency, while innovation has seen some real winners. The innovation league is topped by Luxembourg, at 2.2 per cent per year, followed by Switzerland (2.1 per cent) and Norway (2 per cent), although

several countries that have done well in this area. Country by country analysis reveals that TFP growth, in most cases, seems an important contributor to output growth. TFP growth in excess of 2 per cent per year was achieved by Cyprus, Italy and Luxembourg. In many other countries, for example, Australia, Belgium, Denmark, Finland, Iceland, the Netherlands, Norway and Sweden, TFP growth was high. Interestingly, with zero TFP growth, Japan is second to worst, ahead only of the U.K. with a negative growth rate. Finally, the U.S., which has done extremely well since the 1990s has, over the 40-year period, only performed moderately well in terms of innovation, and actually quite poorly with respect to TFP growth. Comparing the unweighted with weighted mean suggests that large countries tend to constitute a drag on overall TFP growth.

The Asia and Pacific region (table 9) reveals surprisingly poor productivity figures. How can these aggregate figures be explained? Starting with output growth and capital deepening, some amazingly high figures emerge. The real champions, in terms of output growth, are Singapore (9.5 per cent annually), Taiwan (8.5 per cent), Korea (7.9 per cent), Hong Kong (7.8 per cent), Thailand (7 per cent), Malaysia (6.7 per cent) and China (6.1 per cent). All these countries have also done extraordinarily well in accumulating capital per worker. However, other countries have also registered fairly high rates of capital deepening (for example, Nepal, Sri Lanka and Papua New Guinea) but have failed to translate this increase in capital intensity into growth. This obviously implies that it takes more than just investment to grow.

TFP growth varies greatly across countries, but the best performers are Hong Kong (1.5 per cent per year), Taiwan (1.2 per cent) and Pakistan (1 per cent). Many countries have performed very poorly in this area, for example, Bangladesh (-1.7 per cent), Indonesia (-1.7 per cent) and Nepal (-1.4 per cent). Even for the best TFP performers, TFP growth as a contributor to output growth is dwarfed by factor accumulation. For example, based on growth accounting, in Hong Kong and Taiwan TFP growth accounts for nearly 40 per cent, while in Pakistan that figure was around 20 per cent. Innovative activities have yet to take off in the region, as reflected by the fact that only three countries show positive technological change (led also here by Singapore). The region’s strong catching-up performance is largely due to China (2.3 per cent per year), Pakistan (1.9 per cent), India (1.8 per cent) and Taiwan (1.4 per

cent). China and India's strong performance are particularly prominent in this area, although it still has a long way to go.

Table 10 shows the performance of countries in Latin America and the Caribbean. Brazil being the main exception, the fast growers here tend to be small countries, for example, Dominican Republic (5.5 per cent annually), Brazil (5.1 per cent), Panama (5 per cent), Mexico (4.7 per cent), Barbados (4.6 per cent) and Paraguay (4.6 per cent). The role of capital deepening in output growth is significant here as well, with Paraguay being the top performer. With the exception of Barbados (2.5 per cent per year) and Brazil (1 per cent), the TFP growth column is far from impressive, where the strongly negative performers include Nicaragua (-2.2 per cent per year), Honduras (-1.1 per cent), and Costa Rica, El Salvador and Paraguay (each –1 per cent). Innovation is only slightly positive with some very poor performances (for example, Haiti and Paraguay). There are two outstanding performers in terms of catching up, namely, Barbados and Haiti. The other dismal performers are Nicaragua, Venezuela and Costa Rica.

Table 11 covers countries in sub-Saharan Africa.[18] At nearly 9 per cent per year Botswana's growth has been phenomenal, but attributable entirely to factor accumulation, as TFP growth was strongly negative. Cape Verde (6 per cent), Congo (5.7 per cent), Gabon and Mauritius each (5.5 per cent), Zimbabwe and Seychelles (5.1 per cent) also grew rapidly. However, in most of these countries, Seychelles being a shining exception, capital deepening has been weak, and in Zimbabwe and Chad even negative on average. However, some African countries have accumulated capital at a double-digit rate (Botswana, the Gambia and Lesotho). There are also some real growth disasters in this region, for example, Democratic Republic of Congo (-1.5 per cent), Central African Republic (0.5 per cent) and Sierra Leone (1.4 per cent).

Growth in TFP provides for another depressing story. Lesotho is the worst performer at –7.7 per cent per year, closely followed by Sierra Leone (-4.3 per cent), Democratic Republic of Congo and Equatorial Guinea (-3.8 per cent), the Gambia (-3.4 per cent),

Rwanda (-2.9 per cent) and Nigeria (–2.8 per cent). Some countries have however performed well in this area. Ranked by TFP growth, these countries include Congo, Gabon, Ghana, Kenya and Zimbabwe. All things considered and fully aware of the importance of TFP growth for welfare improvement, it is no longer necessary to ask why Africa is poor, at least not in a proximate sense. As can be expected, technological change is poor with strongly negative trends in Burundi, Democratic Republic of Congo, Equatorial Guinea, Gambia, Lesotho, Madagascar, Mozambique, Rwanda, Sierra Leone and Uganda. With a few exceptions, for example, South Africa and Namibia, technological regress is prevalent. Only a small number of countries did well with technical efficiency change and managed to creep closer to the technology frontier. Most noteworthy are Cape Verde, Congo, Ghana, Kenya and Zimbabwe, but many countries have also slipped back. However, the dominant picture is one of poor productivity growth and very strong factor accumulation.

The final region discussed is the Middle East and North Africa (MENA) (table 12). Syria and Jordan grew the fastest (6.7 and 6.2 per cent annually, respectively). Overall, the region has performed well in this respect, with capital deepening being less dominating compared with other regions. Algeria barely managed to record a positive rate of capital intensity accumulation and has the weakest level in the region. Tunisia (1 per cent annually) leads the TFP growth league followed by Algeria (0.9 per cent) and Morocco (0.8 per cent), while Jordan (-1.3 per cent) and Turkey (-0.6 per cent) recorded negative TFP growth rates. Egypt, Morocco and Syria closed in on the frontier by more than 1 per cent annually, while Jordan again stands out as the poor performer in this respect. Iran achieved the highest technological progress at 0.7 per cent annually, while Egypt registered the lowest at –1.1 per cent.

To summarize, the most important message of this section is that, at early stages of development, countries rely totally on factor accumulation for their growth. As they advance, productivity starts contributing to output growth. Most of the fastest-growing countries are found in Asia, where catching up has been significant. Latin America has gone the other way, while sub-Saharan Africa in general displayed a

[18] Here one needs to attach a question mark to some of the figures that appear to be too high to be true. As data quality undoubtedly increases with income per capita, it is not surprising that data pertaining to this region appear somewhat questionable from time to time.

very depressing performance, in particular with respect to TFP growth. This suggests that exploring the determinants of TFP growth helps to better understand why sub-Saharan Africa is so poverty-stricken.

5. Capital deepening, technological progress and change in technical efficiency

Attention is now turned to the relationship between change in technical efficiency, technological progress and capital deepening. It has emerged that when a country (or region) enjoys technological progress/regress there is a tendency for it to experience a negative/positive change in technical efficiency.

It may be speculated that, in general, new investments in capital (capital deepening) generate, or imply, technological progress (which, of course, means that it cannot be assumed to be exogenous). However, at the same time, a new input set is available to producers, which entails some learning and adaptation before it can be used with optimal results. This adaptation process is bound to take time, implying that capital deepening may be associated with both technological progress and negative change in technical efficiency.

However, it also seems that it is easier to find cases of both technological progress and reduction in technical inefficiency among relatively rich countries, while among poor countries there is a tendency to score negatively on both. One may conjecture that relatively advanced countries spend less time (compared with relatively poor countries) on learning and adaptation. Furthermore, from a situation of relative technical efficiency, rich countries probably regress on average less than poor countries and therefore revert to efficiency much more quickly. African countries are probably relatively weak in terms of technical efficiency and therefore can quite easily gain ground in this respect. Although technological progress occurs, there is a much smaller probability that it will be experienced in Africa, as many crucial conducive factors, such as human capital and research and development, are lacking or scarce.

Another issue is that productivity growth leads to capital deepening or – if the focus is on technological progress rather than TFP – that technological change spurs

investments through its impact on output. If causation – which is basically the issue – runs in this direction, a more or less similar discussion as that mentioned earlier could be undertaken, albeit with the line of reasoning revolving around output. Technological progress therefore leads to an output (or demand) increase, which in turn boosts investment (that is, investment is a function of output). The capital per worker ratio increases and leads to a new set of inputs that need to be organized for optimal use. There is again a period of learning and adaptation, where technical efficiency change becomes negative. Again, it is quite possible that a pattern of capital deepening (increased capital per worker ratio), technological progress and negative technical efficiency change may be observed.

Before concluding this paper, the issues of localized innovation, technological spillovers and divergence are briefly discussed. It was observed that in 2000 the distribution of countries had assumed a bipolar shape, suggesting divergence in income per worker.[19] In addition, the world technology frontier had moved outward in a non-neutral fashion, which means that innovation occurs at high levels of capital intensity. It also implies that diminishing returns can be postponed. Unless such innovation is appropriate for follower countries, it will simply elude them and they will most likely fall behind, leading to further divergence. The way to avoid such divergence is to accumulate capital, or as Abramowitz (1986) pointed out, increase social and technological capabilities. Hence, one of the roles of capital deepening is to create a capability for increasing the benefits of technological spillovers.

6. Conclusions

The purpose of this paper has been to describe the world in terms of income and productivity, levels and growth rates. The data analysed cover a 40-year period (1960 to 2000) and 112 countries. It started by ranking countries according to their relative performance in terms of income per worker and TFP level. Later it showed that, in these terms, the world appeared somewhat unequal and displayed a tendency to increase inequality. Ranking by TFP levels seemed to compress the spread of countries a little, but a closer inspection suggested the emergence of two groups and divergence. Several countries have managed to catch up with the industrialized

countries. The good performers were mainly in Asia, (for example, Hong Kong, Japan, Korea, Singapore and Taiwan, some European countries (for example, Cyprus, Greece, Ireland, Luxembourg, Portugal and Spain) and a few African countries (for example, Botswana and Mauritius). However, countries that were poor in 1960 generally stayed poor in 2000, and some of the "entrants" joining this group of (poor) countries were from Latin America and sub-Saharan Africa.

Thereafter, the so-called world technology frontier was traced. Apart from the world as a whole, the focus was on the industrialized country group, LDCs and an ad hoc group called dynamic developers. First of all, the world graph seemed to confirm the notion that the world is becoming polarized and that divergence is indeed a real phenomenon. The difficult situation faced by LDCs was confirmed and it was shown that technological change appears to be related to the level of capital intensity.

Finally, growth patterns were discussed. World TFP growth turned out to be stationary. The perhaps most important message was that, in early stages of development, countries rely totally on factor accumulation for their growth. As they advance, productivity growth starts to contribute to output growth. The discussion also delivered more distressing news on divergence. Most of the fastest-growing countries were in Asia, which is also the region that has managed to catch up significantly. Latin America was shown to have gone the other way, while sub-Saharan Africa, in general, displayed a very depressing performance, in particular with respect to TFP growth. It was argued that part of the reason why sub-Saharan Africa is poverty-stricken is due to poor TFP growth.

While this paper contains only guesses and conjectures, it confirms that capital accumulation is very important in order to benefit from technological spillovers. However, a proper understanding requires thorough research of TFP determinants

[19] A result also obtained by Kumar and Russell (2002).

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Table 1. Ranking of Countries by Income per Worker, 1960 and 2000

Ranking	Country	1960	Country	2000
1	Switzerland	106	Luxembourg	160
2	New Zealand	102	Ireland	101
3	U.S.A.	100	U.S.A	100
4	Canada	92	Belgium	88
5	Luxembourg	92	Norway	84
6	Australia	87	Italy	84
7	Venezuela	83	Canada	81
8	Denmark	79	Netherlands	81
9	Netherlands	77	Australia	80
10	Sweden	77	Hong Kong, SAR of China	80
11	Norway	69	Singapore	79
12	United Kingdom	69	Austria	78
13	Iceland	69	France	76
14	Belgium	67	Denmark	75
15	France	60	Switzerland	73
16	Italy	55	Finland	73
17	Finland	54	Sweden	70
18	Argentina	52	Iceland	70
19	Israel	51	United Kingdom	69
20	Austria	50	Spain	68
21	South Africa	44	Taiwan, Province of China	66
22	Trinidad and Tobago	43	New Zealand	61
23	Ireland	43	Cyprus	61
24	Mexico	42	Israel	60
25	Uruguay	42	Japan	60
26	Chile	39	Portugal	54
27	Costa Rica	37	Greece	52
28	Spain	37	Barbados	51
29	Mauritius	36	Mauritius	50
30	Algeria	35	Republic of Korea	48
31	Greece	34	Argentina	40
32	El Salvador	33	Trinidad and Tobago	39
33	Fiji	33	Chile	39
34	Iran	30	Malaysia	37
35	Namibia	30	Botswana	37
36	Nicaragua	29	Seychelles	36
37	Barbados	28	Uruguay	33
38	Portugal	27	Mexico	33
39	Jordan	27	Iran	30
40	Hong Kong, SAR of China	26	Brazil	30
41	Japan	25	South Africa	29
42	Peru	25	Gabon	27
43	Brazil	24	Tunisia	27
44	Cyprus	24	Dominican Rep.	25
45	Panama (excl. Canal Zone)	23	Venezuela	24
46	Guatemala	23	Costa Rica	23
47	Equatorial Guinea	22	Namibia	23
48	Jamaica	22	Algeria	23
49	Guyana	22	Panama (excl. Canal Zone)	22
50	Singapore	22	Turkey	22
51	Tunisia	20	Fiji	21
52	Malaysia	20	Jordan	20
53	Seychelles	20	Syria	20
54	Colombia	20	Colombia	18
55	Ecuador	20	Thailand	18
56	Dominican Rep.	19	Egypt	17
57	Bolivia	18	Guatemala	16
58	Turkey	18	Paraguay	16
59	Philippines	17	El Salvador	16
60	Paraguay	17	Peru	16
61	Guinea	17	Cape Verde	16
62	Honduras	16	Morocco	14
63	Gabon	16	Ecuador	14
64	Republic of Korea	15	Equatorial Guinea	13
65	Syria	14	Philippines	13
66	Angola	14	Guyana	13
67	Egypt	14	Indonesia	12
68	Comoros	13	Sri Lanka	12
69	Taiwan, Province of China	13	Jamaica	11
70	Papua New Guinea	12	Bolivia	11
71	Central African Rep.	12	China	10
72	Morocco	12	Guinea	9
73	Senegal	11	Papua New Guinea	9

Ranking	Country	1960	Country	2000
74	Sri Lanka	11	India	9
75	Cote d'Ivoire	10	Haiti	9
76	Cape Verde	10	Honduras	8
77	Niger	9	Pakistan	8
78	Mozambique	9	Zimbabwe	8
79	Cameroon	9	Cote d'Ivoire	7
80	Zambia	9	Nicaragua	7
81	Sierra Leone	8	Cameroon	6
82	Madagascar	8	Congo	6
83	Indonesia	8	Comoros	5
84	Chad	8	Senegal	5
85	Botswana	7	Lesotho	5
86	Thailand	7	Bangladesh	5
87	Zimbabwe	7	Nepal	5
88	Bangladesh	6	Angola	5
89	Haiti	6	Mauritania	5
90	Benin	6	Ghana	4
91	India	6	Benin	4
92	Mauritania	6	Kenya	4
93	Mali	6	Gambia, The	4
94	Nigeria	6	Togo	3
95	Pakistan	6	Central African Rep.	3
96	Togo	6	Zambia	3
97	Gambia, The	6	Mali	3
98	Rwanda	6	Mozambique	3
99	Congo, D.R.	5	Burkina Faso	3
100	Ghana	5	Sierra Leone	3
101	Kenya	4	Chad	3
102	Nepal	4	Uganda	3
103	China	4	Niger	3
104	Lesotho	4	Rwanda	3
105	Burkina Faso	4	Madagascar	3
106	Congo	4	Malawi	3
107	Ethiopia	4	Ethiopia	2
108	Uganda	3	Nigeria	2
109	Burundi	3	Guinea-Bissau	2
110	Guinea-Bissau	3	Burundi	2
111	Malawi	3	United Republic of Tanzania	1
112	United Republic of Tanzania	2	Congo, D.R.	0

Source: Heston, Summers and Aten (2002).

Table 2. Catching up and falling behind relative to the U.S.: 1960 to 2000

Catching up	Change	No change	Change	Falling behind	Change
Luxembourg	68	Turkey	4	Denmark	-5
Ireland	58	Indonesia	4	Chad	-5
Singapore	57	Netherlands	4	Congo, D.R.	-5
Hong Kong, SAR of China	54	Egypt	3	Sierra Leone	-5
Taiwan, Province of China	53	Morocco	3	Zambia	-5
Cyprus	37	Pakistan	3	Madagascar	-5
Japan	35	India	3	Senegal	-5
Republic of Korea	34	Haiti	2	Ecuador	-6
Spain	31	Congo	2	Mozambique	-6
Botswana	30	Sri Lanka	1	Guatemala	-6
Italy	28	Zimbabwe	1	Niger	-6
Austria	28	Iceland	1	Sweden	-6
Portugal	27	Lesotho	1	Jordan	-7
Barbados	23	Nepal	0	Namibia	-7
Belgium	21	Iran	0	Comoros	-7
Finland	19	Chile	0	Australia	-7
Greece	19	United Kingdom	0	Bolivia	-7
Malaysia	17	Malawi	0	Guinea	-8
Seychelles	16	Ghana	0	Honduras	-8
France	16	Uganda	-1	Central African Rep.	-9
Norway	14	Guinea-Bissau	-1	Angola	-9
Mauritius	14	Kenya	-1	Uruguay	-9
Gabon	11	Paraguay	-1	Equatorial Guinea	-9
Thailand	10	Panama	-1	Mexico	-9
Israel	9	United Rep. Tanzania	-1	Peru	-9
Tunisia	6	Burkina Faso	-1	Guyana	-9
Cape Verde	6	Ethiopia	-1	Jamaica	-11
Dominican Rep.	6	Mauritania	-1	Canada	-11
Syria	5	Burundi	-1	Fiji	-12
Brazil	5	Bangladesh	-1	Argentina	-12
China	5	Gambia, The	-2	Algeria	-13
		Colombia	-2	Costa Rica	-14
		Cameroon	-2	South Africa	-15
		Togo	-2	El Salvador	-17
		Benin	-2	Nicaragua	-22
		Cote d'Ivoire	-2	Switzerland	-32
				New Zealand	-41
				Venezuela	-59

Source: Author's own calculations.

Table 3. Ranking of countries by TFP, 1960 and 2000

Ranking	Country	1960	Country	2000
1	U.S.A.	100	Luxembourg	139
2	New Zealand	92	Ireland	112
3	Switzerland	90	U.S.A.	100
4	Canada	87	Belgium	86
5	Denmark	80	Hong Kong, SAR of China	83
6	United Kingdom	79	Netherlands	83
7	Australia	79	Italy	83
8	Venezuela	78	Canada	83
9	Equatorial Guinea	78	Taiwan, Province of China	83
10	Luxembourg	76	Australia	82
11	Netherlands	75	Barbados	82
12	Sweden	74	Mauritius	80
13	El Salvador	69	United Kingdom	79
14	Trinidad and Tobago	69	Norway	78
15	Belgium	66	Austria	78
16	France	66	Denmark	77
17	Iceland	65	France	77
18	Argentina	64	Finland	77
19	Ireland	63	Sweden	76
20	Seychelles	62	Singapore	74
21	South Africa	61	Iceland	74
22	Norway	61	Cyprus	73
23	Costa Rica	60	Spain	73
24	Jordan	60	Switzerland	70
25	Austria	59	New Zealand	69
26	Italy	57	Israel	67
27	Finland	57	Trinidad and Tobago	67
28	Mexico	56	Portugal	64
29	Uruguay	56	Botswana	63
30	Nicaragua	55	Greece	61
31	Sierra Leone	52	Japan	60
32	Iran	52	Chile	57
33	Israel	51	Argentina	57
34	Mauritius	49	Republic of Korea	57
35	Lesotho	49	Seychelles	56
36	Chile	48	Uruguay	55
37	Fiji	48	South Africa	54
38	Spain	48	Malaysia	53
39	Greece	46	Gabon	52
40	Namibia	46	Dominican Rep.	50
41	Guatemala	45	Mexico	49
42	Comoros	44	Iran	49
43	Mozambique	44	Tunisia	49
44	Portugal	43	Egypt	48
45	Paraguay	43	Brazil	46
46	Malaysia	42	Syria	45
47	Egypt	41	Costa Rica	42
48	Singapore	41	Namibia	41
49	Dominican Rep.	40	Guatemala	41
50	Japan	40	Venezuela	40
51	Papua New Guinea	40	Fiji	40
52	Algeria	39	El Salvador	40
53	Botswana	39	Jordan	40
54	Panama (excl. Canal Zone)	39	Algeria	40
55	Guinea	38	Haiti	39
56	Turkey	38	Turkey	38
57	Colombia	36	Colombia	38
58	Angola	36	Panama (excl. Canal Zone)	36
59	Cameroon	36	Paraguay	35
60	Brazil	36	Cape Verde	34
61	Central African Rep.	36	Morocco	32
62	Hong Kong, SAR of China	35	Sri Lanka	29
63	Honduras	35	Peru	29
64	Philippines	35	Philippines	29
65	Barbados	35	Thailand	28
66	Tunisia	35	Equatorial Guinea	28
67	Gambia, The	35	Bolivia	28
68	Syrian Arab Rep.	34	Ecuador	27
69	Bolivia	34	Guyana	27
70	Rwanda	34	Indonesia	27
71	Senegal	33	Guinea	26
72	Taiwan, Province of China	33	Cote d'Ivoire	25
73	Niger	33	India	25

Ranking	Country	1960	Country	2000
74	Sri Lanka	32	Pakistan	24
75	Republic of Korea	32	Papua New Guinea	24
76	Madagascar	32	China	23
77	Jamaica	31	Jamaica	23
78	Cyprus	30	Cameroon	22
79	Haiti	30	Honduras	21
80	Ecuador	29	Senegal	20
81	Indonesia	29	Zimbabwe	20
82	Cote d'Ivoire	29	Uganda	19
83	Guyana	29	Comoros	19
84	Peru	29	Congo	19
85	Nigeria	28	Ghana	18
86	Gabon	28	Mozambique	18
87	Mauritania	27	Nicaragua	18
88	Togo	27	Bangladesh	17
89	Mali	27	Angola	17
90	Bangladesh	26	Mauritania	17
91	Benin	25	Madagascar	17
92	Uganda	24	Benin	16
93	Morocco	24	Gambia, The	16
94	Nepal	23	Nepal	15
95	Burkina Faso	22	Rwanda	15
96	Congo, D.R.	20	Kenya	15
97	Pakistan	20	Central African Rep.	15
98	India	19	Mali	14
99	Chad	19	Sierra Leone	14
100	Ethiopia	19	Niger	14
101	Thailand	18	Ethiopia	14
102	Cape Verde	18	Lesotho	13
103	Burundi	16	Togo	13
104	Zambia	15	Chad	12
105	China	14	Burkina Faso	12
106	Ghana	12	Malawi	12
107	Kenya	11	Zambia	11
108	Malawi	11	Nigeria	9
109	Zimbabwe	10	Burundi	8
110	Congo	9	Guinea-Bissau	8
111	United Republic of Tanzania	8	United Republic of Tanzania	6
112	Guinea-Bissau	7	Congo, D.R.	3

Source: Isaksson (2007).

Table 4. Catching up and falling behind relative to the U.S.: 1960 to 2000

Catching up	Change	No change	Change	Falling behind	Change
Luxembourg	64	Australia	4	Ethiopia	-5
Taiwan, Province of China	50	Kenya	4	Uganda	-5
Ireland	49	Sweden	2	Bolivia	-6
Hong Kong, SAR of China	48	Colombia	1	Seychelles	-7
Barbados	47	Guinea-Bissau	1	South Africa	-7
Cyprus	43	Algeria	1	Philippines	-7
Singapore	33	Turkey	0	Mexico	-7
Mauritius	31	Malawi	0	Chad	-7
Italy	26	United Kingdom	0	Nepal	-7
Republic of Korea	25	Peru	0	Paraguay	-8
Spain	25	Uruguay	0	Argentina	-8
Gabon	24	Ecuador	-2	Bangladesh	-8
Botswana	24	Trinidad and Tobago	-2	Fiji	-8
Portugal	21	United Rep. of Tanzania	-2	Burundi	-8
Belgium	20	Guyana	-2	Benin	-8
Japan	20	Indonesia	-2	Jamaica	-9
Finland	20	Panama	-3	Mauritania	-10
Austria	19	Denmark	-3	Burkina Faso	-10
Norway	18	Sri Lanka	-3	Guinea	-12
Cape Verde	16	Iran	-3	Mali	-13
Israel	16	Zambia	-3	Senegal	-13
Greece	15	Guatemala	-4	Cameroon	-14
Tunisia	14	Namibia	-4	Togo	-14
France	11	Canada	-4	Honduras	-14
Thailand	11	Cote d'Ivoire	-4	Madagascar	-15
Syria	11			Papua N. Guinea	-16
Malaysia	11			Congo, D.R.	-17
Brazil	10			Costa Rica	-18
China	10			Rwanda	-18
Zimbabwe	10			Niger	-19
Congo	10			Nigeria	-19
Haiti	9			Angola	-19
Dominican Rep.	9			Gambia, The	-19
Chile	9			Switzerland	-19
Iceland	9			Jordan	-20
Morocco	8			Central African Rep.	-21
Netherlands	8			New Zealand	-23
Egypt	6			Comoros	-25
Ghana	6			Mozambique	-26
India	6			El Salvador	-29
Pakistan	5			Lesotho	-36
				Nicaragua	-37
				Venezuela	-38
				Sierra Leone	-38
				Equatorial Guinea	-49

Source: Author's own calculations.

Table 5. Distance to the world technology frontier, 1960 and 2000

Country group	1960	2000
World	0.56	0.58
Industrialized	0.75	0.68
Dynamic developers	0.48	0.62
LDCs	0.46	0.44

Note: A smaller figure implies greater technical *in*efficiency and thus greater distance from the frontier.
Source: Isaksson (2007)

Table 6. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: World

"Development level"	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Industrialized	3.75	1.23	5.78	4.49	-0.39	0.79	0.41
Developing	5.27	2.38	7.21	4.72	0.88	-0.62	0.26
LDCs	2.89	2.23	5.92	3.63	0.17	-1.71	-1.55
Dynamic developers	*6.36*	*2.26*	*8.92*	*6.51*	*1.47*	*-1.28*	*0.19*
15 Country cases	*5.41*	*2.33*	*7.37*	*4.93*	*0.91*	*-0.72*	*0.20*
Unweighted mean	3.97	1.95	6.30	4.28	0.22	-0.51	-0.29
Weighted mean	4.30	1.67	6.31	4.56	0.09	0.23	0.32

Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 7. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: World

"Region and Development level"	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Industrialized	3.75	1.23	5.78	4.49	-0.39	0.79	0.41
Asia and the Pacific	5.93	2.23	8.36	6.00	1.54	-1.27	0.27
Tigers	*8.14*	*2.62*	*11.47*	*8.62*	*0.67*	*-0.09*	*0.60*
Latin America & Caribbean	4.25	2.59	5.39	2.73	-0.17	0.38	0.25
MENA	5.00	2.63	6.91	4.19	0.27	-0.17	0.08
SSA	3.14	2.39	4.94	2.50	0.08	-0.61	-0.54
SSA without South Africa	*3.01*	*2.33*	*5.45*	*3.06*	*0.12*	*-1.17*	*-1.05*
Unweighted mean	4.41	2.21	6.28	3.98	0.27	-0.18	0.09
Weighted mean	4.30	1.67	6.31	4.56	0.09	0.23	0.32

Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 8. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: Industrialized countries

Country	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Australia	3.77	2.03	4.85	2.76	-0.50	1.50	1.10
Austria	3.35	0.28	5.41	5.13	-0.20	1.00	0.80
Belgium	3.16	0.52	4.44	3.91	0.10	1.60	1.70
Canada	3.84	2.19	5.49	3.23	-0.70	1.00	0.30
Cyprus	5.67	1.04	5.21	4.12	1.60	0.40	2.00
Denmark	2.66	0.86	4.58	3.68	-0.50	1.50	1.00
Finland	3.39	0.63	4.53	3.86	0.20	1.10	1.30
France	3.34	0.77	5.35	4.53	-0.40	1.00	0.70
Greece	3.89	0.75	5.92	5.15	-0.20	0.70	0.60
Iceland	4.10	2.03	5.07	2.97	-0.20	1.60	1.50
Ireland	4.98	0.80	6.83	5.99	0.30	0.70	1.00
Israel	5.76	3.25	6.37	3.01	0.40	0.90	1.30
Italy	3.31	0.30	4.44	4.14	0.40	1.70	2.00
Japan	5.20	0.96	8.58	7.53	-0.40	0.40	0.00
Luxembourg	4.32	0.88	4.36	3.45	0.40	2.20	2.60
Netherlands	3.31	1.24	4.70	3.42	-0.20	1.60	1.30
New Zealand	2.51	1.83	3.98	2.10	-1.10	1.40	0.20
Norway	3.62	1.18	4.52	3.29	-0.20	2.00	1.80
Portugal	4.35	0.60	6.77	6.15	0.00	0.70	0.70
Spain	4.22	0.65	6.16	5.48	0.00	0.30	0.30
Sweden	2.59	0.86	3.92	3.02	-0.30	1.40	1.10
Switzerland	2.22	1.19	4.14	2.92	-1.50	2.10	0.60
United Kingdom	2.46	0.51	4.37	3.84	-0.60	0.10	-0.50
U.S.A.	3.64	1.67	5.56	3.82	-0.50	0.70	0.20
Unweighted mean	3.74	1.13	5.23	4.06	-0.40	1.17	0.75
Weighted mean	3.75	1.23	5.78	4.49	-0.39	0.79	0.41

Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 9. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: Asia and the Pacific

Country	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Bangladesh	3.65	2.30	7.30	4.90	0.30	-2.00	-1.70
China	6.14	1.96	7.97	5.89	2.30	-1.80	0.50
Fiji	3.46	2.51	4.47	1.89	-0.30	0.50	0.20
Hong Kong, SAR of China	7.79	2.77	8.78	5.85	1.00	0.40	1.50
India	4.97	2.07	6.67	4.51	1.80	-1.10	0.70
Indonesia	5.64	2.54	10.54	7.80	0.50	-2.10	-1.70
Republic of Korea	7.85	2.68	11.64	8.72	0.30	-0.30	0.00
Malaysia	6.74	3.12	10.27	6.94	-0.10	-0.10	-0.20
Nepal	3.98	1.75	9.60	7.72	-0.40	-1.00	-1.40
Pakistan	5.84	2.87	8.25	5.25	1.90	-0.90	1.00
Papua New Guinea	3.32	1.99	7.83	5.74	-0.30	-0.60	-0.80
Philippines	3.97	2.74	6.00	3.19	0.00	-0.30	-0.30
Singapore	9.46	3.66	13.65	9.68	-0.10	0.90	0.80
Sri Lanka	4.05	1.79	7.44	5.55	0.60	-1.50	-0.90
Taiwan, Province of China	8.53	2.17	12.00	9.61	1.40	-0.20	1.20
Thailand	6.99	2.56	10.12	7.36	0.70	-0.50	0.30
Unweighted mean	5.77	2.47	8.91	6.29	0.60	-0.66	-0.05
Weighted mean	5.93	2.23	8.36	6.00	1.54	-1.27	0.27

Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 10. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: Latin America and the Caribbean

Country	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Argentina	2.67	1.25	4.07	2.78	-0.60	0.30	-0.30
Barbados	4.56	0.95	2.82	1.85	2.10	0.40	2.50
Bolivia	2.75	2.11	3.40	1.26	0.30	-0.10	0.20
Brazil	5.11	2.54	6.10	3.45	0.20	0.70	1.00
Chile	4.33	2.22	4.89	2.63	0.20	0.10	0.40
Colombia	4.30	2.59	5.39	2.73	0.50	-0.40	0.10
Costa Rica	4.42	3.66	6.56	2.80	-0.90	-0.10	-1.00
Dominican Republic	5.45	2.72	7.16	4.33	0.70	-0.50	0.20
Ecuador	4.19	2.98	4.86	1.84	0.10	0.50	0.60
El Salvador	3.09	2.95	5.40	2.38	-0.60	-0.40	-1.00
Guatemala	4.03	2.87	5.06	2.14	0.50	-0.60	-0.10
Guyana	2.60	1.75	2.10	0.33	0.40	0.30	0.70
Haiti	4.28	1.17	5.34	4.15	1.70	-1.30	0.40
Honduras	3.65	3.35	6.13	2.70	-0.50	-0.60	-1.10
Jamaica	2.05	1.75	2.94	1.20	-0.40	0.30	-0.10
Mexico	4.66	3.28	6.29	2.92	-0.60	0.50	-0.10
Nicaragua	2.01	3.56	5.04	1.43	-2.00	-0.20	-2.20
Panama (excl. Canal Zone)	4.95	2.97	7.27	4.18	-0.60	0.50	-0.10
Paraguay	4.55	2.64	7.84	5.07	0.00	-0.90	-1.00
Peru	3.48	2.56	2.87	0.31	0.50	0.00	0.60
Trinidad and Tobago	3.77	1.82	5.21	3.32	-0.30	0.30	0.00
Uruguay	2.04	0.64	2.64	2.00	-0.10	0.40	0.40
Venezuela	2.52	3.64	3.17	-0.45	-1.20	0.30	-0.90
Unweighted mean	3.72	2.43	4.89	2.41	-0.32	-0.06	-0.37
Weighted mean	4.25	2.59	5.39	2.73	-0.17	0.38	0.25

Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 11. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: Sub-Saharan Africa

Country	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Angola	1.65	1.85	3.28	1.43	-0.50	-0.40	-0.90
Benin	3.24	2.49	5.83	3.28	0.30	-1.10	-0.70
Botswana	8.95	2.43	16.56	13.84	0.30	-1.90	-1.50
Burkina Faso	2.95	1.65	8.26	6.52	-0.70	-1.40	-2.10
Burundi	2.51	1.79	6.07	4.21	0.00	-2.20	-2.20
Cameroon	3.32	1.96	7.43	5.39	-0.10	-1.50	-1.60
Cape Verde	6.02	2.48	5.08	2.55	2.10	-0.70	1.40
Central African Republic	0.50	1.61	2.39	0.77	-0.60	-0.70	-1.30
Chad	2.42	2.24	1.78	-0.43	0.30	-0.50	-0.20
Comoros	2.38	2.42	6.57	4.04	-0.50	-1.00	-1.60
Congo	5.72	2.35	4.12	1.76	3.10	-0.50	2.60
Congo, D.R.	-1.54	2.40	1.92	-0.46	-1.90	-2.00	-3.80
Cote d'Ivoire	4.18	2.84	5.92	3.00	1.00	-0.50	0.50
Equatorial Guinea	3.59	1.20	9.65	8.43	-1.80	-2.00	-3.80
Ethiopia	3.25	2.35	5.14	2.73	1.40	-2.00	-0.60
Gabon	5.45	1.66	5.09	3.37	1.70	0.00	1.70
Gambia, The	4.33	3.24	10.37	6.93	-1.20	-2.20	-3.40
Ghana	4.13	2.05	2.04	-0.01	2.50	-0.60	1.90
Guinea	2.31	1.84	4.10	2.23	0.00	-0.50	-0.60
Guinea-Bissau	4.40	1.97	3.04	1.06	1.70	-0.80	0.90
Kenya	4.57	2.86	3.47	0.59	2.10	-0.80	1.30
Lesotho	4.49	1.80	19.50	17.41	-3.40	-4.50	-7.70
Madagascar	1.72	2.47	3.01	0.53	1.20	-2.20	-1.00
Malawi	4.62	2.41	6.18	3.67	1.40	-1.60	-0.20
Mali	2.47	1.93	5.97	3.97	-0.50	-1.20	-1.60
Mauritania	4.05	2.00	7.62	5.52	-0.20	-1.00	-1.20
Mauritius	5.49	2.47	5.26	2.73	0.90	0.20	1.20
Mozambique	1.44	1.90	4.57	2.62	-0.20	-2.00	-2.20
Namibia	3.65	2.13	4.91	2.75	-0.20	0.40	0.20
Niger	1.85	2.71	4.32	1.56	0.00	-1.80	-1.80
Nigeria	2.34	2.38	7.77	5.26	-1.80	-1.00	-2.80
Rwanda	3.65	2.67	7.40	4.74	-0.20	-2.70	-2.90
Senegal	2.61	2.37	4.62	2.19	0.30	-1.10	-0.80
Seychelles	5.07	1.34	11.21	9.71	-0.60	-0.40	-1.00
Sierra Leone	1.19	1.59	8.03	6.35	-2.10	-2.20	-4.30
South Africa	3.38	2.51	4.03	1.49	0.00	0.40	0.40
United Rep. of Tanzania	4.09	2.84	5.80	2.88	0.90	-1.90	-1.00
Togo	3.05	2.13	7.84	5.63	-0.90	-1.30	-2.20
Uganda	4.73	2.95	7.52	4.44	1.80	-3.70	-2.00
Zambia	2.33	2.66	1.39	-1.23	0.60	0.10	0.70
Zimbabwe	5.14	2.48	2.36	-0.12	2.60	-0.10	2.50
Unweighted mean	3.45	2.23	6.03	3.74	0.21	-1.24	-1.02
Weighted mean	3.14	2.39	4.94	2.39	0.08	-0.61	-0.54

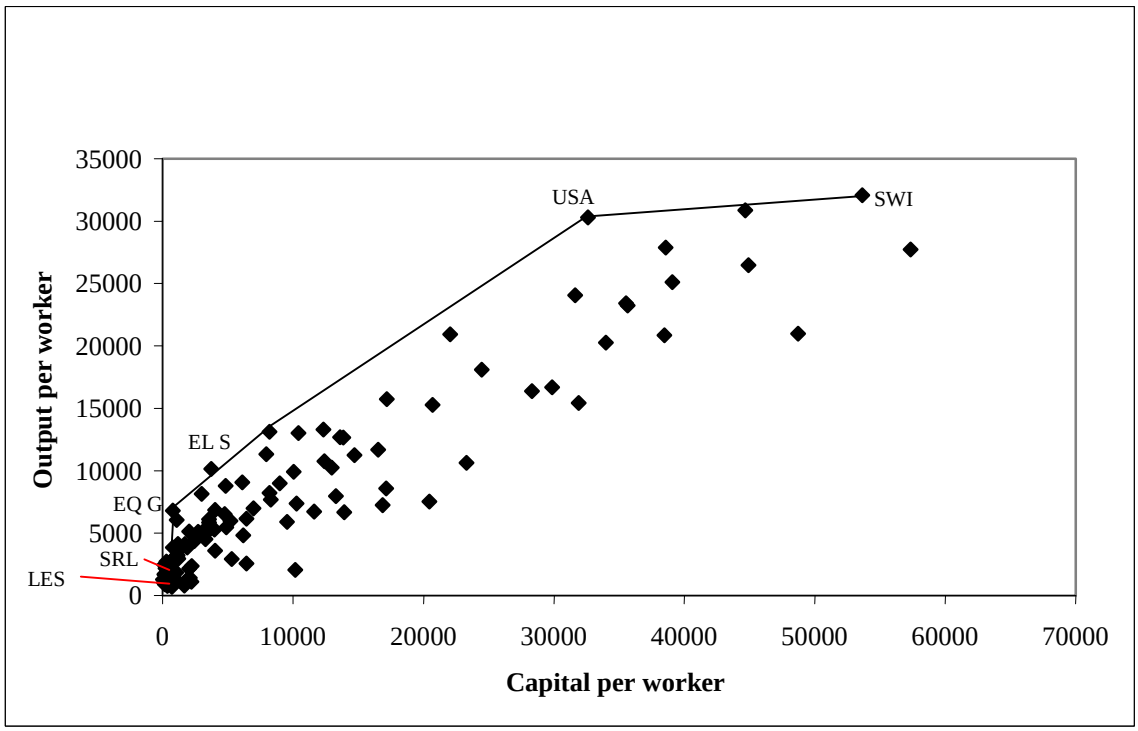
Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Table 12. Change in Output, Inputs, Technical Efficiency, Technology and TFP, 1960-2000: Middle East and North Africa

Country	Output	Labour	Capital	Capital per worker	Technical efficiency	Technology	TFP
Algeria	4.51	3.38	3.79	0.39	0.50	0.30	0.90
Egypt	5.07	2.45	7.07	4.52	1.40	-1.10	0.30
Iran	5.15	2.85	7.53	4.55	-0.60	0.70	0.00
Jordan	6.17	4.66	9.76	4.91	-0.80	-0.50	-1.30
Morocco	5.15	2.52	5.67	3.08	1.30	-0.40	0.80
Syria	6.71	3.20	7.68	4.37	1.20	-0.60	0.60
Tunisia	5.28	2.57	6.02	3.39	0.80	0.20	1.00
Turkey	4.71	2.12	7.74	5.51	-0.10	-0.50	-0.60
Unweighted mean	5.34	2.97	6.91	3.84	0.46	-0.24	0.21
Weighted mean	5.00	2.63	6.91	4.19	0.27	-0.17	0.08

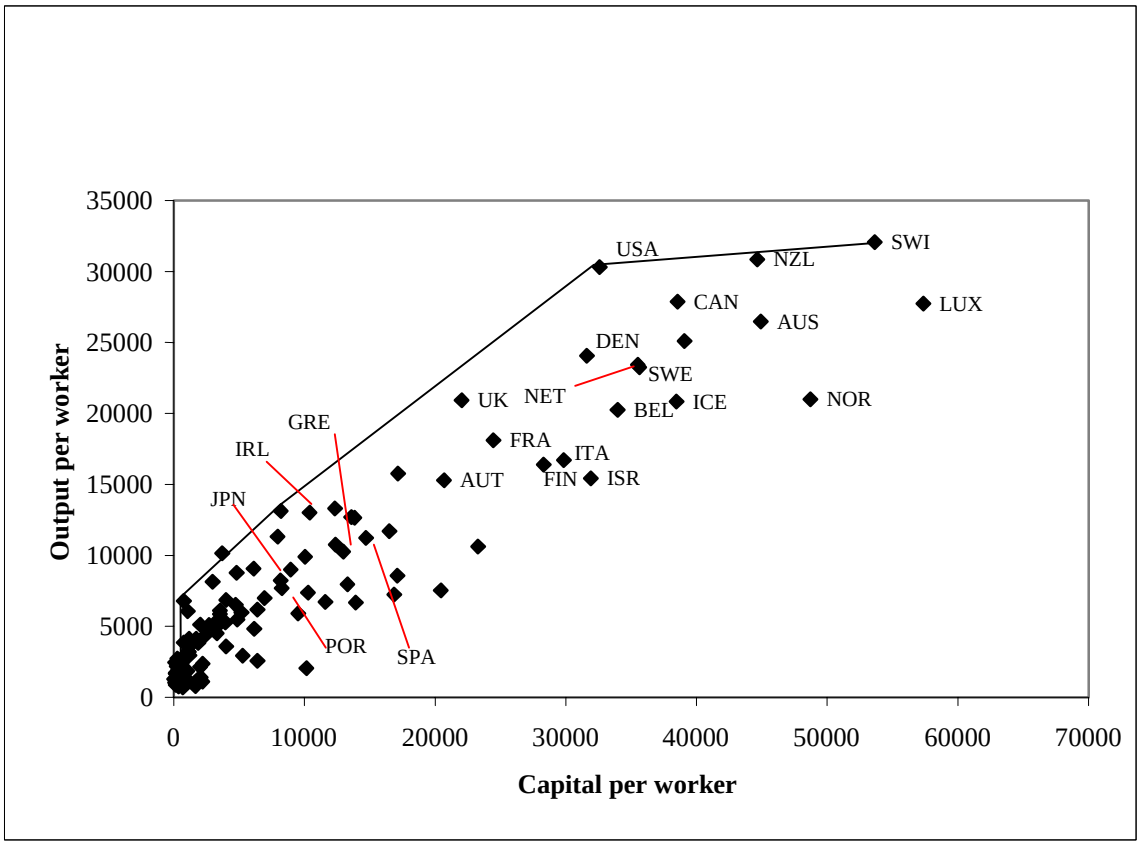
Note: Weight is average real GDP (1960-2000).
Source: Isaksson (2007).

Figure 1. World technology frontier, 1960



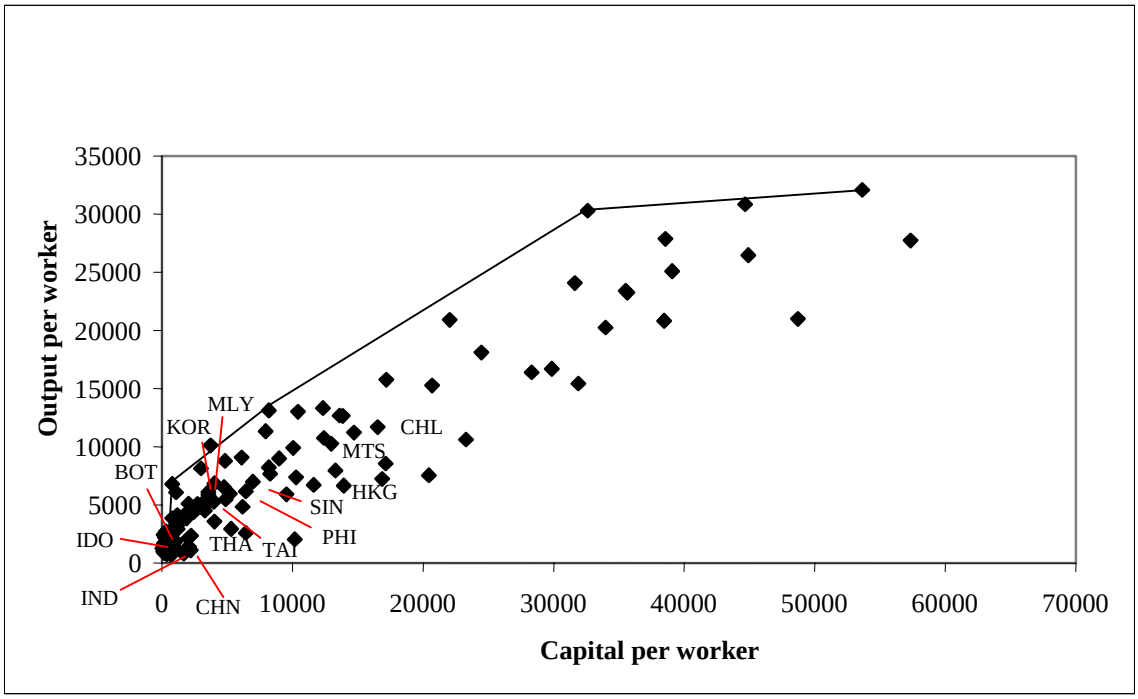
Source: Isaksson (2007).

Figure 2. World technology frontier, 1960: Industrialized countries



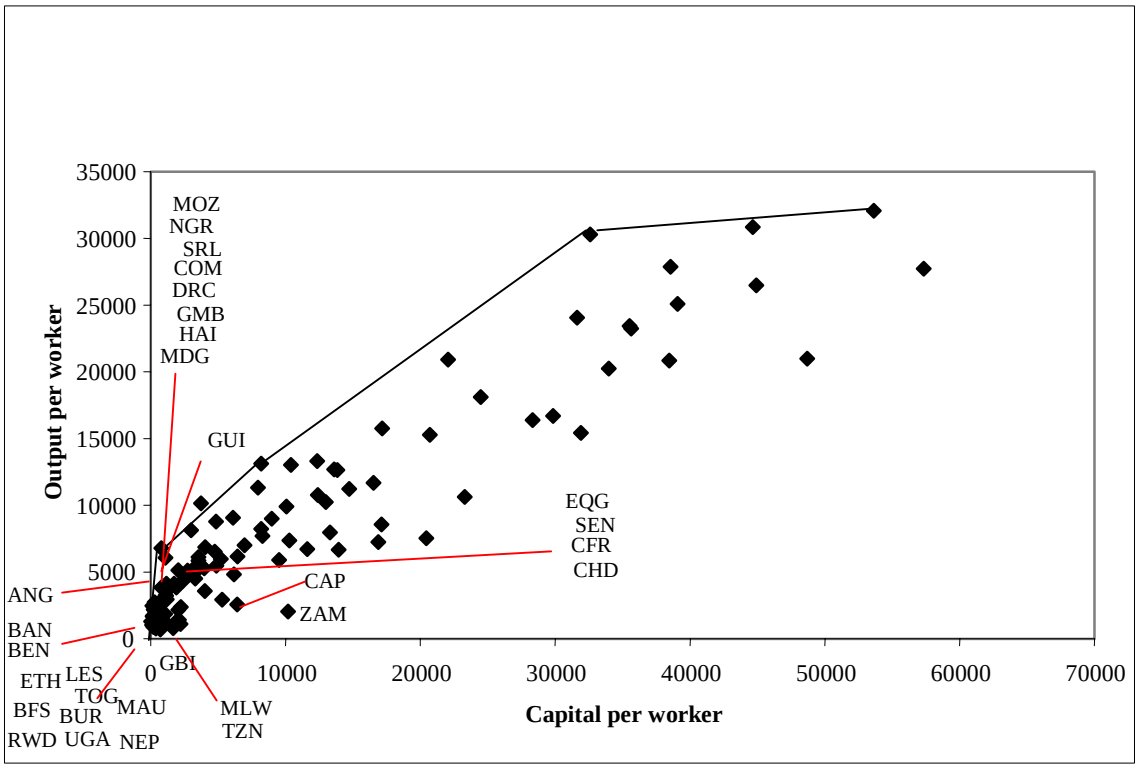
Source: Isaksson (2007).

Figure 3. World technology frontier, 1960: Dynamic developers



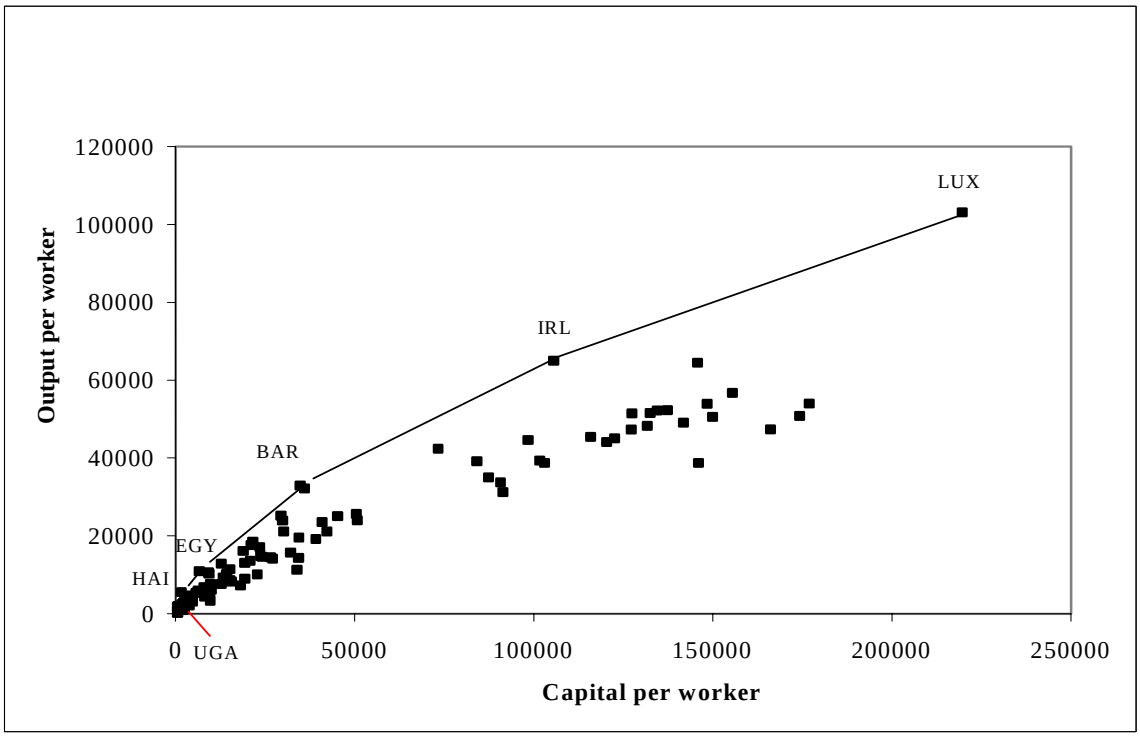
Source: Isaksson (2007).

Figure 4. World technology frontier, 1960: LDCs



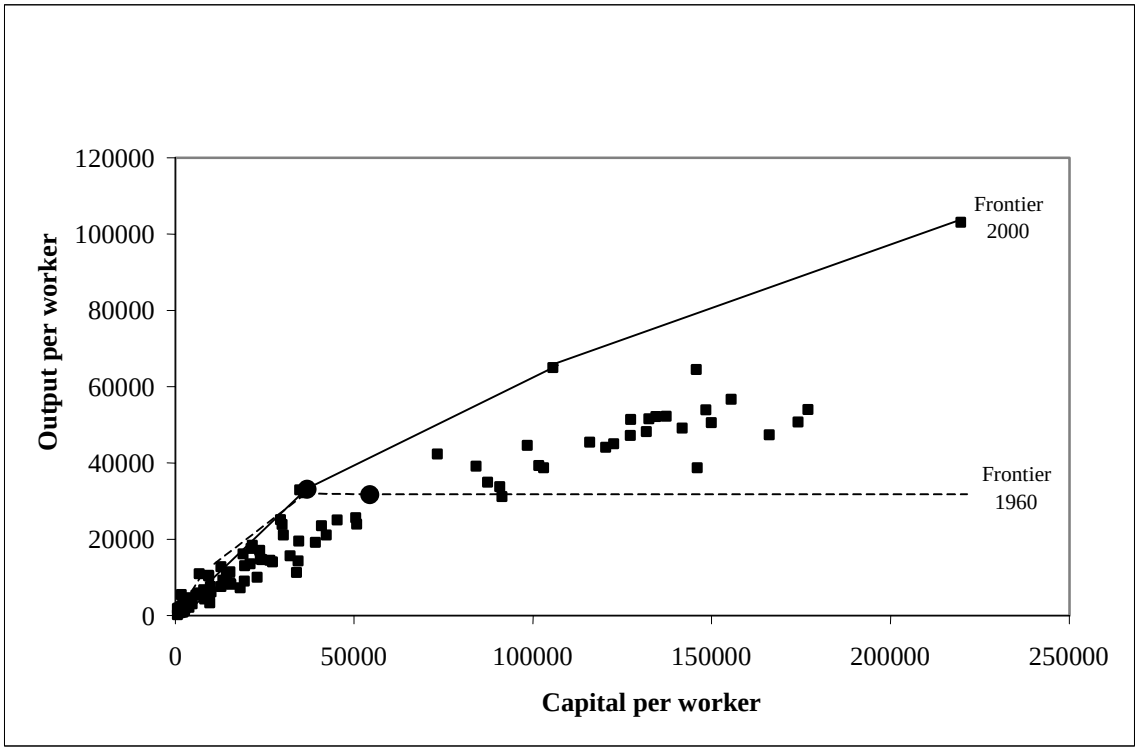
Source: Isaksson (2007).

Figure 5. World technology frontier, 2000: World



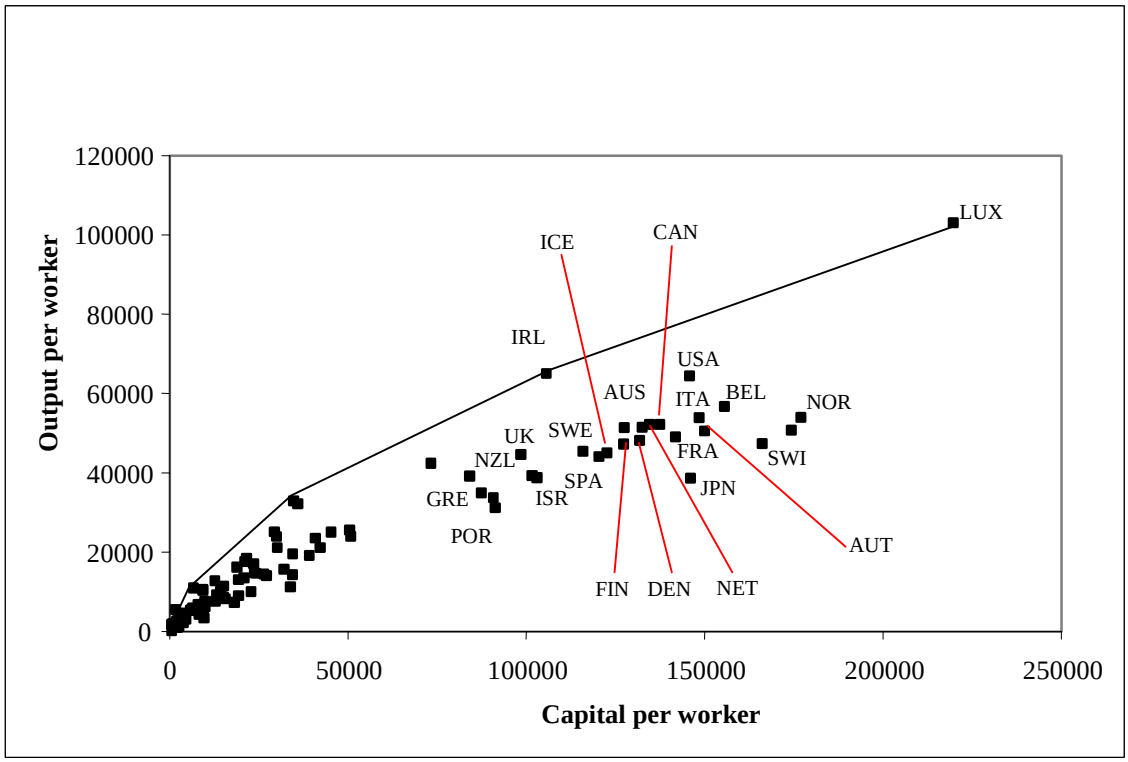
Source: Isaksson (2007).

Figure 6. World technology frontier, 1960 and 2000



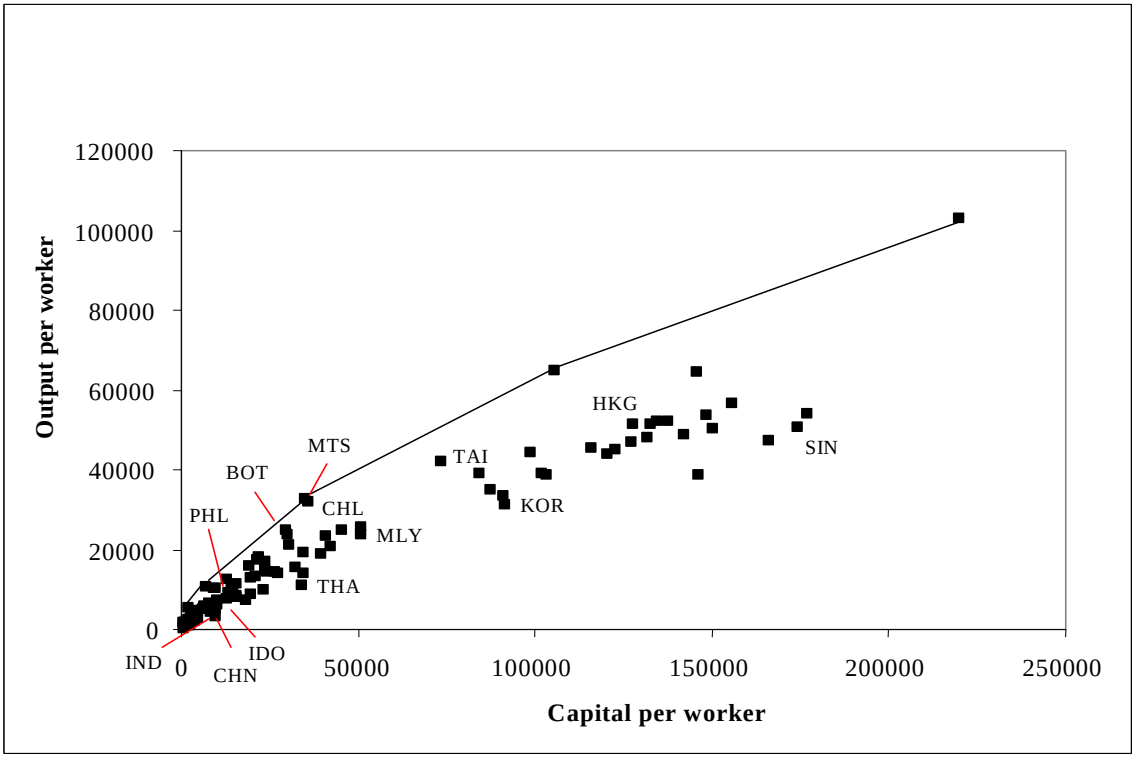
Source: Isaksson (2007).

Figure 7. World technology frontier, 2000: Industrialized countries



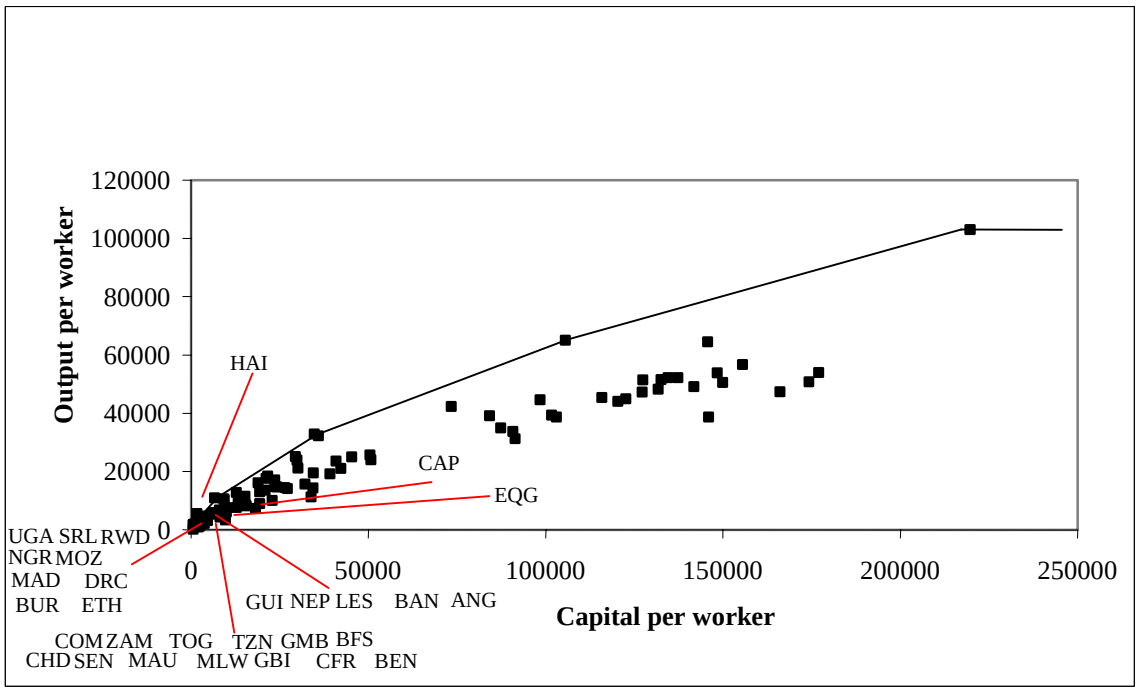
Source: Isaksson (2007).

Figure 8. World technology frontier, 2000: Dynamic developers



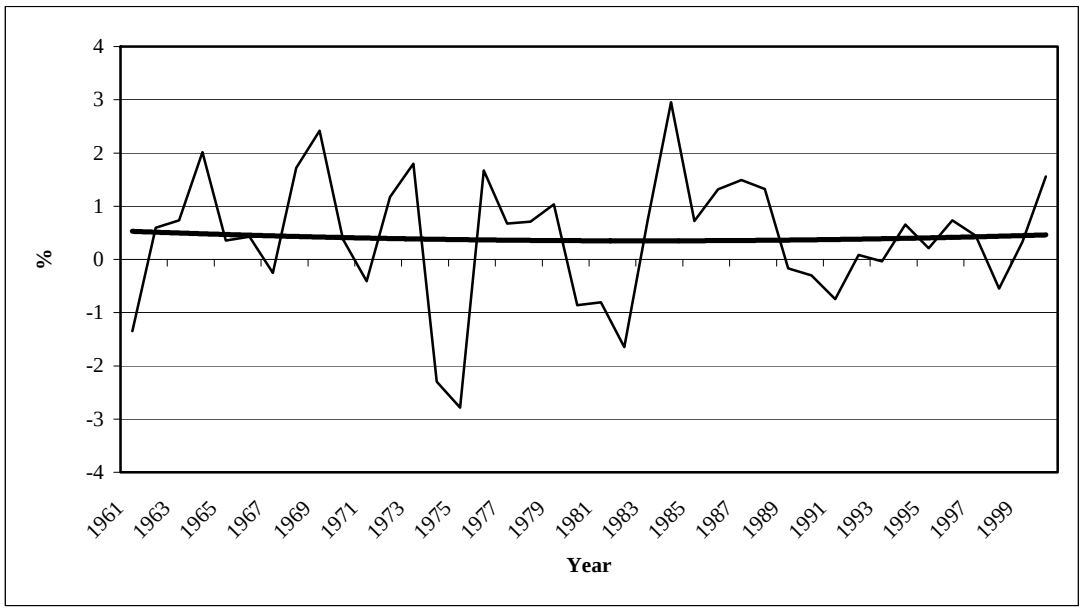
Source: Isaksson (2007).

Figure 9. World technology frontier, 2000: LDCs



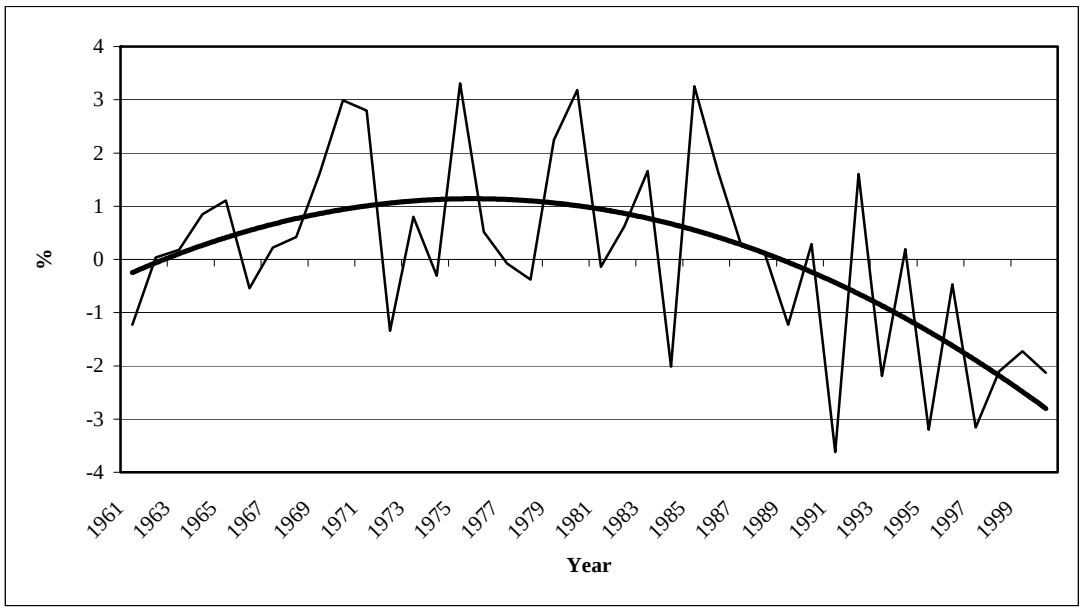
Source: Isaksson (2007).

Figure 10. World TFP growth, 1960-2000



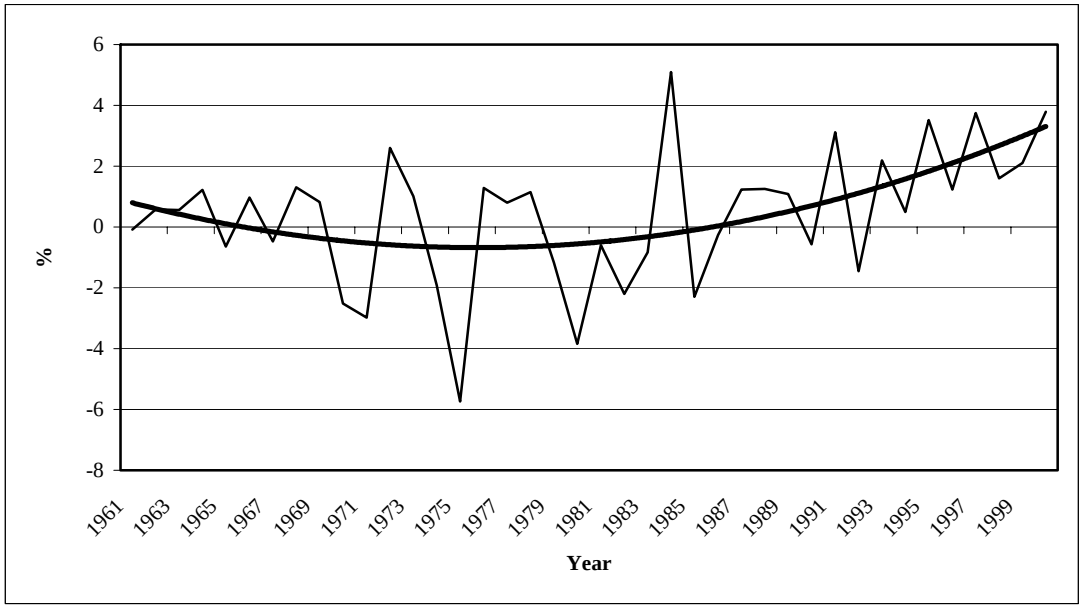
Source: Isaksson (2007).

Figure 11. Change in world technical efficiency, 1960-2000



Source: Isaksson (2007).

Figure 12. World technological progress, 1960-2000



Source: Isaksson (2007).

Appendix. Table A1. Country sample

Country	Code	Country	Code	Country	Code
Algeria	ALG	Gabon	GAB	Nicaragua	NIC
Angola	ANG	Gambia, The	GMB	Niger	NGR
Argentina	ARG	Ghana	GHA	Nigeria	NGA
Australia	AUS	Greece	GRE	Norway	NOR
Austria	AUT	Guatemala	GUA	Pakistan	PAK
Bangladesh	BAN	Guinea	GUI	Panama (excl. Canal Zone)	PAN
Barbados	BAR	Guinea-Bissau	GBI	Papua New Guinea	PNG
Belgium	BEL	Guyana	GUY	Paraguay	PAR
Benin	BEN	Haiti	HAI	Peru	PER
Bolivia	BOL	Honduras	HON	Philippines	PHI
Botswana	BOT	Hong Kong, SAR of China	HKG	Portugal	POR
Brazil	BRA	Iceland	ICL	Rwanda	RWD
Burkina Faso	BFS	India	IND	Senegal	SEN
Burundi	BUR	Indonesia	IDO	Seychelles	SEY
Cameroon	CMR	Iran	IRA	Sierra Leone	SRL
Canada	CAN	Ireland	IRL	Singapore	SIN
Cape Verde	CAP	Israel	ISR	South Africa	RSA
Central African Rep.	CFR	Italy	ITA	Spain	SPA
Chad	CHD	Jamaica	JAM	Sri Lanka	SRI
Chile	CHL	Japan	JPN	Sweden	SWE
China	CHN	Jordan	JOR	Switzerland	SWI
Colombia	COL	Kenya	KEN	Syria	SYR
Comoros	COM	Republic of Korea	KOR	Taiwan, Province of China	TAI
Congo	CNG	Lesotho	LES	United Republic of Tanzania	TZN
Congo, D.R.	DRC	Luxembourg	LUX	Thailand	THA
Costa Rica	CRI	Madagascar	MAD	Togo	TOG
Cote d'Ivoire	CIV	Malawi	MLW	Trinidad and Tobago	TT
Cyprus	CYP	Malaysia	MLY	Tunisia	TUN
Denmark	DEN	Mali	MAL	Turkey	TUR
Dominican Rep.	DOM	Mauritania	MAU	Uganda	UGA
Ecuador	EDU	Mauritius	MTS	United Kingdom	UK
Egypt	EGY	Mexico	MEX	U.S.A.	USA
El Salvador	ELS	Morocco	MOR	Uruguay	URU
Equatorial Guinea	EQG	Mozambique	MOZ	Venezuela	VEN
Ethiopia	ETH	Namibia	NAM	Zambia	ZAM
Fiji	FIJ	Nepal	NEP	Zimbabwe	ZIM
Finland	FIN	Netherlands	NET		
France	FRA	New Zealand	NZL		

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