International Income Growth and Convergence and the South African Economy[*]

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ABSTRACT

This paper considers the growth experience of the South African economy during 1970-1994, against the background of the international convergence phenomenon affirmed by Baumol (1986). Convergence refers to the idea that countries with initially low real per capita income tend to grow faster than wealthier countries, and that their per capita income levels and growth rates will eventually reach a common end-state. This empirically observed catching-up process by the developing countries is assisted by their economic restructuring. Here the growth performance of the South African economy is compared with some established and newly industrialised countries, using statistical dispersion and distance measures.

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INTRODUCTION

Growth rates differ over time and across countries. Higher growth rates yield higher productivity growth via Verdoorn's law. Growth rate differentials can be explained by the catching-up or convergence phenomenon. Countries with a lower real per capita income have the potential to grow faster than economically developed countries, through structural changes which boost the catching-up process.

The present study concentrates on the growth path of some selected countries. South Africa with its natural resources and diversified economy is a country with a great growth potential, and this paper also assesses its growth performance in the international context. Sustained economic growth bridges the gap between the rich and poor nations. Growth rates differ over time, since economies grow by passing from one developmental stage to another, with higher growth rates leading to greater productivity growth according to Verdoorn's law.

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[*] In memoriam G L de Wet

DEVELOPMENT AND GROWTH

The so-called convergence phenomenon has been empirically studied by, for example, Abramovitz (1983), Baumol (1986) and Cornwall (1977). This phenomenon refers to the idea that countries with initially low per capita output tend to grow faster than economically more advanced countries, and that their per capita real income levels and growth rates will eventually converge. Countries with low technological endowment can exploit existing knowledge and attain high rates of productivity growth, while countries within the more developed category have fewer opportunities for higher productivity growth. Japan , given its scant natural resources, is an excellent example of restructuring through a four-phase product cycle and economic modernisation through structural change. This catching-up process was formulated by Akamatsu (1962), to explain the design of Japanese industrial growth, which he termed the "flying wild-geese pattern". This theory envisages a continuous shift of comparative advantage from economies in a higher phase of development to those in a lower phase. The advantage of economic backwardness is a rapid catching-up process, implying convergence that may result from deliberate government policy .

Some explanations of convergence state that technology is a public good, and the opportunity of obtaining technology and knowledge from the more advanced countries, through the so-called spill-over effect, thus benefit the less advanced countries. Countries with a low initial level of productivity therefore grow faster than the more affluent countries (Abramovitz, 1979). With a given ratio of investment to GDP, poorer countries with low capital-labour and capital-output ratios, will also show a faster rate of growth of their capital stock.

Data sets developed by the World Bank (Summers & Heston, 1991) provide economic information on international growth rate differences. Structural changes between countries at the same point in time, may provide an explanation for observed growth rate differences. The gap between different economic outcomes may be measured by Euclidean distance. The coefficient of convergence can be defined as a mean value across countries of the percentage deviation from a postulated economic frontier (the USA). A decreasing value indicates convergence or catching-up, and an increasing value points to divergence.

An important related concept is conditional convergence. Unconditional convergence is the idea that countries move towards the same level of productivity, while conditional convergence suggests that forces push an economy towards a steady-state level of productivity and a steady-state rate of

growth. With conditional convergence, observed growth rates of output per person depend inversely on the initial level of output per person. Empirical studies show that there is strong negative correlation between growth rates and initial per capita income. The theory developed by Olson offers a possible explanation for the general success of the catching-up model: special interest groups reduce the rate of growth along with the level of income, by using their power to block innovation. Barriers to efficient resource allocation can also reduce the economic growth rate. Countries where special interest groups have been abolished by, say, totalitarian government, foreign occupation or war, enjoy the greatest gains in economic growth (Mueller, 1983).

GROWTH AND CONVERGENCE

The catching-up hypothesis as formulated and tested by Abramovitz (1979), unconditionally states that countries with a relatively low level of productivity should grow relatively faster. Unconditional convergence includes the proposition that countries actually move towards the same level of productivity. Conditional convergence is a more subtle notion and allows for "the possibility that there are forces pushing the economy towards the steady-state level of productivity and steady state growth rate. Unconditional convergence is a result of a special case of the traditional neo-Classical model. Both the traditional and the Augmented-Solow models predict conditional convergence where the steady-state level of income depends on population growth and rates of capital accumulation" (Crafts, 1995). Conditional convergence occurs where observed growth rates of output per person depend inversely on the initial level of output per person, reflecting the scope of catching-up. As Abramovitz has suggested, "the post-World War II decades ....proved to be the period when - exceptionally - the three elements required for rapid growth by catching-up came together. The elements were large technological gaps, enlarged social competence... and conditions favoring rapid realization of potential" (Abramovitz, 1986).

MEASURING CONVERGENCE

So-called ß-convergence is confirmed if there is a mean reversion in the GDP. So-called γ-convergence again shows the decline in the cross sectional dispersion of real per capita GDP. The coefficient of variation is then diminishing over time. The test for conditional convergence has been to regress the growth rates of per capita GDP against the investment/GDP ratio, initial education levels, the initial level of per capita real income relative to that of the

USA, the population growth rate and a constant. If the coefficient of the initial relative level of per capita income is negative, then convergence is confirmed. Catching-up is a many-sided concept which has been used in historical studies (Gerschenkron, 1962), neo-Classical production function models (Dowrick & Nguyen, 1989), Keynesian-type models (Cornwall,1977), and empirical studies in general (Baumol, 1986 and Abramovitz, 1983). Evidence of convergence, or the tendency for poor countries to grow faster than the rich ones, is empirically supported by studies conducted by Steve Dowrick and Duc-Tho Nguyen (1989), and the widely reported convergence of the OECD countries. The belief that economic growth depends on the expansion of a key sector of the economy, was stressed by the Physiocrats and has persisted ever since. If the income elasticity of demand for the output of a sector is greater than one, then the share of that sector in total output will rise as the economy grows.

The convergence view has been discussed by many authors, including Moses Abramovitz (1986, 1990), William J. Baumol (1986), and Baumol *et al.*(1989). Using data collected by Maddison (1982,1989), these authors provide evidence that incomes have in fact been converging over a fairly long period. For example, Baumol (1986) finds a high inverse correlation between a country's productivity level (as proxied by GDP per work-hour) in 1870, and its productivity growth in terms of GDP per work-hour over the next 110 years. While these results have been shown to be very sensitive to the sample of countries selected (De Long, 1988), there is also evidence that convergence has occurred among an *ex ante* chosen subset of OECD countries (Baumol & Wolff, 1988; Baumol *et al.*, 1989). It should be noted that the partial measure of productivity used in these studies, namely labour productivity , may also have influenced their results. The present study explicitly measures *total* factor productivity.

Steven Dowrick and Duc-Tho Nguyen (1989) have added further evidence of convergence based on a sample of OECD countries in the post-World War II period. They argue that one needs to distinguish between the catch-up or convergence of real per capita income (or income per work-hour) and total factor productivity (TFP) catch-up. Following Baumol (1986) and Abramovitz (1986, 1990), Dowrick and Nguyen confirm that TFP catch-up is inversely related to a country's initial level of relative labour productivity. Steven Dowrick extended the Dowrick and Nguyen (1989) results by allowing for sectoral change. He found evidence that "GDP growth since 1950 has been systematically higher in those OECD countries which have been able to reallocate the greater proportion of their labour force out of agriculture".

Catching-up is also based on differences in marginal capital productivity between nations. Countries at a lower level of development have a larger potential to grow faster than the developed countries (Rebelo,1991). Most convergence studies are limited to the OECD countries and do not look at convergence between industrialised and developing nations. Barrow and Sala-i-Martin (1991) found convergence for the USA, regions of Europe and Japan at a rate of 2 per cent per year. Paul M. Romer (1989) and Sergio Rebelo (1991) again emphasised the lack of correlation between initial per capita GDP and per capita growth rate for a sample of 100 countries, as evidence against convergence. Neo-classical growth models developed by Frank Ramsey (1928), Robert M. Solow (1956), Trevor Swan (1956), and Tjalling C. Koopmans (1965) suggest that different steady-state economies are due to differences in government policy, the rate of saving, the nature of production, technology and so on. Barro *et al.* (1995) report that after allowing for differences in investment rates, the initial stock of human capital and some other variables, countries converge conditionally at the rate of 2 per cent per year. Labour productivity and per capita income levels in the industrialised market economies, have tended to converge over the last century. Baumol found that 88 per cent of the variation in labour productivity in the growth rates across a sample of sixteen industrialised countries over the period 1870-1979, can be accounted for by a systematic tendency for the poorer countries to experience higher rates of growth. Capital-deepening supports this evidence.

Baumol regressed the average annual rate of labour productivity growth over 1870-1979, on a constant and the log of labour productivity in 1870 for the "Maddison sixteen" data, which provided a strong case for convergence. (This is a sample of developed capitalist nations, consisting of the following individual members: Australia, UK, Switzerland, Belgium, Netherlands, Canada, USA, Denmark, Italy, Australia, Germany, Norway, France, Finland, Sweden and Japan). But Baumol's regression tells little about the strength of the forces making for convergence since 1870 among industrial nations. The sample suffers from selection bias because any nation that was relatively rich in 1870 but did not converge, failed reach the "Maddison sixteen" group of countries (De Long, 1988).

Studies that focus on the convergence or divergence of real per capita income, have been found to hold for a number of industrialised countries during the period 1870-1979. It is a common practice to compare a country's economic growth rate with the average growth rate from some related group of countries. Olson (1982) thus found that "the United States has had the highest per capita income of all major nations". The other countries, however, at least had the opportunity to catch-up. In the context, Kormendi and Meguire (1985) found

that catching-up was statistically significant in their sample of 47 countries from the OECD and the middle-income market economies in the post-war period. Dowrick and Duc-Tho Nguyen (1989) suggest that some part of the convergence pattern is due to systematic variations in the sectoral composition of total output. Thus, if the productivity growth in the service sector is lower than in the primary and manufacturing sectors, labour productivity convergence is explained by a higher rate of investment that tends to increase the capital-labour and output-labour ratios.

Baumol writes that "forces accelerating the growth of nations who were latecomers to industrialization and economic development give rise to a long-run tendency towards convergence of levels of per capita product or, alternatively of per worker product" (Baumol, 1986). Such ideas were already expressed by Gerschenkron (1952) who pointed out that backwardness need not be without its advantages.

DISTANCE FUNCTION

The convergence hypothesis is tested here by means of data from the National Productivity Institute's *Productivity Focus* (1995).The difference between recorded output levels is measured by a distance function. If a one-to-one correspondence between all numbers in a system $(x_1, x_2, ... x_n)$ is possible, and if x is any point in the Euclidean space R^n of n-dimensions, then the distance between two points , if

$X = (x_1, x_2 , ...,x_n)$ and $Y = (y_1, y_2, ...,y_n)$　　　　is
$$\|X - Y\| = (x_1 - y_1)^2 + (x_2 - y_2)^2 + ...(x_n - y_n)^2 \tag{1}$$

and this will satisfy the triangle inequality
$$|X - Y| \leq |X - Z| + |Y - Z| \tag{2}$$

To test the catching-up trend, a convergence coefficient is used. A decreasing value indicates convergence, while an increasing one indicates divergence. The distance between two production structures can be measured by Minkowisiki's p-metric

$$d_{ij}(p) = \sum_{k=1}^{m} [| X_{ik} - X_{jk}^{p} |]^{1/p} \tag{3}$$

Minkowiski's p-metric results in the Euclidean distance.

CONVERGENCE EMPIRICS

Baumol (1986) analysed Maddison's (1870-1979) data and showed that convergence has been strong among the industrialised nations. He regressed the average rate of annual labour productivity growth over 1870-1979 on a constant and the logarithm of labour productivity in 1870, and found an inverse relationship between them. Baumol's regression line does however not identify the forces leading to convergence among the industrial nations. The independent variable is measured with error and there is a selection bias arising from Maddison's data which includes nations that were relatively rich in 1870. Baumol's findings imply that only one variable, namely a country's 1870 GDP per work-hour, matters, and that other factors such as the propensity to invest or policies to stimulate growth, do not. DeLong (1988) found that estimates of early per capita GNP for a wider spectrum of countries show that a less biased sample exhibits little sign of convergence. The period 1950-73 was considered a "golden age", as the experience of rapid economic growth was internationally shared. It was also a period of conditional convergence since policy reforms were successfully implemented (e.g. in Ireland and Spain) to speed up the growth process. Verspagen (1996) found evidence that catching-up in the golden age led to a reduction of the technology gaps between countries. Olson (1982) argued that established democracies are characterised by vested interest groups whose activities slow down the rate of economic growth. Investment boom, capital accumulation, free trade, and competition all play an important part in the catching-up process. Figure 1 demonstrates the growth experience of Maddison's group of sixteen industrialised countries during 1985-95.

The nations in Maddison's sample of sixteen countries are among the richest nations in the world today. The negative slope indicates that 1985 and 1995 relative incomes are uncorrelated. A fair test of convergence requires an *ex ante* sample of countries that are likely to converge.

Figure 1:   The per capita GNP for Maddison's Sixteen-1985-95

Per capita GNP for Maddison 's Sixteen
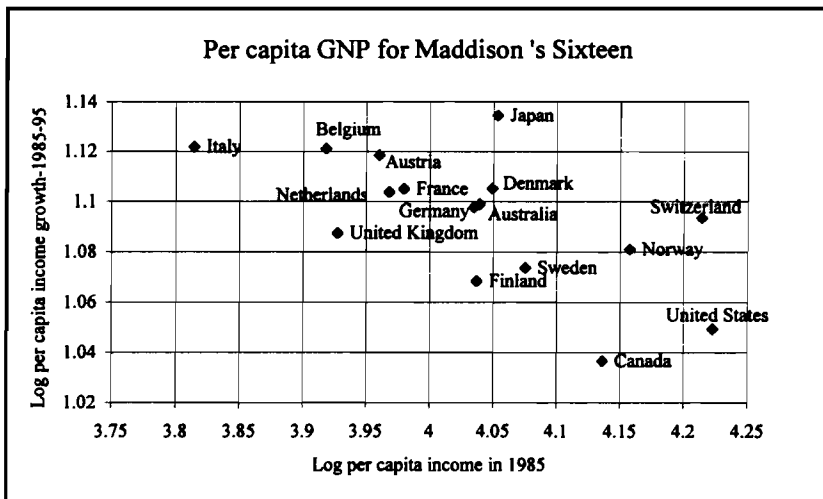
SOUTH AFRICA AND CONVERGENCE

South Africa with its abundant natural resources and relatively sophisticated infrastructure has an economy with great development potential. The economy is classified by the World Bank in the category of developing "upper-middle-income countries". However , real per capita income in South Africa still falls well behind its counterparts in the leading industrialised countries. Much of the problem evidently lies in mismanagement and misallocation of available resources. Mobilising savings into appropriate channels and producing new investment goods to increase the stock of capital, which – *inter alia* – depend on an efficient capital market, have slowed down and led to structural problems.

In the present study the convergence phenomenon is tested mainly by means of data from National Productivity Institute. GDP per capita for 21 countries were taken from the period 1965-91 and ranked in descending order. Six samples of countries were then drawn, consisting of a set of the top nine, thirteen, fourteen, sixteen, eighteen, and twenty countries. The coefficient of variation was calculated for each sample. The results showed divergence among the lower and convergence among the higher income countries. The coefficient of variation (CV) for each sample of countries is given in Table 1.

Table 1:   The Coefficient of Variation for a Sample of Countries,1965–1991

	Top 9	Top 13	Top 14	Top 16	Top 18	Top 20
1965	0.0025	0.0290	0.0319	0.0380	0.0539	0.7200
1970	0.0240	0.0250	0.0290	0.0350	0.0450	0.0640
1975	0.0220	0.0230	0.0290	0.0340	0.0402	0.0620
1980	0.0210	0.0250	0.0320	0.0350	0.0397	0.0610
1985	0.0200	0.0240	0.0380	0.0400	0.0427	0.0650
1991	0.0200	0.0260	0.0394	0.0399	0.0401	0.0650

The above table supports the convergence phenomenon. CV is lowest for top 9 countries and it systematically increases with the addition of more countries. STATISTICA (1996) was used for the above computation. The CV has dropped in 1991 as compared to 1965 and also showed an increasing tendency to fall as countries in the lower income groups were added to the sample. This tendency clearly suggests divergence among lower income countries and convergence among the higher income countries
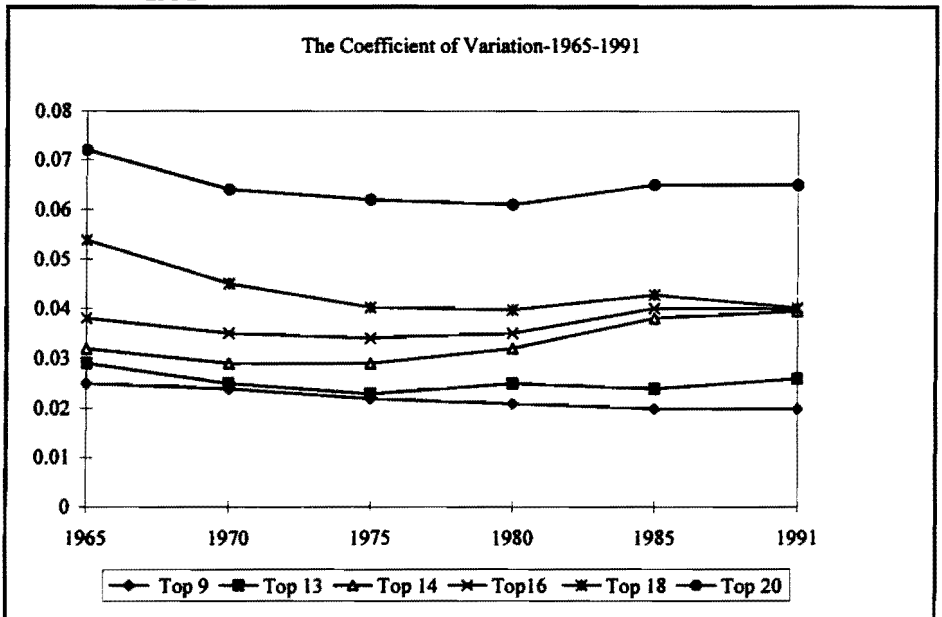
Figure 2:   The Coefficient of Variation for a Sample of Countries, 1965–1991

Figure 2 shows the coefficient of variation for all six samples. A declining coefficient of variation suggests convergence.

Measuring the distance or gap

The income gap between countries can also be calculated using the following formula

$$Gap = \ln \frac{Q_{USA}}{Q_{country}} \qquad (4)$$

For equal values of per capita income the gap is zero. An increasing gap indicates divergence and a gap closer to zero indicates convergence. Countries closer to the frontier (USA) have smaller growth rate differentials and countries further away from the frontier show divergence or greater growth rate differentials. Convergence phenomena related to the gap measure are analysed by means of data from the National Productivity Institute (1994, 1995).

Figure 3 shows the distance between some selected countries from 1985 to 1991, and comparable data for some East Asian countries, plus South Africa and USA, are shown in Figure 4.

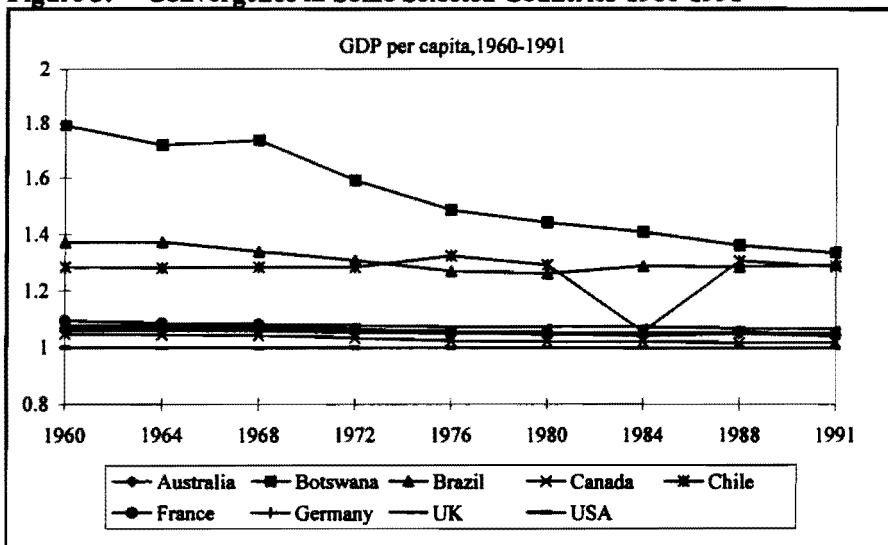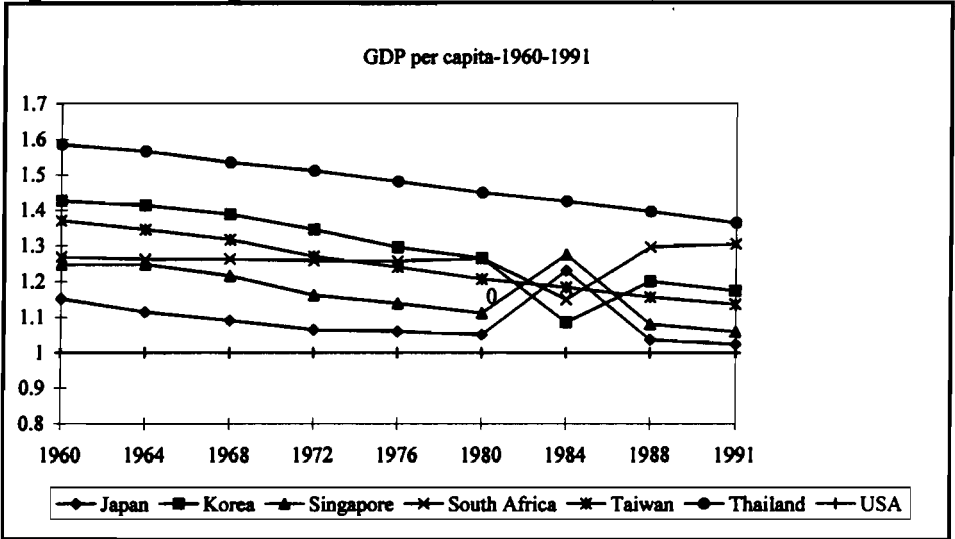**Figure 3:   Convergence in Some Selected Countries-1960-1991**

GDP per capita,1960-1991

Australia Botswana Brazil Canada Chile France Germany UK USA

Figure 4:   Convergence in Some East Asian Economies, SA and USA

GDP per capita-1960-1991

It appears that South Africa's per capita GDP (using distances) compares favorably with at least some of the newly industrialised countries (NICs). South Africa has in fact a great potential for convergence since it falls within the band of the relatively advanced NICs as shown in Figure 5.

Figure 5:   Per capita GNP for Some East Asian Economies and South Africa 1985-1995

Per capita GNP for East Asian Economies and South Africa
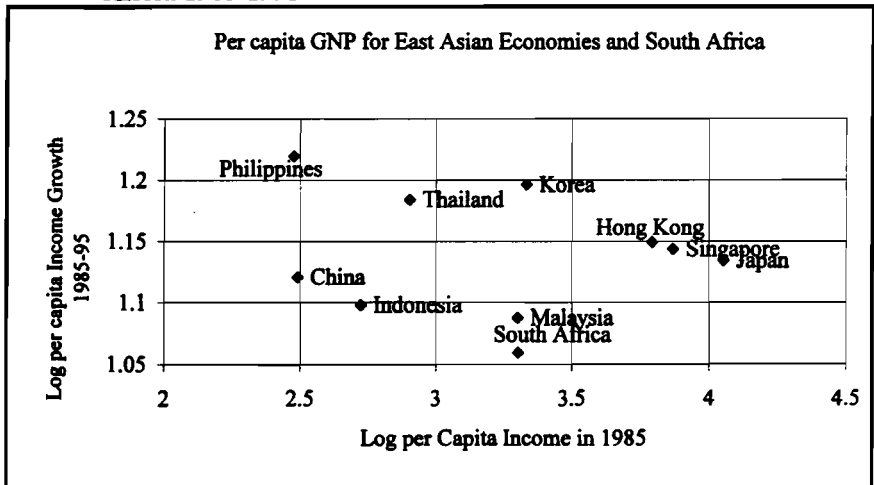
A regression was fitted for a sample of countries, and the results showed divergence in GDP per capita for the period 1965-1980, but convergence during 1985-1993. The regression equation is

$$\ln \frac{GDP}{GDP_{t-n}} = \ln GDP_{t-n} + e \tag{5}$$

A positive relationship between the two variables in equation (5) indicates ß-divergence and a negative ß indicates convergence. The regression was run for a sample of the top 20 and the top 13 countries, and the results are presented in Table 2.

Table 2:   Regression Results

	Top 13		Top 20	
	1960-1980	**1980-1991**	**1960-1980**	**1980-1991**
ß	0.2140	-0.0900	0.0220	-0.1400
Intercept	-20.2500	1.7440	7.4030	1.5803
R	0.2143	0.0882	0.0218	0.1375
R²	0.0459	0.0077	0.0005	0.0189
F	0.5290	0.0862	0.0085	0.3470
p	0.4820	0.7745	0.9272	0.5621
t	-0.5052	1.1740	0.5008	3.5840

The results in Table 2 clearly show that convergence took place during the period 1980-1991 for the Top 13 and Top 20 countries. A distance matrix giving Euclidean distance is presented in Table 3.

The distance matrix gives the distance between any two countries. Multidimensional scaling was used to find distances between countries. Canonical correlation which gives the relationship between countries was also used. Canonical correlation is unique in that it is a statistical procedure which assesses the relationship between two sets of countries.

Table 3: Euclidean Distance Matrix

	Australia	Korea	Singapore	S Africa	Sweden	Taiwan	UK	Botswana	Brazil	Canada	Chile	Denmark	France	Germany	Greece	USA
Australia	.00	.34	.12	.64	.12	.43	.02	.68	.56	.07	.57	.72	.12	.24	.08	.66
Korea	.34	.00	.30	.44	.45	.10	.33	.35	.24	.41	.36	.38	.45	.41	.41	.48
Singapore	.12	.30	.00	.54	.21	.39	.11	.64	.52	.16	:53	.67	.19	.27	.16	.62
South Africa	.64	.44	.54	.00	.75	.41	.64	.45	.40	.69	.67	.46	.73	.65	.69	.59
Sweden	.12	.45	.21	.75	.00	.54	.12	.80	.67	.06	.64	.83	.03	.30	.06	.75
Taiwan	.43	.10	.39	.41	.54	.00	.43	.25	.15	.50	.36	.29	.54	.48	.50	.46
UK	.02	.33	.11	.64	.12	.43	.00	.68	.56	.07	.56	.72	.12	.26	.08	.66
Botswana	.68	.35	.64	.45	.80	.25	.60	.00	.15	.75	.46	.04	.80	.71	.76	.50
Brazil	.56	.24	.52	.40	.67	.15	.56	.15	.00	.63	.46	.17	.67	.59	.63	.50
Canada	.07	.41	.16	.69	.05	.50	.07	.75	.63	.00	.62	.79	.05	.27	.02	.71
Chile	.57	.36	.53	.67	.64	.36	.56	.46	.46	.62	.00	.49	.65	.67	.62	.52
Denmark	.72	.38	.67	.46	.83	.29	.72	.04	.17	.79	.49	.00	.83	.74	.79	.53
France	.12	.45	.19	.73	.03	.54	.12	.80	.67	.05	.65	.83	.00	.29	.05	.75
Germany	.24	.41	.27	.65	.30	.48	.26	.71	.59	.27	.67	.74	.29	.00	.28	.71
Greece	.08	.41	.16	.69	.06	.50	.08	.76	.63	.02	.62	.79	.05	.28	.00	.72
USA	.66	.48	.62	.59	.75	.46	.66	.50	.50	.71	.52	.53	.75	.71	.72	.00

CONCLUSIONS

A learned paper by William J Baumol (1986) has come to serve as a role model to which empirical convergence studies of the present kind are anchored. Baumol found that a sample of 16 advanced market economies (known as Maddison's sixteen) has shown a remarkable convergence of GDP per capita in the long term. This was associated with a historically unprecedented growth in productivity. No such convergence was however, observed for the economically less developed countries.

Seeing that the South African economy has often been described as a " blend of the first and third worlds", it seems fitting to ask: in which direction is it actually tending to move? Alternatively expressed: does the convergence hypothesis also apply to the South African economy? If yes, South Africa would show at least the affinity to gravitate towards the first world; if no, there would be at least a presumption that it rather belongs to the third world.

In order to test the convergence hypothesis, South Africa was grouped together with various other states into country sets conditionally classified as either (1) developed market economies (like Maddison's 16) or (2) newly industrialised countries (generally known as NICs). The World Bank classifies South Africa as one of 17 "upper-middle-income" countries, a group that includes NICs like Malaysia, Korea, Brazil and Chile. There is only one income group that is higher in the World Bank's rank-order, namely, the developed market economies (including 5 small states that might also be classified as "developing", according to criteria other than per capita income).

The present research confirms that, in terms of per capita output, South Africa belongs to neither the first nor the third world, but rather to an intermediate group together with the NICs. Within this intermediate group, however, South Africa finds itself in the vanguard. Taking the United States to represent the Grand Frontier, the gap that separates South Africa from the Frontier, according to a distance function, is smaller than that for most NICs. In terms of a Euclidean distance matrix South Africa had covered 0,59 of the way to the Frontier during 1985-93, compared to, for example 0,52 for Chile, 0,50 for Brazil, 0,48 for Korea, and 0,46 for Taiwan. At the same time, it is evident that South Africa had not yet caught up with such developed (or OECD) countries as France and Sweden (both 0,75), Canada and Germany (both 0,71) and the United Kingdom (0,66).

The conclusion that South Africa is at least moving (i.e. gravitating) towards the first-world countries as a group, is supported by measures of dispersion known

as β-convergence and γ-convergence. Convergence over time would be indicated by a negative β-coefficient and a γ-coefficient of decreasing value.

The convergence observed for the South African economy is, however, a fairly recent phenomenon, that has taken place in spite of South Africa's rather indifferent growth record: during the period 1985-93 real GDP per capita more often fell than rose. It must be however borne in mind that "the golden age" of economic growth in the developed market economies had ended in 1973. Since then the first-world growth path has followed a rather lower trajectory. Although the causes of this secular change cannot be discussed here, these have been of a deep-seated institutional nature, where the growth-retarding influence of inte-rest groups " has been — and remains — an important factor" (Mueller, 1983).

Is the evident convergence of South Africa's real per capita income likely to continue in the future? An important demographic development has been the recent decline in fertility, and economic growth would accelerate if South African industry could rid itself of its currently wasteful production techniques. These are too capital-intensive given the country's relative resource endowment, thus resulting in an inappropriately high capital-output ratio. Briefly put, there exists considerable scope for improvement in the productivity of both labour and capital.

ENDNOTES

(1) The author is indebted to Prof M.L.Truu for valuable suggestions and comments that contributed towards the process of finalising this paper.
(2) The author would like to acknowledge with gratitude the constant encouragement and support received from the National Productivity Institute.
(3) This article is based on the author's D.Phil. thesis *Economic Growth and Convergence in the South African Economy,* University of Pretoria,1997. Data pertaining to specific aspects of this topic may be obtained on request from the author at the National Productivity Institute, P.O. Box 3971, Pretoria 0001.

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