ECONOMIC GROWTH IN SOUTH AFRICA: A KALDORIAN APPROACH

BY

MARK WAYLAND MILLIN

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF COMMERCE IN ECONOMICS, UNIVERSITY OF NATAL, PIETERMARITZBURG

AUGUST 2003

As the candidate's supervisor, I have approved this thesis for submission.

Signature Tennessee Nichola

Name Prof T Nichola

Date 14/11/03

ACKNOWLEDGMENTS

My sincere thanks to my supervisor, Professor Tennassie Nichola, for his ongoing support and encouragement, throughout my studies, and work career. You have been a true inspiration to me throughout my years at UNP. May God bless you and your family richly in the many years ahead!

To my family, especially my parents, for their loving support and assistance over the past number of years! To my brother and friend, Matthew, for his continued encouragement and brotherly advice!

To my best friend and confidant, Damon, for the constant encouragement and many hours of talking we have done, "you go you good thing"!

Last, but always first in my heart, to my Lord and Saviour. May this work glorify your name!

DECLARATION

This dissertation was undertaken in the School of Business: Economics and Finance Discipline, University of Natal, Pietermaritzburg under the supervision of Professor Tennassie Nichola. This is an original work by the author and has not been submitted in any form for any other degree or diploma to any other university. Where the work of others has been used, it has been duly acknowledged in the text.

Signature ____________________

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Professor Lord Nicholas Kaldor (1908 – 1986) made original and important contributions to the theory of the firm, to Keynesian economics, to growth and distribution theory, to equilibrium economics, and to thinking about domestic and international economic policy. However, the emphasis of this thesis is Kaldor's contribution to growth and distribution theory namely, Kaldor's three laws of growth, and the application thereof to the South African economy.

According to Kaldor (1966) the industrial sector, manufacturing in particular, is deemed to be the *engine of growth* and is generally referred to as Kaldor's engine of growth hypothesis. Kaldor's first law states that there is a strong positive correlation between the growth of manufacturing output and the growth of overall GDP. The second law states that there is a strong positive correlation between the growth of manufacturing output and the growth of productivity in the manufacturing sector. The third law states that there is a strong positive correlation between the growth of manufacturing output and the growth of productivity outside of the manufacturing sector or in the non-manufacturing sector.

The general finding of this thesis is supportive of the Kaldorian approach to economic growth in South Africa. Hence, the manufacturing sector is an engine of growth in the South African economy. Given the importance of the manufacturing sector, and future economic growth in South Africa, investment and policy formulation should be increasingly geared towards promoting this sector.

CHAPTER ONE
INTRODUCTION

1.1 Overview

Economic growth is broadly characterised by an increase in a nation's productive capacity, which is consistent with an outward shift or persistent expansion of the production possibilities frontier (Parkin, 1990: 56). An increase in a nation's productive capacity can be achieved by, shifting resources from lower-productivity to higher-productivity sectors (Chenery, 1986: 13). This is a central feature of the Kaldor (1966)[1] model in that it considers structural change as a means of achieving economic growth. This structural approach to growth "manifests itself in an increasing share of industrial activity in the economy." (McCarthy, 1988: 1) The persistent expansion of the production possibilities frontier is representative of sustained economic growth and implies a positive increase in *real* GDP over two consecutive quarters or more.

Economic growth can be measured as the rate at which *real* output grows over time. *Real* Gross Domestic Product (GDP) is the most widely used basis for determining economic growth (Dornbusch, Fischer, Mohr and Rogers, 1998: 36). A simple measure of economic growth is the annual growth rate of *real* GDP or the percentage increase in *real* GDP from one year to the next and equals $[((GDP_t - GDP_{t-1})/GDP_{t-1}) \times 100]$ (Fourie, 1999: 212).

The South African economy experienced a period of uninterrupted prosperity (McCarthy, 1999: 143) from 1933 to the late 1960's. This was highlighted by rapid economic growth after the Second World War. With reference to Table 1, during the period 1946 – 1971, national income increased on a yearly basis and recessions were generally seen as

[1] Kaldor's (1966) original study, along with later studies undertaken by Cripps and Tarling (1973) and Hansen and Zhang (1996) make use of a cross-sectional research methodology. This thesis employs a time series approach and is more consistent with the methodology employed by Drakopoulos and Theodossiou (1991) and Bairam (1991). In this thesis, where reference is made to the results found by cross-sectional studies, I do realise the limitations of drawing comparisons between the two research methods. However reference is made to these cross-sectional studies as a point of discussion and to substantiate the a priori expectations and findings surrounding this thesis.

decelerations in the growth rate (Jones and Müller, 1992: 278). The annual increase in *real* GDP varied between 1.9 percent (in 1947) and 7.9 percent (in 1964) and averaged 5.0 percent over the 25 years. The 'golden sixties' saw an even more astounding economic performance where *real* GDP rose by an average 5.5 percent per year.

However during the mid-1970's, both the economy and industrial sector production had begun to slow down (Jones and Müller, 1992: 278; McCarthy, 1999: 143). This period was highlighted by a decline in the long-run growth rate and hence a change in the pattern of economic growth towards increased fluctuation and instability as opposed to the period 1946 - 1971 (Gelb, 1991: 2). The average annual rate of growth of *real* GDP dropped from 5.5 percent in the 1960's to 3.3 percent in the 1970's. The recession in the world economy, after the second oil price increase in 1979, was countered by a marked increase in the price of gold, but the subsequent fall in commodity prices, the high levels of *real* interest rates and the first contraction of international trade after the Second World War, all impacted negatively on the South African economy (McCarthy, 1994: 67).

The 1980's proved no better and stand out as a decade of poor economic growth performance (McCarthy, 1994: 73). This period was marked by stagnation in output growth; persistent inflation over 13 percent per year; a relatively weak rand; a decrease in foreign exchange reserves and low personal savings ratios (Gelb, 1991: 1). The experience of low economic growth, rising unemployment, high inflation and recurring balance of payments problems during the 1980's and early 1990's, was in stark contrast to the previous decades of relatively healthy growth (Dornbusch et. al., 1998: 44). The average annual rate of growth of *real* GDP during the 1980's dropped further to 2.2 percent and for the period 1990 – 1998, growth had slowed to 1.3 percent. While the South African economy had ranked among the top worldwide performers during the 1960's, this situation had reversed dramatically by the 1980's and early 1990's (Dornbusch et. al., 1998: 44).

Table 1: Percentage Growth of *Real* GDP, 1947 – 1998

Year	GDP	Year	GDP	Year	GDP	Year	GDP
1947	1.9	1960	3.0	1973	4.6	1986	0.0
1948	7.4	1961	3.8	1974	6.1	1987	2.1
1949	2.3	1962	6.2	1975	1.7	1988	4.2
1950	5.0	1963	7.4	1976	2.2	1989	2.4
1951	4.8	1964	7.9	1977	-0.1	1990	-0.3
1952	3.0	1965	6.1	1978	3.0	1991	-1.0
1953	4.5	1966	4.4	1979	3.8	1992	-2.1
1954	6.5	1967	7.2	1980	6.6	1993	1.2
1955	5.7	1968	4.2	1981	5.4	1994	3.2
1956	5.6	1969	4.7	1982	-0.4	1995	3.1
1957	4.5	1970	5.2	1983	-1.8	1996	4.2
1958	2.8	1971	4.3	1984	5.1	1997	2.5
1959	4.6	1972	1.7	1985	-1.2	1998	0.5

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the South African Reserve Bank (SARB) Quarterly Bulletin, June 1999.

The manufacturing sector plays a key role in the South African economy (Black and Stanwix, 1987: 47; McCarthy, 1994: 66), and "one could settle on a description of the South African economy as a developing economy that has made substantial industrial progress, to the extent of the manufacturing sector being the most important commodity-producing sector in terms of employment and income creation." (McCarthy, 1988: 3) Since the Kaldorian model of economic growth places special emphasis on the manufacturing sector of the economy it is necessary to define manufacturing and list the various types of manufacturing activities in the South African economy.

The Department of Statistics (1981) defines manufacturing as, "the mechanical or chemical transformation of inorganic or organic substances into new products, whether the work is performed by power-driven machines or by hand, whether it is done in a factory or in the worker's home and whether the products are sold wholesale or retail."

According to the Standard Industrial Classification of All Economic Activities (SIC) the manufacturing sector of the South African economy comprises the following sub-sectors or categories: Food; Beverages; Tobacco; Textiles and Clothing; Leather and leather products; Footwear; Wood and cork products; Furniture; Paper and paper products; Printing; Chemical, Petroleum and coal products; Industrial chemicals; Other chemical products; Rubber products; Plastic products; Non-metallic mineral products; Pottery; Glass and glass products; Other non-metallic mineral products; Basic metals; Iron and steel basic industries; Non-ferrous metal basic industries; Metal products; Machinery; Electrical machinery; Transport equipment; Motor vehicles, parts and accessories; Professional equipment, not elsewhere classified (n.e.c); Other manufacturing industries.

The history of South African industrial development is well documented and need not be discussed at length in this study.[2] Prior to the 1980's the industrial sector and development thereof tended to be more inward looking whereas the mining sector was more outward oriented. The mining sector generated foreign exchange earnings for South Africa whilst the manufacturing sector was geared towards the domestic market and was a net consumer of foreign exchange (McCarthy, 1994: 68).

A couple of factors led to the more inward looking growth of manufacturing. A major factor relates to the isolation of South Africa from foreign suppliers during the course of two world wars and this created an environment conducive to import substitution. Another factor was the protectionist policies followed by consecutive governments since 1925, which saw the creation of formal policies to protect domestic industry (McCarthy, 1994: 68).

Industrial development in South Africa up to the 1960's can be seen as the first stage of import substituting industrialisation where protection basically followed the infant industry approach (McCarthy, 1994: 68). The second stage began in the mid-1970's but followed a forced import substitution policy with a strategic industry approach (McCarthy, 1994: 69). Focus now shifted to the production of products that were of strategic importance to the economy. Some examples of strategically important industries were the investment in projects such as the Armaments Development Corporation (Armscor) established in 1967; the Iron and Steel Corporation (ISCOR); Sasol II (1974); Sasol III (1979) and later, Mossgas (1987).

---

[2] See McCarthy (1994: 67) for a list of sources that discuss the history of the South African industrial sector.

The manufacturing sector of the South African economy experienced fast growth rates and accumulation of capital and labour in the 1960's and 1970's in the face of high tariff and non-tariff barriers due to South Africa's adoption of an import substitution strategy. In the 1980's, a number of factors that included the decline of import substitution possibilities, the gold boom of the 1980's and rising wages led to a loss of competitiveness of the local manufacturing sector. However the poor performance of the manufacturing sector in the early 1990's was largely due to the general recession at the time, deflationary policy as a result of depleted public finances and political uncertainty (International Monetary Fund, 1998: 48).

The manufacturing sector contributes a large proportion to overall GDP in South Africa. Viljoen (1983) studied the increased contribution of manufacturing industry to the GDP and the slowing share of industry in GDP since the mid-1960's. He concluded that South Africa was fast approaching the stage of industrial maturity (Viljoen, 1983: 33). In an earlier study focusing on the structural changes in the manufacturing industry between 1916 and 1975, Marais (1981: 26 - 32) found that particular changes had taken place, which could be viewed as showing the evolution of a "mature industrial economic system".

With reference to Table A.1: Contribution to GDP, 1946 – 1998 (see Appendix A), the average annual rate of growth of manufacturing output during this period was in *excess* of the overall rate of *real* GDP growth (4.9 percent and 3.5 percent respectively). The share of manufacturing output in the GDP increased from 10.6 percent in 1946 to 20.2 percent in 1998. The overall share of secondary sector output in the GDP increased from 15.6 percent in 1946 to 26.9 percent in 1998, rising to over 30 percent during the period 1973 – 1984 (SARB, 1999).

In a recent study that applied the Kaldorian growth theory to the Greek economy, Drakopoulos and Theodossiou (1991: 1683) found similar results for the Greek manufacturing industry. During the period 1950 – 1980, the average annual rate of growth of the industrial sector exceeded the rate of GDP growth (7.6 percent and 5.9 percent respectively) (Agapitos, 1989: 76, cited by Drakopoulos and Theodossiou, 1991). The share of manufacturing output in the GDP increased form 11.5 percent in 1951 to 21 percent in

1973. Therefore the situation in South Africa was not dissimilar to the Greek experience over a roughly similar period. Another interesting observation for South Africa and substantiated by the findings of Drakopoulos and Theodossiou (1991) is the declining contribution of the overall primary sector and agriculture in particular. Over the study period, the agricultural and mining and quarrying sectors showed a steady decline in contribution to overall output or GDP.

1.2 Research Problem

The research problem under investigation is whether the manufacturing sector determines economic growth in South Africa. According to Kaldor (1966) the industrial sector, manufacturing in particular, is deemed to be the *engine of growth* (this is generally known as Kaldor's engine of growth hypothesis (Bairam, 1991)). The research problem therefore relates to whether the manufacturing sector has been a major driving force behind economic growth in South Africa. The focus of this study is an examination of Kaldor's three growth laws in the context of the South African economy. Kaldor's growth laws are a unique approach to economic growth modelling in that they offer a multi-sector view of economic growth and hence consider manufacturing and non-manufacturing activities in assessing the problem at hand.

1.3 Objective of the Study

The objective of this study is to examine the relevance of Kaldor's three laws of growth with respect to the South African economy. More specifically, Kaldor's three laws of growth will be tested with respect to the South African economy to see whether:

1. There is a strong positive correlation between the growth of manufacturing output (g_m) and the growth of overall GDP (g_{GDP}).
2. There is a strong positive correlation between the growth of manufacturing output (g_m) and the growth of productivity in the manufacturing sector (p_m).

3. There is a strong positive correlation between the growth of manufacturing output (g_m) and the growth of productivity in the non-manufacturing sector (p_{nm}) or overall productivity growth (p_{GDP}).

1.4 Procedure and Data

This study makes use of published macroeconomic data to test Kaldor's three laws of growth with respect to South Africa. The study is essentially econometric in nature and will make use of the Ordinary Least Squares (OLS) estimation of linear regressions, using the SHAZAM version 8.0 econometric software package. To analyse Kaldor's three growth laws, various linear regression specifications are used and will be assessed in terms of model prediction, and statistical significance of estimators.

The data in question consists of 52 observations for *real* GDP (constant 1995 prices) and the gross value added or GVA (constant 1995 prices) by kind of economic activity or sector, on an annual basis, according to the nine major categories of the SIC, fifth edition, January 1993, taken from South Africa's national accounts 1946 – 1998 (SARB, 1999). GVA refers to the difference between the value of a firm's output and the value of the firm's inputs it has purchased from others. This approach is consistent with the *production method* of GDP determination (SARB, 1999: 13).

The GVA at constant 1995 prices according to the SIC equals *real* GDP plus subsidies on products less taxes on products. Therefore GDP is the sum of all GVA by the sectors plus taxes less subsidies on products (SARB, 1999: 13). The nine *major* SIC categories are Agriculture, Forestry and Fishing (AFF); Mining and Quarrying (MQ); Manufacturing (M); Electricity, Gas and Water (EGW); Construction (C); Wholesale and Retail trade, Catering and Accommodation (WRtCA); Transport, Storage and Communication (TSC); Financial intermediation, Insurance, Real estate and Business services (FiIReBs); Community, Social and Personal services (CSPs).

The Central Statistical Service (CSS) for South Africa was the main source of labour statistics (for the computation of productivity estimates in manufacturing and non-manufacturing activities) used in this thesis. The majority of the labour statistics come from the 1993 issue of South African Labour Statistics published by the CSS with additional information from South African Labour Statistics (1986 and 1995) and Bulletin of Statistics (1995, 1996 and 1997). This data source comprises a smaller data set and hence consists of 26 observations (1970 – 1996) for total employment by each of the SIC sectors, on an annual basis. Missing figures for agriculture (1970, 1982, 1984 and 1989) and transport, storage and communication (1971 – 1976) were calculated using exponential or compound growth rates between periods, a method employed in Kaldor's (1966) original study.

A reduced sample size of 26 observations to test laws two and three is still sufficient for the purposes of this study and is larger than that used by previous studies undertaken by Drakopoulos and Theodossiou (1991) of 22 observations and Bairam (1991) of 11 observations. Note that the data set compiled for the employment statistics generally excludes the former Transkei, Bophuthatswana, Venda and Ciskei (TBVC) states, but this should not affect the study in question as the employment statistics are nonetheless consistent in nature and compilation amongst all sources used. The data used in this study and the statistical sources consulted are presented in Appendix C, Tables C.1 – C.6.

Employment in the primary sector, for the purposes of this study, consists of agriculture, mining and quarrying only. These are the two main sub-sectors within the overall primary sector and the sub-sectors from which labour is drawn into the industrial sector according to the hypothesis made by the Kaldor growth theory. According to the Department of Agriculture and Environmental Affairs (DAEA) and Department of Water Affairs and Forestry (DWAF), at present, the remaining sub-sectors within the overall primary sector namely, forestry and fishing, account for roughly 90 000 employees (this was confirmed telephonically). In 1996, this would have accounted for approximately 6 percent of total employment in the overall primary sector. Hence the majority of employment in the South African primary sector is concentrated in the agricultural and mining and quarrying sub-sectors.

Excluding the employment statistics for the forestry and fishing sub-sectors from the overall primary sector should not detract from the study at hand. It must also be noted that accurate employment figures for the forestry sub-sector may be difficult to obtain as this figure excludes independent contractors. Pertaining to the fisheries sub-sector, employment figures relate to commercial fisheries only, and hence may give an inaccurate representation. However as this study measures the *growth* in productivity, we do not expect a significant impact in the estimated results by excluding employment for the forestry and fishing sub-sectors. Notwithstanding the above, it must be noted that earlier studies tend to focus on the importance of employment and productivity in agriculture and mining activities *specifically* (Thirlwall, 1987; Bairam, 1991 and Drakopoulos and Theodossiou, 1991) and hence the approach adopted by this study.

1.5 Thesis Organisation

Following on from this introductory chapter, chapter two discusses several major theories of economic growth that attempt to explain the mechanics of how economic growth takes place, from a theoretical viewpoint. This leads the discussion on to chapter three in which a detailed exposition of the Kaldorian approach to economic growth is made. A priori predictions pertaining to Kaldor's three laws of economic growth are outlined in this chapter. Chapter four then presents all the estimated regression results and the interpretation thereof so as to establish the relevance or irrelevance of the Kaldorian theory to the South African context. Hence all estimated results are discussed alluding to their significance in light of the relevant literature. Finally, chapter five draws brief conclusions and proposes recommendations as to future policy regarding economic growth in South Africa.

CHAPTER TWO
THEORIES OF ECONOMIC GROWTH

2.1 Introduction

The birth of modern theory of economic growth can be traced back to the immediate post-war period. This evolution in growth theory was heralded by the work of Harrod (1939) and Domar (1947). However during the mid-1950's, the Harrod-Domar approach was broadened to include a more comprehensive set of factors or sources of economic growth.[3] The measurement of the sources of economic growth is taken from the pioneering work of growth theorists such as Abramovitz (1956), Solow (1957) and Denison (1962).

The discussion that follows outlines three of the major pioneering theories of economic growth. The contributions of Harrod (1939) and Domar (1947), Solow (1956) and Romer (1986) will be discussed in order to establish an understanding of how economic growth takes place in countries. These theories follow a one-sector approach to growth theory. The Romer model however can follow a one-sector or multi-sector approach depending on whether external economies of scale or positive externalities are viewed for the economy as a *whole* or a specific industry. A discussion of these exogenous and endogenous theories of growth[4] is made so as to establish the foundation for our understanding of how economic growth occurs. A brief discussion of the structural approach is then made in order to lead the discussion into

[3] This thesis does not attempt to outline and discuss the sources of economic growth, but rather, through this chapter, analyses the mechanics of economic growth as expounded by several major growth theories that form the foundation for understanding how growth takes place. I therefore in no way understate the value of a discussion of the sources of growth. The structural approach to sources of economic growth essentially includes the neoclassical sources plus reallocation of resources to higher productivity sectors, economies of scale and learning by doing and reduction of internal and external bottlenecks (Chenery, 1986: 15). The Kaldorian approach to economic growth, being post Keynesian in nature, follows the structural approach. The Kaldor approach, and theoretical discussion thereof that follows in the next chapter, will discuss the implications of the structural approach to sources of growth with special reference to the manufacturing sector that, in Kaldorian growth theory, is considered to be the driving force behind economic growth or, said another way, a major source of economic growth.

[4] The theories of Harrod, Domar and Solow are generally referred to as exogenous growth models in that technical progress is independent of investment (Scott, 1989: 72) or not considered explicitly within the model. The new growth theory of Romer is referred to as an endogenous growth model in that technical progress, along with other variables, are viewed as an integral part of the model.

the alternative theoretical approach to economic growth that this thesis is based on namely, Kaldorian growth theory (after Lord Nicholas Kaldor of Cambridge University, 1966 and a pioneer of the post Keynesian approach to economic analysis) and which is discussed in the next chapter. The Kaldorian model follows the structural model of growth theory, and uses a multi-sector approach as it takes into account the manufacturing and non-manufacturing sectors of the economy. The Kaldorian approach to growth theory essentially postulates that the manufacturing sector of the economy is the vehicle through which economic growth takes place, and is the focus of this thesis. Kaldor's growth laws are discussed in detail in chapter three, and their empirical applications to the South African economy are presented in chapter four.

2.2 Major Growth Theories: Exogenous and Endogenous Growth

2.2.1 Introduction

The earlier models of Harrod (1939) and Domar (1947) and Solow (1956) can be classified as exogenous growth models whereas the contribution of Romer (1986) is classified as the beginnings of the new endogenous growth theory. Section 2.2 reviews these three major economic growth theories. The Harrod-Domar growth model explains economic growth as the result of interaction between three variables, namely: the savings rate, the rate of growth of the labour force, and the capital-output ratio (Solow, 1988: 307). The neoclassical approach followed by Solow focuses on capital accumulation in that, saving and investing more, a country can increase the amount of capital that it leaves to its future workers thereby increasing their productivity, and hence their income. The approach followed by Romer or the endogenous growth model postulates an alternative view to long-run growth. The rate of investment, and the rate of return on capital can increase rather than decrease with increases in capital stock, thus diminishing returns does not apply.

However it must be said that both the neoclassical and endogenous growth models suffer from a common shortcoming. They both fail to explain other important factors that may affect growth, such as the degree to which a country fosters free trade and free enterprise. Although the precise relationship between these other important factors and growth are hard to estimate, they may impact on growth to the same or larger degree as savings rates, schooling and basic research. An important lesson governments can learn about growth might be that, if they want to promote it, they must give up their desire to control it (The Economist, 1995: 110).

2.2.2 The Harrod-Domar Growth Model

Harrod (1939) and Domar (1947) explained economic growth as the result of the interaction of three variables: "the savings rate, the rate of growth of the labour force, and the capital-output ratio - which were all given or constant: one a matter of preferences, the second a matter of social demography, the third a matter of technology." (Solow, 1988: 307) The Harrod-Domar model, in a Keynesian sense, is one that proposes government intervention and does not necessarily rely on the market or self-correcting mechanism that the classical approach prescribes (Thirlwall, 1999: 89). The Harrod-Domar approach thus does not guarantee the existence of full employment (Y_f).

The Harrod-Domar model of economic growth, is built on two simplifying assumptions:

1. The national income of a country is proportional to its capital stock,
2. Increases in the capital stock come from savings of households, and assumes to represent a proportion of national income.

The above simplifying assumptions suggest the following policy prescription: to increase growth, the national savings rate must be increased (Harberger, 1984: 3). The Harrod-Domar model assumed that labour input grows automatically in proportion to capital (Aghion and Howitt, 1998: 24). In this sense, one must scrutinise what national savings means. National savings refers to the combination of private and government savings. If national savings is increased, but this is done via increased government savings, this would entail a budget surplus that is usually obtained through raising the general level of taxes. If tax rates increase in an economy, then investment spending (via the national income identity savings equals investment or $S = I$) is likely to decline as savings from households are used to pay for higher tax obligations. This means that increases in existing or new capital stock may not come about as predicted by the simplified Harrod-Domar assumption.

From another perspective, increasing savings means that investment spending increases as well. This makes perfect *Hicksian* sense (after one of the originators of the *IS*/*LM* model namely Hicks and Hansen). Through the national income identity $S = I$, an outward shift of the *IS* curve results causing an increase in income/output. Given the Harrod-Domar condition where an economy is at less than full employment, if output per person is declining, then an increase in growth is likely to result from an increase in savings. The concept of diminishing returns (a usual assumption in growth theory) does not apply in this instance as a faster growth of labour input, due to surplus unemployed labour in the economy (Aghion and Howitt, 1998: 25), is supplemented by a faster growth of capital input.

Another question that begs answering is whether Harrod-Domar equilibrium will be self-correcting (as in the typical classical analysis) or not self-correcting. This brings into question the dynamic nature of a model in which intervention, in some sense, may be necessary. In answering this question, an exposition of the two independent views as proposed by Harrod and Domar must be made.

Harrod's original model can be seen as being a dynamic extension of Keynes' static equilibrium model (Thirlwall, 1999: 89) and proposes that if changes in income (Y) induce a change in investment (I), better known as the accelerator process, at what rate should Y grow in order for planned investment to equal planned savings (S) to satisfy the condition of dynamic equilibrium for a growing economy over time. Thus Harrod wanted to know what rate of savings is needed to equal investment in order for growth to take place. This is different from the self-correcting approach of the underlying static Keynesian analysis that states that, if $S \neq I$, a new equilibrium in the economy results via the multiplier process. Harrod distinguishes between two growth rates namely, the actual growth rate (g) and warranted growth rate (g_w). In equilibrium therefore $g = g_w$.

$$\text{Thus } g = s/c_r = (S/Y) / (I/\Delta Y) = (S/Y)(\Delta Y/I)$$

Given $S = I$, then $\Delta Y/Y$ is the target growth in output

However from Harrod's perspective, actual growth may not necessarily explain a steady-state relationship between S and I at Y_f and hence the concepts of g_w and natural rate of growth (g_n) are important. Warranted growth can be defined as the optimal level of I to match S and keep capital fully employed. Thus there is no over or under-utilisation of capital. This is determined by plans to save or $S = sY$ where s is the marginal propensity to save. If this relationship ($S = sY$) determines the supply-side of the economy and demand for I is given by the accelerator principle $c_r = \Delta K/\Delta Y = I/\Delta Y$, then $I = c_r \Delta Y$ where c_r is the accelerator coefficient for capital. Therefore under the Keynesian notion of $S = I$ then,

$$S = sY \text{ and } I = c_r \Delta Y$$

$$\text{Thus } sY = c_r \Delta Y$$

$$\therefore \; s = c_r (\Delta Y/Y)$$

$$\therefore \; s/c_r = \Delta Y/Y = g_w$$

From Harrod's perspective, to maintain dynamic equilibrium, the economy must grow at this rate (g_w). However if there is a departure from the equilibrium condition (say $g > g_w$), then actual investment is below the level needed to meet an increase in output. This results in shortages and hence the incentive to invest more. This in turn causes a further departure from g_w. Therefore from Harrod's explanation, a departure from dynamic equilibrium is not self-correcting and some other mechanism is needed to correct the economic situation.

Domar, however, through independent research, arrived at the same general conclusion that Harrod postulated and hence the Harrod-Domar growth model. Domar, instead of determining the optimal rate of savings, wanted to know what rate of investment is needed to maintain supply growth in relation to demand growth at Y_f. Domar saw investment as a "double-edged sword" in which investment increases demand via the multiplier process ($I \Rightarrow Y$) and increases supply via the accelerator process ($Y \Rightarrow I$) and, hence expands capacity.

$$\Delta Yd = \Delta I/S \text{ and } \Delta Ys = I\sigma$$

(where σ is the productivity of capital or $\Delta Y/I$)

Thus for $\Delta Yd = \Delta Ys$

$$\therefore \; \Delta I/S = I\sigma$$

$$\therefore \; \Delta I/I = S\sigma$$

Thus investment must grow at a rate $S\sigma$. If σ equals $1/c_r$ at Y_f, then Harrod and Domar have the same result for growth, even though both tackled the question from opposing angles. Since the final result arrived at by Harrod and Domar independently were the same, the combined model, as we know it today, is commonly referred to as the Harrod-Domar model.

The Harrod-Domar model does not however guarantee that all labour in an economy will be fully employed if the economy grows at S/c_r. Thus full employment equilibrium can be defined as a situation where capital and labour are fully utilised and hence $g = g_w = g_n$ where g_n is the natural rate of growth. The concept of natural rate of growth is exogenously determined in Harrod's framework (Thirlwall, 1999: 94) hence the reason for including the Harrod-Domar approach amongst the group of exogenous growth models.

In a situation where $g_n > g_w$, or the rate of labour force growth is in *excess* of the warranted rate of growth or growing faster than the rate of capital accumulation, unemployment results and plans to invest are greater than plans to save. This in turn leads to an inflationary environment. In this sense the Harrod-Domar approach is not self-correcting and intervention is needed from outside sources (like the government or central bank) to rectify such a situation. Solow (1956: 56) therefore argues that the Harrod-Domar model of economic growth hinges on a seemingly dubious assumption that brings into question the results postulated. "The characteristic and powerful conclusion of the Harrod-Domar line of thought is that even for the long-run the economic system is at best balanced on a knife-edge of equilibrium growth. Were the magnitudes of the key parameters – the savings ratio, the capital-output ratio, the rate of increase of the labour force – to slip ever so slightly from dead centre, the consequence would be either growing unemployment or prolonged inflation."

2.2.3 The Solow Growth Model

A methodology used to estimate the sources of growth in the neoclassical framework is taken from the work of Solow (1956). An aggregate production function in the following form is assumed:

$$Q = F(K, L, t)$$

This equation assumes that aggregate output is a function of capital, labour and time. Thus from the above Solow aggregate function, a basic neoclassical growth equation can be written as:

$$G_V = G_A + \beta_K G_K + \beta_L G_L$$

From this equation, in logged variable form, it is shown that growth of total factor productivity (TFP) or G_A is the difference between G_V (aggregate output) and the weighted sum of input growth $\beta_K G_K + \beta_L G_L$ (growth in capital and labour respectively). Each input coefficient (β_K and β_L) measures the elasticity of output with respect to that input (either capital or labour in this simplified model). Thus the beta coefficient represents the effect on output growth with a 1 percent increase in the growth of that input (Chenery, 1986: 17). Therefore if a beta for a particular input has a value greater than one, then this would indicate increasing returns to that input. In this instance, if the input were labour, we could say that labour input is highly productive, or used very productively, and exhibits increasing returns to labour. To restate Solow's (1956) seminal contribution, the concept of economic equilibrium over time can be shown by the following differential equation that is similar to the basic model postulated at the outset of this section, and describes the evolution of an economy's capital stock:

$$\partial K(t) = sF\,[K(t), L(t)]$$

Thus the rate of change (derivative) of the stock of a single type of capital good is a function of capital and labour over time. However Solow made the simplifying assumption that aggregate savings is a constant fraction (s) of aggregate income. But, the question arises as to what value for s is desirable for any given economy? The work of Phelps (1965) explored the existence of an ideal savings rate across countries and this resulted in the famous Golden-Rule or golden-age path of growth theory (Becker and Burmeister, 1991). By golden-age path we mean a growth path in which every variable changes (if at all) at a constant relative rate. Essentially, this result postulates that, "a golden-age path on which the competitive interest rate equals the growth rate and hence gross investment equals the gross competitive earnings on capital – then this golden-age produces a path of consumption which is uniformally higher than the consumption path associated with any other golden-age." (Phelps, 1965: 793)

The neoclassical approach to growth theory focuses on capital accumulation. By saving and investing more, a country can increase the amount of capital that it leaves to its future workers, thereby increasing their productivity, and hence their income. Eventually, a country reaches a point at which each generation saves just enough to replace the capital that it has depleted. At this point, income per capita can grow only as rapidly as the technology it has access to improves (The Economist, 1995: 110).

The neoclassical model assumes that countries with similar production technologies, resource endowment, time-preference of consumption as well as comparable savings and population growth rates should converge to similar steady-state levels of per-capita income. This convergence property means that poor countries starting with a relatively low standard of living and a lower capital-labour ratio, grow quicker during transition as they catch-up with the rich countries, but in the end, both groups attain the same level of per capita income (Heng and Siang, 1999). Mankiw (The Economist, 1995: 110) believes that the neoclassical prescription (Solow, 1956) is the better way to understand growth. He suggests that the goal of studying growth theory is to explain why some countries grow faster than others, not necessarily why they grow in the first place.

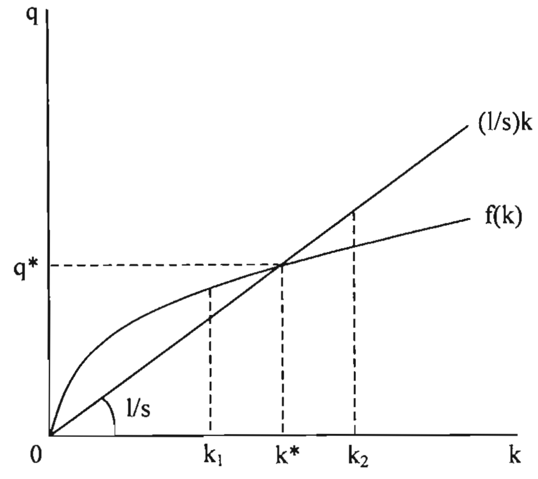

Figure 1: Neoclassical Equilibrium

Source: Thirlwall (1999: 96)

In Figure 1, Thirlwall (1999) shows neoclassical equilibrium being q^* (output per head) and k^* (capital-labour ratio). This results from the interaction of the production function (where output is a function of capital) and a ray along which the rate of growth of capital is equal to the rate of growth of labour. Hence the capital-labour ratio and capital-output ratio are constant ($q = (l/s)k$). A useful exposition will be to note what happens when there is an increase in either the ratio of savings (and investment) to national income or the level of technical progress.[5]

An increase in savings and investment to national income or s has implications for capital accumulation. As s is raised, the slope of the l/s line becomes flatter and hence the

[5] According to Todaro (1982: 90) technical progress, in its simplest form, results from new and improved ways of accomplishing traditional tasks. Technological progress can be neutral, labour-saving and capital-saving. Neutral technological progress occurs when higher output levels are obtained without changing the quantity and combinations of factor inputs. Labour-saving technological progress refers to a situation where higher levels of output are achieved with the same level of labour input. Capital-saving technological progress is a far more, uncommon phenomenon and implies that higher levels of output are achieved with the same level of capital input.

equilibrium level of per capita income and the capital-labour ratio increase, however equilibrium rate of growth remains constant. Equilibrium growth is unchanged in the neoclassical growth model, as a higher savings-investment ratio is offset by a higher capital-output ratio (as increased savings-investment impacts positively on the numerator or capital portion of the capital-output ratio). The capital-output ratio in turn adjusts slowly to keep the growth of capital in line with the rate of growth of the labour force. Thus this satisfies one of the major propositions of the neoclassical model in that the long-run steady-state rate of growth is determined by the rate of growth of the labour force plus the rate of growth of labour productivity. Therefore said another way, a rise in the savings-investment ratio leads to a higher capital-output ratio, and hence lowers productivity of capital. This is due to the neoclassical assumption of diminishing returns to capital (Thirlwall, 1999: 94).

An increase in technology or technological progress can be explained in a similar fashion. If it is assumed that technological progress augments or supplements the productivity of labour only (Harrod neutral technical progress as the capital-output ratio is constant) the *effective* labour force now grows at $l + \dot{q}$ where $\dot{q}$ is the rate of growth of labour productivity. This means that the *l/s* line now becomes steeper as output/income per head is now higher to supply the savings and capital accumulation needed to maintain a capital-output ratio consistent with a faster rate of growth of the *effective* labour force. A rise in the savings-investment ratio has no effect on equilibrium growth of output, unless a higher level of investment raises the rate of growth of labour-augmenting technical progress. However this prescription is negated in the neoclassical model, as technical progress is assumed to be an exogenous variable (Thirlwall, 1999: 97).

Lastly, the neoclassical model predicts that countries at different stages of growth will converge (Hence the name of convergence theory, attributed to Solow's model) as their respective natural growth rates approach the same rate associated with long-run steady-state. Thus an explanation must be given for how such convergence takes place in the model. Output growth, in the neoclassical model, results from one of three factors namely, an increase in labour force quantity and quality, an increase in capital stock (through savings and investment) and improvements in technology. Thus closed economies, with lower savings rates, ceteris paribus, grow more slowly in the short-run and converge to lower per capita income levels. However open economies that encourage foreign direct investment and trade, experience rapid growth and income convergence at higher levels of per capita income, as capital is assumed to flow from rich or developed countries (DC's) to poor or lesser developed countries (LDC's).

The convergence property of the neoclassical model means return on investment is greater in LDC's that have lower capital-labour ratios. Alternatively, these countries have a higher marginal productivity of capital. To restate, there is a larger degree of relative growth in open economy LDC's than DC's. This is portrayed by a rapid growth in emerging market investment nowadays, and the subsequent concern around emerging market volatility. In the absence of external *shocks* or technological change, the neoclassical approach assumes that all economies will converge to zero growth (Todaro, 2000: 99). Therefore the prediction of neoclassical theory is that poor countries should grow faster than rich countries, given the assumption of diminishing marginal returns to capital, identical preferences and technology across countries (Thirlwall, 1999: 115).

However Thirlwall (1983: 343) points to the neoclassical assumption that long-run growth of output cannot be regarded as being determined by an exogenously given long-run rate of growth of the overall labour force and technical progress. This has largely led to the impetus for endogenous growth theory. Hence a theoretical discussion involving the endogenous approach to growth theory is now made to present a balanced view of the causes and consequences surrounding economic growth.

2.2.4 The Romer Growth Model

The more recent works of Romer (1986) and later Lucas (1988) extend the Solow approach by making allowance for external economies of scale on an aggregate level.[6] Even if economic agents expect constant returns to scale, collective decisions may lead to increasing returns for an economy as a *whole*. The important distinction that these models make is that growth paths do not necessarily converge to a steady-state, and need not be Pareto optimal (Becker and Burmeister, 1991). Therefore the Romer (and later Lucas) model of growth helps explain why growth rates are different across countries, and provide a useful insight into why divergence occurs between developed and developing nations. The approach followed by Romer was the beginning of new growth or endogenous growth theory.

In just the same way two firms within the same country and industry can enjoy widely different levels of productivity, some countries, may possess a technological advantage over others. This is why critics of the neoclassical approach prefer endogenous growth models as they deal with technological change explicitly. Instead of focusing on investments in human capital (the amount of money spent imparting knowledge to the workforce) these models focus on the incentives to create new knowledge, and the ways in which this knowledge spreads. They do so by incorporating microeconomic decision-making, and by explicitly examining the interaction between researchers and producers (The Economist, 1995: 110). The Romer (1986: 1002) model presents a fully specified model of long-run growth as it considers a number of factors, including those important in exogenous growth theory. The endogenous growth model also assumes knowledge to be an input in production that has increasing marginal productivity. Further, the model is basically a competitive equilibrium model with endogenous technological change, unlike the approach followed by exogenous growth theory.

---

[6] External economies of scale with respect to endogenous growth theory, when viewed for the economy as a *whole* or a specific industry, relates very much to knowledge-intensive activities. An example of this is the expansion of 'silicon valley' in California, USA where rapid advances in technology and human capital development in such knowledge-intensive industry has led to positive externalities in the information technology sector and other sectors of the economy.

The Romer model presents an alternative view to long-run growth. It stipulates that the rate of investment, and the rate of return on capital can increase rather than decrease with increases in capital stock. Given that preferences, technology and even population size are held constant, this condition results in the general recommendation that the level of per capita output need not converge in different countries, and growth might therefore be consistently slower in LDC's if growth results at all. The critical factor in the Romer long-run growth model is a departure from the normal assumption of diminishing returns (Romer, 1986: 1003).

Todaro (2000) and Thirlwall (1999) propose certain factors that have provided impetus for the development of the new growth theory. Todaro (2000: 99 – 100) says that neoclassical growth theory fails to expound the sources of long-run growth. The neoclassical model implies that factors not attributed to short-run adjustment in capital/labour are allocated to the Solow *residual*. The Solow *residual* captures those variables that are outside of Solow's neoclassical model and hence the name exogenous growth theory. The Solow *residual* is thus seen as a catchall or error variable attempting to capture the process of technological change. However this *residual* accounts for approximately 50 percent of historical growth in industrialised nations. Thus the neoclassical approach attributes the majority of economic growth to an exogenous source or independent process of technological change. The new growth, or endogenous growth theory is so named, as capital, labour and technology are all endogenous variables in the model. Thus new growth theory attempts to explain the Solow *residual* as an endogenous component of economic growth.

The exogenous feature of the neoclassical growth model has two implications. Firstly, it is impossible to study the actual determinants of technical advance, as they are exogenous to the model, and thus assumed independent of the decisions of economic agents. Secondly, neoclassical theory cannot explain large differences in *residuals* across nations with similar technology (Todaro, 2000: 100). Thus there was growing concern in the 1980's and 1990's, due to the increase in third world debt, and the neoclassical model's failure to explain increased divergence or differences in economic performance across countries.

Thirlwall (1999: 115) cites several reasons for increased research into the new growth theory. Firstly, there is heightened concern about the economic performance of poor countries, and the growing divergence between countries and continents. Secondly, the availability of suitable secondary data has contributed largely to sound econometric analysis of the above factors. Thirdly, the work of development pioneers like Baumol (1986) have found that no convergence in per capita incomes has occurred anywhere around the world, and this refutes the neoclassical theory to a large extent.

To explain why growth is viewed as being endogenous in the approach followed by the new growth models, Thirlwall (1999) uses the concept of positive externalities whereas Todaro (2000) explains this with respect to the Solow *residual.* In discussing the positive externalities of new growth theory, Thirlwall (1999: 115) refers to the pioneering studies undertaken by Romer (1986, 1990) and Lucas (1988) saying that these are as a direct result of human capital development (education and training) and research and development. This is said to be particularly evident in knowledge-intensive industries like the information technology and telecommunication sectors. Additional factors that are endogenous to new growth theory and therefore affect productivity and economic growth are learning by doing, and associated technical progress (Arrow, 1962 and Kaldor, 1957), technological spillovers from trade (Grossman and Helpman, 1990; 1991) and foreign direct investment (De Mello, 1996).

2.2.5 The Structural Approach to Growth

The structural and Kaldorian approaches to growth are both post Keynesian models. The pioneering studies of growth tended to follow the neoclassical approach, but the introduction of the structural approach (1950's to present) heralded a new era. The structural view was unique in that it included neoclassical sources of growth plus the reallocation of resources to higher-productivity sectors; the attainment of economies of scale, learning by doing, and the reduction of internal and external bottlenecks in the production process. The concept of reallocation of resources to higher-productivity sectors (the manufacturing sector in particular), increasing returns and learning effect are all important features in the Kaldorian approach to growth theory.

The structural approach is more concerned with the differences amongst *sectors* of the economy that deter equilibrium adjustments in resource allocation implied by the neoclassical theory. It can be said that disequilibrium is more evident in the discrepancy between returns to labour and capital in differing uses than by shortages and surpluses that prohibit market clearing. In contrast, the neoclassical theory assumes that equilibrium is maintained over time through flexibility of prices, which limits the sources of growth to supply-side factors only (Chenery, 1986: 16).

The structural approach however identifies some factors that make full adjustment unlikely (similar to a Keynesian approach to growth theory that assumes an equilibrium below full employment or Y_f). An example of this would be a labour market where population is growing too fast to be absorbed into the high-productivity sectors of the economy. Thus elastic supply of unskilled labour results, located mainly in the agricultural and service sectors (Chenery, 1986: 15). The idea of surplus labour in the agricultural sector is consistent with the Lewis (1954 and 1958) model that explains the complementary relationship between industry and agriculture. This concept also forms the foundation to the Kaldor growth model as surplus labour is needed to boost industrial output, a sector subject to increasing returns. Hence a brief discussion surrounding the structural approach is a suitable forerunner to discussing the Kaldor growth theory that will be discussed in chapter three.

2.3 Summary and Conclusion

To summarise, Todaro (2000) presents three key factors (capital accumulation, population and labour force growth and technological progress) that are viewed as components or sources of economic growth. These factors are tabulated to give a concise comparison of how the three major growth theories, discussed so far, differ from one another with respect to each relevant component.

Table 2: Summary of the Major Growth Theories

SOURCES/COMPONENTS OF GROWTH		MAJOR THEORIES OF GROWTH		
		Harrod-Domar	**Neoclassical (Solow)**	**New (Endogenous) Growth (Romer)**
1	**Capital Accumulation**	Increase in capital stock attained via increase in savings rate	Savings rate and investment important for increase in capital stock and capital-labour ratio	Stresses importance of both human and physical capital stock
2	**Population and Labour Force Growth**	Proposes natural rate of growth (g_n) but does not guarantee Y_f	Growth can be achieved by increasing labour force quantity and quality	Human capital and knowledge development are endogenous to model
3	**Technological Progress**	Model doesn't consider technology	Technology seen as exogenous variable and forms part of Solow *residual*	Technology seen as endogenous variable especially important in human capital and knowledge-intensive industries

The discussion undertaken above makes a detailed analysis of the mechanics underpinning the major growth theories identified after their originators namely, Harrod (1939) and Domar (1947), Solow (1956) and Romer (1986) growth models. These models, along with a brief discussion surrounding the structural approach, were reviewed to provide background and context for Kaldor's growth theory, which is the focus of this study. The Harrod-Domar approach explains economic growth in terms of the interaction between the savings rate, rate of growth of the labour force and the capital-output ratio. In this model full employment or Y_f cannot be guaranteed and technology is assumed to be exogenous to the model. The Solow model states that the savings and investment rate are important for increases in the capital stock and capital-labour ratio, whereas the quantity and quality of the labour force are important for growth. Once again, technology is assumed to be exogenous to the Solow model, hence the reason the Harrod-Domar and Solow approaches are referred to as exogenous growth models.

The Romer model nevertheless stresses the importance of both the human and physical capital stock. Human capital development, physical capital stock and technology are now all endogenous to the Romer model. In the Romer model, knowledge is seen as an input variable to the production function and competitive equilibrium is consistent with increasing aggregate returns due to externalities. Thus unlike the more traditional (exogenous) growth model, Romer postulates that knowledge exhibits increasing marginal productivity. This means the production of goods from increased knowledge exhibits increasing returns. Thus knowledge shows signs of increasing marginal productivity (Shaw, 1992). Much of what has become known as endogenous growth theory, encompasses the process of learning by doing and the macroeconomic effect of human capital development, which all implies increasing returns to industry. Therefore endogenous growth theory is, as will be shown in the next chapter, closely related to the economic theory underpinning the Kaldorian growth model (in this sense we might say that Kaldor's theory of economic growth was before its time).

CHAPTER THREE
THE KALDORIAN APPROACH TO ECONOMIC GROWTH

3.1 Introduction

Professor Lord Nicholas Kaldor (1908 – 1986) made original and important contributions to the theory of the firm, to Keynesian economics, to growth and distribution theory, to equilibrium economics, and to thinking about domestic and international economic policy (Targetti and Thirlwall, 1989: 1). This chapter focuses on Lord Kaldor's contribution to growth and distribution theory, and discusses the Kaldor growth model with special reference to three regularities that have become known as Kaldor's growth laws (Parikh, 1978; Thirlwall, 1983; McCombie and de Ridder, 1983; McCombie, 1983; Mizuno and Ghosh, 1984; Drakopoulos and Theodossiou, 1991). These three laws, and their application with regard to the South African economy, form the basis for this thesis.

Kaldor's original research question was to analyse why growth rates might differ for advanced capitalist countries at similar stages of development. An attempt to answer such an intriguing question came in two sets of lectures delivered in 1966, the most prominent of which was Kaldor's Inaugural Lecture at Cambridge University in November, entitled "Causes of the Slow Rate of Growth of the United Kingdom." In these lectures, Kaldor presented a series of *laws* that have come to form the foundation of a model that explains the applied economics of growth (Thirlwall, 1987: 184). These laws have profound consequences for understanding the different growth rates of the advanced countries (McCombie and de Ridder, 1983: 373).

The general conclusion of the Kaldorian model is that growth in manufacturing output is positively related to the growth in overall GDP (law one), growth of productivity in manufacturing (law two) and growth of productivity in non-manufacturing (law three) respectively. Thus the growth of manufacturing output leads to a rise in productivity of non-manufacturing activities and hence overall economic growth. In this sense, the manufacturing sector is deemed to be the driving force behind economic growth.

3.2 The Kaldor Growth Model

3.2.1 Introduction

Research[7] has shown that a close association exists across countries between the growth of industry and the growth of GDP. More specifically, GDP growth is faster, the greater the *excess* of industrial growth relative to GDP growth, or when the share of industry in total GDP is rising the fastest (Thirlwall, 1999: 78).

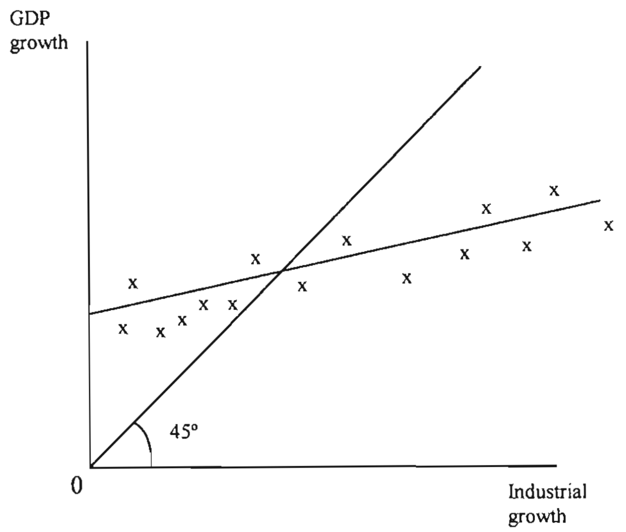

Figure 2: The Kaldorian Hypothesis
Source: Thirlwall (1999: 78)

Figure 2 shows the quintessential Kaldorian hypothesis as outlined above, where GDP growth is measured on the vertical axis and industrial growth is measured on the horizontal axis. The scatter points represent observations for individual countries. A hypothetical line drawn through the points with a slope less than unity (slope here is defined as GDP growth *divided*

[7] For example, see the Symposium on Kaldor's growth laws, edited by A. P. Thirlwall in the *Journal of Post Keynesian Economics*, Spring 1983; Bairam (1991); Drakopoulos and Theodossiou (1991); Hansen and Zhang (1996).

by industrial growth) or points to the *right* of the 45° equilibrium line, shows that the greater the *excess* of industrial growth over GDP growth, the faster GDP seems to grow. The 45° equilibrium line, gives the average growth rate that divides countries between those where the share of industry is falling and are growing slowly overall, and those where the share of industry is rising and are growing fast overall.

This thesis estimates statistical relationships pertaining to growth that arise from the predictions of Kaldor's growth model. The original approach adopted by Kaldor (1966) was used to explain "growth rate differences between advanced capitalist countries" (Thirlwall, 1983: 345). Section 3.2.2 gives a brief exposition of the propositions surrounding the Kaldorian approach to economic growth. Sections 3.2.3 – 3.2.5 then make a more detailed discussion of Kaldor's three laws of growth that will be empirically analysed in this thesis. In past studies, these laws have been tested in developed and developing countries using both cross-section (across countries) and time series data. This thesis uses the time series approach and is consistent with the study undertaken by Drakopoulos and Theodossiou (1991).

3.2.2 Basic Model Propositions

This section briefly discusses the basic propositions of the Kaldor growth model. The seven points that follow are taken from Thirlwall (1983: 345 - 347). Propositions six and seven refer to how the open economy influences the Kaldorian approach, but for the purpose of econometric testing, these issues are beyond the scope of this thesis. Thirlwall does note that these basic propositions are not as Kaldor originally stated them, but have come to be the foundations of the Kaldorian model, as researchers understand it today.

1. The faster the rate of growth of the manufacturing sector, the faster is the rate of growth of GDP, not merely because manufacturing output is a large constituent of overall output, but for essential economic reasons associated with induced productivity growth, both inside and outside the manufacturing sector. This is by no means a new concept, and is the reason for the manufacturing sector being termed the *engine of growth*. Many other growth theorists

have also remarked on the significance of the manufacturing sector for economic growth (Solow, 1970).

2. The faster the rate of growth of manufacturing output, the faster the rate of growth of labour productivity in manufacturing owing to static and dynamic economies of scale, or increasing returns in the most far-reaching sense (the idea of static and dynamic economies are discussed in more detail in section 3.2.3 that outlines Kaldor's first law). Kaldor, in the spirit of Allyn Young (1928), viewed returns to scale as a macroeconomic occurrence linked to the interaction between the elasticity of demand for, and supply of manufactured products. This important interaction is what accounts for the positive relationship between manufacturing output and productivity growth, more commonly referred to as Verdoorn's Law.[8]

3. The faster the rate of growth of manufacturing output, the faster the rate of labour being transferred from other sectors of the economy that are subject to diminishing returns, or where there is no relationship between employment growth and output growth. A decline in labour input in these sectors tends to raise productivity growth outside of manufacturing. Owing to increasing returns in manufacturing, and induced productivity growth in non-manufacturing, we expect that the faster the rate of growth of manufacturing output, the faster the rate of growth of productivity in the overall economy.

4. As the possibility for labour transfer from diminishing returns activities dries up, or as output comes to depend increasingly on employment in all sectors of the economy, the extent of overall productivity growth induced by manufacturing growth declines, with the overall rate of growth declining as well.

5. Kaldor later came to believe that it was in the latter sense in point four above that countries at an advanced stage of development, with little or no surplus labour in agriculture or non-manufacturing activities, are subject to a "labour shortage" and experience a deceleration of

[8] Verdoorn, P.J. (1949) Fattori che Regolano lo Sviluppo della Produttivita del Lavoro, *L'Industria*, Vol. 1, pp. 3 – 10.

growth. Kaldor's original contention that, manufacturing output is constrained by a shortage of labour, and this he proposed was the UK's problem, was later retracted (Kaldor, 1978).

6. The growth of manufacturing output is *not* constrained by labour supply, but is more importantly determined by demand from agriculture in the early stage of development, and export demand in the later stage. Export demand is seen as the main component of autonomous demand in an open economy, which must equate to the leakage of income into import demand. Hence the level of industrial output must adjust to the level of export demand relative to the propensity to import, via the functioning of the Harrod trade multiplier.[9] Essentially, the rate of growth of output equates to the rate of growth of exports divided by the income elasticity of demand for imports (Thirlwall, 1979).

7. A fast rate of growth of exports and output tends to invoke a cumulative process, or virtuous circle of growth (sustained process of economic growth), through the association between output and productivity growth. The lower costs of production in fast growing economies make it harder for other (newly industrialising) economies to establish export activities with favourable growth tendencies, except where these newly industrialising economies have exceptional industrial enterprise.

3.2.3 Kaldor's First Law

The first law postulates that there exists a positive relationship between the growth of GDP (g_{GDP}) and the growth of manufacturing output (g_m) (Drakopoulos and Theodossiou, 1991). Hence "a fast rate of economic growth (g_{GDP}) is associated with a fast rate of growth of the manufacturing sector of the economy (g_m)" (Thirlwall, 1983: 347):

$$g_{GDP} = a_1^1 + b_1^1(g_m) \qquad b_1^1 > 0 \qquad (1.1)$$

[9] The implications of the Harrod trade multiplier are beyond the scope of this thesis. For an exposition and discussion thereof, see Kennedy and Thirlwall (1979) and Thirlwall and Vines (1982).

In equation (1.1)[10] b_1^1 represents the functional relationship that Kaldor hypothesised to be positive (Thirlwall, 1999: 79). The slope coefficient (b_1^1) must be positive, as a negative slope coefficient would imply a situation where the share of industry in the total economy is falling, and hence growth in overall GDP is declining. This would be tantamount to saying that the manufacturing sector is not driving overall economic growth, a situation contrary to a priori economic theory. Kaldor's original study considered a cross-section of twelve developed countries, and estimated the following relationship between g_{GDP} and g_m:

$$g_{GDP} = 1.153 + \underset{(0.040)}{0.614} g_m \qquad R^2 = 0.959$$

According to Kaldor (1975: 893) and Thirlwall (1987: 186) an important property of the above estimated regression equation is that the slope coefficient (0.614) is significantly less than unity. This implies that the greater the *excess* of the rate of growth of manufacturing output (g_m) over the rate of growth of the overall economy (g_{GDP}), the faster the overall growth rate. If we set $g_{GDP} = g_m$ it is shown that growth rates above 3 percent are found *only* in countries where the rate of growth of manufacturing *exceeds* the overall growth rate of the economy or alternatively, where the share of the manufacturing sector in the overall economy is increasing. Therefore equation (1.1) does not capture the idea of increasing or decreasing returns, *per se*, but rather shows for what level of economic growth manufacturing is in *excess* of overall economic growth. In this sense, it can be said that growth in manufacturing is driving overall economic growth.

Kaldor argued that the relationship given in equation (1.1) is characteristic of the transition from "immaturity" to "maturity," where "immaturity" is a situation in which productivity is lower in activities outside of industry (agriculture in particular) and labour is in relatively abundant supply for use in industry (Thirlwall, 1983: 347). In the literature, the sector that provides surplus labour, is generally thought of as agriculture, because in the early stages of

[10] Note that the intercept and slope coefficients in all equations use a sub-script and super-script. The sub-script shows which of Kaldor's laws are being estimated (i.e. law one, two or three) whereas the super-script shows which specification is estimated for each of the three laws. Therefore the super-script does *not* indicate that the parameter values are in power-form.

development a large portion of the population derives its living from agriculture.[11] However surplus labour, or disguised unemployment in the services sector, had been just as prevalent in Victorian England, as in India, or Latin America in the 1970's, as there were large numbers of people who derived a living in urban areas as hawkers, petty tradesman, servants and the like on very low earnings (Kaldor, 1968: 387).[12]

The specification given in equation (1.1) is essentially the crux of the Kaldor argument, and if there is a strong and positive relation estimated for the above regression equation, this is tantamount to establishing the view that the industrial sector, manufacturing in particular, is the driving force behind economic growth in a country. However what accounts for the fact that the faster manufacturing output grows relative to GDP, the faster GDP seems to grow? Alternatively, what is special about industry, and manufacturing in particular, which accounts for the empirical association given in equation (1.1) and which makes industry the *engine of growth*? Thirlwall (1983: 349; 1999: 78) states that differences in the growth of GDP are generally credited to differences in the rate of growth of labour productivity. This means that the expansion of the manufacturing sector leads to a rise in overall productivity (Drakopoulos and Theodossiou, 1991: 1684). This is expected for several reasons (Thirlwall, 1983).

---

[11] The re-allocation of labour is captured in the Lewis model (1954 and 1958) where the economy consists of two sectors. Firstly, a traditional, ***rural subsistence sector*** with very low productivity surplus labour and secondly a high productivity modern ***urban industrial sector*** into which labour from the former sector is slowly transferred (Todaro, 1982: 233). Due to low productivity in agriculture, many developing countries, being agriculture dependent, experience slow rates of development and growth (Thirlwall, 1999: 127). An explanation for the existence of labour surplus is analogous to Keynes' definition of involuntary unemployment where a labour surplus exists when a faster rate of increase in the demand for labour in the high-productivity sectors causes a faster rate of labour-transference even when it is attended by ***a reduction, and not an increase, in the earnings-differential between the different sectors*** (Kaldor, 1968: 386). According to Lewis, the existence of surplus labour in the factor contribution process plays a major role in development and growth. Labour transfer in the Lewis model is explained by the wage differential between the traditional agricultural sector and the urban industrial sector. Lewis assumed that urban wages would have to be at least 30 percent higher than the average rural income to induce workers to migrate (Todaro, 1982: 233). This idea of labour abundance or surplus labour in chiefly diminishing returns activities (agriculture in particular) that can be transferred to increasing returns activities (industry in particular) is a basis for Kaldorian growth theory.

[12] According to Kaldor (1968: 387) this relates to both the self-employed and employees alike. In the population Census of 1891, 15.8 percent of the economically active population was employed as domestic servants. In the Census of 1961 the figure was 1.4 percent. The reduction cannot be explained with respect to a shift in consumer preferences or by the assumption that domestic services is an inferior good with a negative income elasticity of demand, but rather by the growing absorption of surplus labour in the economy which led to a rise in wages for domestic services in *excess* of the general rise in wages.

Firstly, where industrial production and employment are rising, additional labour inputs are drawn from other sectors that have disguised unemployment (where there is no relation between employment and output). The existence of surplus labour, or disguised unemployment in the low-productivity sectors of the economy (agriculture and services being the two predominant sectors) means that labour can be transferred to manufacturing without an adverse impact on the output of these sectors (Kaldor, 1968: 386). Likewise, the expansion of industry automatically causes an increase in the stock of capital employed in industry. Hence in activities outside of manufacturing that are subject to diminishing returns, the marginal product of labour is less than the average product of labour (Thirlwall, 1999: 78). Consequently, as labour is drawn from these activities into industry as industry expands, the marginal product of labour (representative of labour productivity) rises in non-industrial activities.

The second reason encompasses the existence of increasing returns, both static and dynamic. This means a relation is to be expected between the growth of industrial output, and the growth of labour productivity in industry. Static returns are indicative of large-scale production whereby the mass production of commodities leads to them being produced at a lower average cost (Thirlwall, 1999: 78). Dynamic returns relate to the induced effect that industrial output growth has on capital accumulation and the characteristic of new technical progress in capital, external economies in production and the like (Thirlwall, 1983: 349). Labour productivity also increases, as industrial output grows through the process of learning by doing (Thirlwall, 1999: 78). Human capital, being representative of the training and education of the factor labour input, leads to more trained scientists and engineers for example and can accelerate research, development and hence labour productivity. An increase in labour productivity brought about by human capital development is a fundamental concept in both Kaldorian and new growth or endogenous growth theory.

A third reason surrounds the presence of economies of scale, or increasing returns to scale, which causes productivity to rise in response to, or as a by-product of the increase in total output. Classical economists contend that manufacturing activities are subject to the "law of increasing returns", the origin of this doctrine, credited to Adam Smith[13] in his famous treatise *Wealth of Nations.* Adam Smith argued that the return per unit of labour input (now commonly referred to as productivity) depends on the division of labour: specialisation and the division of production into many different processes as shown by his famous example of pin-making. In Smith's own explanation, the division of labour is dependent on the size of the market, and the greater the market, the greater the degree to which differentiation and sepcialisation takes place, leading to a rise in productivity (Kaldor, 1966: 287).

Kaldor (1966: 288) stated that Allyn Young[14] viewed increasing returns as a "macro-phenomenon". Although so much of the economies of scale emerge as a result of increased differentiation, the development of new production processes and new subsidiary industries, they cannot be "discerned adequately by observing the effects of variations in the size of an individual firm or of a particular industry." (Young, 1928, cited by Kaldor, 1966: 288) At any particular point in time, there are industries where economies of scale have stopped being important. They may nonetheless, benefit from a general industrial expansion which, as Young said, should be "seen as an interrelated whole". With the extension of the division of labour principle "the representative firm, like the industry of which it is a part, loses its identity". It is in this sense, the "macroeconomic" sense, that Kaldor views increasing returns to manufacturing or the industrial sector, as having a positive impact on overall productivity and economic growth.

The fact that growth of manufacturing output correlates positively, or highly with the growth of GDP is not a surprising result, as the manufacturing sector does constitute a reasonably large portion of GDP. In Kaldor's original study (1966) he noted that, for the countries surveyed, manufacturing contributed approximately 25 – 40 percent of total GDP. In South Africa, for the study period 1946 – 1998, on average, manufacturing contributed about 18.4 percent and the overall secondary sector contributed about 26.1 percent to overall GDP. This is consistent with the study undertaken by Drakopoulos and Theodossiou (1991: 1683) for the Greek economy, where the share of manufacturing in the overall GDP increased from 11.5

[13] Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*, London: Macmillan edn., 1936.

[14] Young, A. (1928) Increasing Returns and Economic Progress, *Economic Journal*, Vol. 38, December, pp. 527 – 542.

percent in 1951 to 21 percent in 1973. However Bairam (1991: 1277) believes that the specification for equation (1.1) *could be* spurious as g_{GDP} and g_m are related by definition. However Thirlwall (1983: 348) says the strong relationship between the two variables is *not* merely because manufacturing output contributes a large share of total output because equation (1.1) rather measures the *excess* of manufacturing output over total output.

The argument that the strong correlation between g_{GDP} and g_m is because manufacturing output constitutes a large proportion of total output is refuted, if there is a strong relation between the growth of non-manufacturing output (g_{nm}) and the growth of manufacturing output as given in equation (1.2). Thirlwall (1983: 348) found that there was an almost identical relation between g_{nm} and g_m hence the results for equation (1.1) and (1.2) were quite similar:

$$g_{nm} = a_1^2 + b_1^2(g_m) \quad b_1^2 > 0 \qquad (1.2)$$

Another implication of law one is that there must also be a positive relationship between the overall rate of economic growth and the *excess* of the rate of growth of manufacturing output over the rate of growth of non-manufacturing output (Thirlwall, 1983; Drakopoulos and Theodossiou, 1991). This is given in equation (1.3):

$$g_{GDP} = a_1^3 + b_1^3(g_m - g_{nm}) \quad b_1^3 > 0 \qquad (1.3)$$

From the analytical framework expounded with respect to law one, there should be no correlation between the rate of growth of GDP and either the growth of agriculture (Thirlwall, 1983: 348; Drakopoulos and Theodossiou, 1991: 1684) or mining (for the purpose of the South African economy) because growth in the Kaldorian model is industry-led.

However there should be a correlation between the growth of GDP, and the growth of services (equation 1.4 in chapter four), and the relation, in Kaldor's original study, was nearly one-to-one. Kaldor contended that the direction of causation is most likely to be from the growth of GDP to service sector growth, rather than the other way around (Thirlwall, 1983:

348). This strong positive correlation with a regression slope coefficient not statistically different from unity is because the demand for services is a result of the demand for manufacturing output itself (Drakopoulos and Theodossiou, 1991: 1684). Likewise, the demand for most services can be seen as being derived from the demand for manufacturing output (equation 1.5 in chapter four) and hence the expectation that the slope coefficient is positive. The growth of industry itself gives rise to the growth of services of many kinds, which are both complementary and ancillary (demand for services like transport, distribution, accountancy, banking services etc. are derived from, but do not generate industrial activities) to the industrial sector. Thus total employment in services tends to increase during the process of industrialisation, though less (in relation to the growth of total output) when the growth in total output is relatively fast (Kaldor, 1968: 387).

Alternatively, other specifications for law one will be tested in light of the unique structure of the South African economy. This includes regressing, in turn, the growth of GDP on the growth of the overall primary sector, the growth of agriculture, forestry and fishing, the growth of mining and quarrying and the growth of the overall industrial or secondary sector (equations 1.6 to 1.9 in chapter four).

3.2.4 Kaldor's Second Law

The faster growth of manufacturing output generates faster growth of productivity in the manufacturing sector, due to static and dynamic returns. This second law is commonly referred to as Verdoorn's law (Verdoorn, 1949, 1980; Thirlwall, 1983) after the Dutch economist P.J. Verdoorn who first found such a relationship for Eastern European countries in the 1940's. Productivity can be defined as:

$$p = q - e$$

In the above explanation for productivity, p is the annual rate of *growth* of productivity, q is the annual rate of *growth* of output and e is the annual rate of *growth* of employment. An important point to note is that all observations for p, q and e are in percentage change format, so as to represent the percentage *growth* from one year to the next. Thus as all level-form variables are in percentage change format, we can say that productivity growth is measured as output growth minus employment growth or $p = q - e$.[15] In considering the second and third laws, use will be made of the above formulation of productivity growth for the manufacturing and non-manufacturing sectors.

For the manufacturing sector this relation shows that there is a positive relationship between the rate of growth of labour productivity in the manufacturing sector, and the rate of growth of manufacturing output (Kaldor, 1966: 306; Thirlwall, 1983: 350; Drakopoulos and Theodossiou, 1991: 1685; Delivani, 1992: 1357). In general, since increasing returns are associated with the manufacturing or industrial sector, productivity increases in this sector. Therefore Kaldor's second law postulates that there exists a positive relationship between the rate of growth of labour productivity in the manufacturing sector (p_m) and the rate of growth of manufacturing output (g_m) (Drakopoulos and Theodossiou, 1991: 1685):

$$p_m = a_2^1 + b_2^1(g_m) \quad b_2^1 > 0 \qquad (2.1)$$

In equation (2.1) b_2^1 represents the functional relationship that Kaldor hypothesised to be positive (Thirlwall, 1999: 79). From equation (2.1) the coefficient of g_m is generally referred to as the Verdoorn coefficient and typically has a value of approximately 0.5 (Thirlwall, 1999: 80). Equation (2.1) is a very common formulation of law two, and has been used by other researchers (Stoneman, 1979; Thirlwall, 1983; Mizuno and Ghosh, 1984; Drakopoulos and Theodossiou, 1992).

However Kaldor (1975: 891) preferred to write equation (2.1) in the form shown in equation (2.2). This stems from the fact that Kaldor regarded the existence of a significant relationship

[15] If productivity is defined as output per labour input, then $P = Q/E$. If we now take logs, to obtain the linear form of this identity at time t, we have: $log\ P_t = log\ Q_t - log\ E_t$. If this relationship holds at time t, then it must hold at time t-1. Hence we now have: $log\ P_{t-1} = log\ Q_{t-1} - log\ E_{t-1}$. If we find the difference between the two equations above, we now have: $log\ P_t - log\ P_{t-1} = log\ Q_t - log\ Q_{t-1} - (log\ E_t - log\ E_{t-1})$. If logged variables are shown in lowercase, we now have $p = q - e$ where the lowercase variables represent the percentage growth of productivity, output and employment, respectively.

between the growth of employment and output as the main test for deciding whether the Verdoorn Law says something significant about reality, or whether it is a simple statistical mirage. Note that equations (2.1) and (2.2) are the mirror image of each other, or two different ways of looking at the same relationship since $g_m = p_m + e_m$ (Thirlwall, 1987: 189), thus the symbols used for equation (2.2) accord with those from equation (2.1), but vary in sign and size:[16]

$$e_m = -a_2^1 + (1 - b_2^1)g_m \qquad 0 < (1 - b_2^1) < 1 \qquad (2.2)$$

Equation (2.2) postulates that there exists a positive relationship between the rate of growth of employment in the manufacturing sector (e_m) and the rate of growth of manufacturing output (g_m). According to Delivani (1992: 1357) for economies of scale to exist, the coefficient for g_m should be approximately 0.5 in both equation (2.1) and (2.2) in order to guarantee that a rise in output leads to a rise in both productivity *and* employment. From equation (2.2) we see that an estimated value for b_2^1 of approximately 0.5 shows that a 1 percent growth in g_m leads to a 0.5 percent growth in e_m. This result implies that output growth exceeds employment growth in manufacturing, and hence overall labour productivity in manufacturing increases. This is indicative of increasing returns in the manufacturing sector of the economy.

Kaldor (1975: 893) concludes by stating that a *sufficient* condition for the presence of static or dynamic returns or economies of scale is the existence of a statistically significant relationship between e_m and g_m, with a regression slope coefficient which is significantly less than unity. A regression slope coefficient of unity, or close to unity would be of the neoclassical kind in that employment varies in a one-to-one relationship with output, and hence exhibits constant returns (Kaldor, 1975: 893). In the event of this condition not being fulfilled, there are certain possibilities. Firstly, there is a significant relationship, but the regression coefficient of e_m on g_m, is either not significantly different from unity (representative of constant returns) or is

[16] Equation (2.2) can be derived algebraically from equation (2.1) and hence the convention used in this instance of keeping the same nomenclature for both equations. This shows how the sign and size of the constant and regression slope coefficient vary respectively between the two equations. Given the identity $p = q - e$, then the mathematical specifications for equations (2.1) and (2.2) hold. See Thirlwall (1983: 352) and McCombie (1983: 415).

significantly greater than unity (representative of decreasing returns). Secondly, if there is no significant relationship between e_m and g_m at all, this is equivalent to saying that the Verdoorn Law has "broken down" (Cripps and Tarling, 1973) and hence the Verdoorn Law does not apply.

Kaldor's second law raises the question of whether increasing returns to scale and diminishing marginal product or marginal productivity of labour are incompatible. This contradiction is implied by the a priori expectation for b_2^1 in equation (2.1) that is found to approximate a value of 0.5 in cross-country research. This means that a 1 percent growth in manufacturing output leads to a roughly 0.5 percent growth of productivity in manufacturing and does not seem to imply increasing returns. However increasing returns to scale refers to scale of production, but not to input mix (variable input versus fixed input or variable input one versus variable input two). That is, it is possible to have increasing returns while marginal productivity declines.

To explain the above concept further, equation (2.2) shows whether increasing returns to scale exists, as it shows by how much manufacturing output is growing faster than employment growth in manufacturing, whilst holding capital constant in the input mix.[17] But, overall scale of production in manufacturing can be increased through the process of labour transfer, from non-manufacturing to manufacturing activities. On the other hand, equation (2.1) merely shows that overall productivity growth in manufacturing can be increased by the process of labour transfer. As the process of labour transfer continues more rapidly, in the latter stages of development, overall productivity may still be positive (total product is still positive) but the rate of change in productivity or marginal productivity of labour in manufacturing is declining. Hence the compatibility of increasing returns to scale and diminishing marginal product. Thus equation (2.1) shows whether, overall, productivity in manufacturing is increasing, but may *not* assert anything (Kaldor, 1975: 892) *per se*. If for instance, the regression slope coefficient for equation (2.2) is 0.7 as opposed to 0.5 then, mathematically, the regression slope coefficient for equation (2.1) must now be 0.3 as opposed to 0.5. This

[17] McCombie (1983) states that the specification given in equation (2.2) may be sufficient to establish the presence of economies of scale, but this depends upon the assumption concerning the rate of growth of capital.

implies that the growth of labour productivity in manufacturing, given by equation (2.1), is still positive and greater than zero, but shows that labour productivity is declining. A value greater than 0.5 for b_2^1 in equation (2.1) means the value for $(1-b_2^1)$ in equation (2.2) will now be less than 0.5, by derivation, and this may suggest the presence of scale economies that are particularly evident in the early stages of development (Thirlwall, 1999: 80).

However some doubt has been raised as to what is cause and what is effect in Kaldor's proposed specification given in equation (2.1). Hence the direction of causation is brought into question. Some theorists have proposed that the direction of causation could be from faster productivity growth, to faster output growth as faster productivity growth means demand expands more rapidly through relative price changes. Thus in this sense, productivity growth would be autonomous. However Kaldor argues that this does not adequately explain large discrepancies in productivity growth in the same industry over the same time period in different countries (Thirlwall, 1983: 350).

If productivity growth in manufacturing is faster, the faster the rate of growth in manufacturing output, and this is the driving force behind overall economic growth in countries where the share of manufacturing is increasing, one must ask what determines the growth of manufacturing output? The explanation for this is revealed to some degree in demand factors, and to some degree in supply factors. Both components, when combined, lead to fast growth, a characteristic of the intermediate stage of economic development. "Following the arguments of Allyn Young, the more demand is focused on commodities with a large supply response, and the larger the demand response (direct and indirect) induced by increases in production, the higher the growth rate is likely to be." (Thirlwall, 1983: 351)

3.2.5 Kaldor's Third Law

The faster growth in manufacturing output leads to faster growth in productivity outside of manufacturing, or in sectors other than manufacturing. This occurs as manufacturing draws labour and other resources from non-manufacturing activities, without having a concomitant reduction in output in these other sectors. This process implies increasing labour productivity in the non-manufacturing sector. The degree to which this process takes place varies from economy to economy, but in a mature, industrialised economy, there may be little or no scope for such labour/resource transfer, which tends to slow growth in such an economy.

In describing his notion of "economic maturity" Kaldor (1975: 385) stated this explicitly "as a state of affairs where *real* income per head had reached broadly the same level in the different sectors of the economy." In this sense, there would be reduced scope for labour transfer from agriculture to manufacturing, for instance. Hence this is a situation where surplus labour is exhausted, and the end of the dual economy begins, as "growth with unlimited supplies of labour" (using the phrase coined by Arthur Lewis), is no longer possible. Bairam (1991: 1277) states that the industrial sector is the engine of growth, not only due to surplus labour and low productivity in the non-industrial sectors, but also because it generates extra demand for output supplied by the non-industrial sectors (Cornwall, 1976, 1977).

Kaldor (1968: 386) contends that it is the rate at which labour is transferred from the surplus-sectors to the high productivity sectors, which determines the growth rate of productivity for the overall economy. The major part of this process concerns the fact that the growth of productivity is accelerated as a result of the transfer at both ends, both the gaining-end and the losing-end. Firstly, because of increasing returns, productivity in industry rises faster given the faster output expands, and secondly, when the surplus-sectors lose labour, the productivity of these sectors is also bound to rise.

The Third law postulates that there exists a positive relationship between the growth of manufacturing output, and the growth of productivity outside of manufacturing or productivity in non-manufacturing (p_{nm}):

$$p_{nm} = a_3^1 + b_3^1(g_m) \quad b_3^1 > 0 \qquad (3.1)$$

In equation (3.1) the regression slope coefficient b_3^1 represents the functional relationship that is assumed to be positive (Thirlwall, 1999: 79). From equation (3.1), we can say that the faster the growth of manufacturing output, the faster the rate of labour being transferred from non-manufacturing to manufacturing. This means that overall productivity growth is positively correlated with the growth of output and employment in manufacturing, but negatively correlated with the growth of employment outside of manufacturing (Thirlwall, 1983: 354).

Thirwall (1999: 80) proposes an alternative approach to estimating law three as it may be difficult to establish productivity growth in numerous activities outside manufacturing, especially the service sector where output can only be measured by inputs, for instance teaching, healthcare and the civil service. Thus we can test the postulated relationship for law three indirectly by regressing overall productivity growth, or the rate of growth of GDP per employed person (p_{GDP}) (Kaldor, 1975: 894) on employment change in non-industrial, or non-manufacturing activities (e_{nm}) holding constant the effect of output growth in industry or manufacturing (g_m) (Drakopoulos and Theodossiou, 1991: 1685). This relationship is given in equation (3.2) and the expectation is that c_3^2 is less than zero (Thirlwall, 1999: 80; Cripps and Tarling, 1973). This particular specification for law three was used to test the Kaldorian approach to regional economic growth in China (Hansen and Zhang, 1996):

$$p_{GDP} = a_3^2 + b_3^2(g_m) + c_3^2(e_{nm}) \quad c_3^2 < 0 \qquad (3.2)$$

Another specification of the third law can be used to reconcile the a priori predictions posed. This means that overall productivity growth must be positively correlated with employment growth in manufacturing, and negatively correlated with the growth of employment in non-manufacturing (Thirlwall, 1987: 193; Drakopoulos and Theodossiou, 1991: 1685). This specification is given in equation (3.3) and once again the expectation is that c_3^3 is less than zero (Thirlwall, 1987: 193; Cripps and Tarling, 1973):

$$p_{GDP} = a_3^3 + b_3^3(e_m) + c_3^3(e_{nm}) \quad c_3^3 < 0 \qquad (3.3)$$

Cripps and Tarling (1973) find support for Kaldor's third law in that the sample of countries they surveyed, showed that the supply of labour from the primary sector (agriculture and mining) was consistently higher for countries with a faster growth of output. Also, the association is far stronger than for total employment growth, thus suggesting that the primary sector is a more vital source of labour in fast growing countries. This lends support to the Lewis growth model and the complementary relationship between industry and agriculture. Cripps and Tarling also find that a negative relationship exists between the growth of output and the absorption of labour by the tertiary sector (Thirlwall, 1983: 355), but no relation between the growth of output and employment in the non-manufacturing sector. This implies that, "growth can be accelerated by diverting labour to manufacturing where there is a correlation, and this is a plank in Kaldor's argument." (Thirlwall, 1983: 355)

The argument surrounding diminishing returns and increasing returns activities has important policy implications. Neglecting the manufacturing sector and foreign trade sector can be detrimental to growth. Long-run growth of output, in the neoclassical sense, cannot be viewed as being determined exogenously by the long-run rate of growth of the total labour force and technical progress. Thus the growth of labour force, capital accumulation and technical progress are mainly endogenous to the economic process dependent on the strength of export demand relative to import demand in an open economy (Thirlwall, 1983: 343).

An important implication of the assumptions underlying the Kaldor model is that economic growth is demand-induced (hence the Kaldor model being Keynesian in nature) and not resource-constrained. Economic growth is to be explained by the growth of demand, which is exogenous to the industrial sector[18] and not by the (exogenously given) growth rates of the factors of production, labour and capital, together with some (exogenously given) technical progress over time (Kaldor, 1975: 895). Finally, according to Kaldor (1975: 893), the remarkable correlation between the growth of GDP and the growth of manufacturing output, asserts that labour absorbed in manufacturing does not diminish output in the rest of the economy. This occurs because the existence of surplus labour in agriculture (and also

[18] According to Kaldor (1975) saying that growth is explained by the rise in demand, which is exogenous to the growing sectors, may be a simplification, but does not invalidate statistical inferences drawn from it. The growth of industrial output is governed in part by the growth of productivity, which in itself affects demand through the change in competitiveness induced by it. It is this reverse link that accounts for the cumulative and circular nature of growth processes. There is a bilateral relationship from demand growth to productivity growth and vice-versa, but the second relationship, in Kaldor's view, is far less regular and systematic than the first.

services) is only eliminated at a late stage of industrial development, or at the stage of "economic maturity".

3.2.6 Additional Laws

The inclusion of laws four and five are explained briefly, but are beyond the scope of this thesis. Law four extends the previous three laws to consider export demand for local manufactured goods, as well as demand outside of manufacturing. Hence Thirlwall (1983: 346) proposes a fourth law that states that faster growth in manufacturing depends on the growth of demand from outside manufacturing. The point that Thirlwall stresses is that outside demand may be in the form of exports to other countries which alleviate the balance of payments constraint on growth (Dixon and Thirlwall, 1975, 1979 and Cornwall, 1977). According to Scott (1989: 344) a fifth law could be included, "namely, that success breeds success and failure failure, but that seems implicit in the above four laws."

3.2.7 Summary

Sections 3.2.2 – 3.2.6 outline the theory and application of the Kaldor growth model. Sections 3.2.3 – 3.2.5 give a detailed explanation of the economic theory and a priori expectations surrounding Kaldor's three laws of economic growth. These three laws form the basis for the application of Kaldorian growth theory to the South African economy, which is the focus of this thesis. Essentially, we have shown that, according to the Kaldorian approach, growth in manufacturing output is positively related to the growth in overall GDP (law one), growth of productivity in manufacturing (law two) and growth of productivity in non-manufacturing (law three) respectively. This means that growth in manufacturing output has a more pervasive effect in that it leads to growth of productivity in the other non-manufacturing sectors of the economy, and hence drives overall economic growth.

3.3 The Industrial Sector and Manufacturing

In undertaking a study of this nature, controversy may arise as to the exact meaning of the industrial sector of an economy. This section briefly outlines what comprises the industrial sector, but more importantly, how past studies have distinguished between the overall industrial sector and manufacturing in testing Kaldor's growth laws. The overall industrial or secondary sector of an economy comprises three major categories or sub-groups according to the SIC, namely, manufacturing, construction and public utilities (electricity, gas and water). However certain studies use the term manufacturing to encompass all activities within the secondary sector, whilst others use this terminology to embody the strictest sense of the word, and hence *only* the manufacturing sector. Other studies have used manufacturing and construction together to explain industrial output.

To explain the meaning of the term *manufacturing* and the implications for growth, Kaldor (1966) stated, "the contention that I intend to examine is that fast rates of economic growth are associated with the fast rate of growth of the 'secondary' sector of the economy – *mainly the manufacturing sector* – and that this is an attribute of an intermediate stage of economic development: it is the characteristic of the transition from 'immaturity' to 'maturity'; and that the trouble with the British economy is that it has reached a high stage of 'maturity' *earlier* than others, with the result that it has exhausted the potential for fast growth before it had attained particularly high levels of productivity or *real* income per head."

Kennedy (1971: 112) stated that Kaldor (1966) contended that the link between output and productivity growth was typically associated with the secondary sector (industrial production including public utilities, construction and manufacturing) rather than with the primary (agriculture and mining) or tertiary sectors of the economy. Notwithstanding Kennedy's understanding of the term 'industrial sector' in Kaldor's own words, we are *mainly* concerned with the manufacturing sector's contribution to overall growth.

In the study conducted by Drakopoulos and Theodossiou (1991) the definition of industry includes both manufacturing and construction, "an established practice followed by a great number of theorists and students of the Greek economy" (Drakopoulos and Theodossiou, 1992: 1360) as the Greek economy is strongly characterised by the predominance of self-employed or small-scale building contractors. However studies that have tested the behaviour of the construction sector in the context of a Kaldorian model have found that it is very similar to the industrial or manufacturing sector (McCombie and de Ridder, 1983: 376 – 383). This indicates that the construction sector is not likely to have distorting effects (Drakopoulos and Theodossiou, 1992: 1360).

Drakopoulos and Theodossiou (1992: 1360) use *both* manufacturing and industrial output in their paper. This was to accommodate studies that used one or the other, or even both. In this thesis, manufacturing is used in the strictest sense of the word and adheres to the SIC definition for manufacturing. However in testing Kaldor's first law, equation (1.9) uses the overall secondary sector as the independent variable to see if the results for this specification differ significantly from the results estimated for equation (1.1).

To conclude on the topic of manufacturing and the debate surrounding the exact *meaning*, various commentators explicitly state that the choice of term is irrelevant to the argument at hand (Thirlwall, 1983). Drakopoulos and Theodossiou (1991: 1686) found quite similar slope coefficients for the Greek economy when regressing GDP growth on manufacturing growth and overall industrial sector growth respectively. Thus Drakopoulos and Theodossiou (1992: 1360) in replying to comments made by Delivani (1992) state that, "the results of the two separate formulations are very similar. This implies that even if construction is excluded, the validity of the model is not affected."

3.4 Conclusion

Chapter three outlined the basic propositions of the Kaldorian model of economic growth. In turn, a more detailed discussion was made surrounding the three laws as expounded by Kaldor (1966). These laws were also discussed with reference to a later study undertaken by Drakopoulos and Theodossiou (1991). In general, the growth in manufacturing output is positively related to the growth in overall GDP (law one), growth of productivity in manufacturing (law two) and growth of productivity in non-manufacturing (law three) respectively. Thus essential to understanding the Kaldorian approach is that, the industrial sector (manufacturing in particular) is the driving force behind overall economic growth. Central to the argument is that growth can be achieved by labour transfer from diminishing returns activities, (mining and agriculture in particular, but also services), to increasing returns activities (manufacturing or the industrial sector). This process implies that overall productivity can be increased without hampering output growth in the non-manufacturing sectors of the economy due to the existence of a labour surplus or disguised unemployment in these sectors. Given that productivity in non-manufacturing is rising and productivity in manufacturing is positive, this is representative of economic growth.

CHAPTER FOUR
EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the empirical results for the Kaldorian model of economic growth as applied to South Africa. The results reported are discussed with respect to each of the three Kaldor growth laws. One must note however that Kaldor's original study was undertaken to help explain growth differences between *advanced capitalist countries* (Kaldor, 1966). Further, the most rigorous test of the theory in question is to survey a cross-section of countries or a cross-section of regions within a particular country (Thirlwall, 1999: 79). Since this study is similar in nature to that undertaken in recent times (Drakopoulos and Theodossiou, 1991; Bairam, 1991) we make use of time series data for output and employment for the various SIC categories in South Africa.

4.2 Econometric Tests

4.2.1 Introduction

Before discussing the estimated regression results pertaining to Kaldor's three growth laws, a brief discussion of certain econometric testing procedures is made. These tests, amongst others, will be undertaken so as to validate the results obtained. The major tests that will be performed are the Ramsey RESET test for specification error, and the Durbin and Watson d test for autocorrelation. In the presence of first-order serial correlation or autocorrelation, the method of generalised least-squares (GLS) will be employed to obtain more efficient estimators.

4.2.2 Ramsey's RESET Test for Specification Error

An important assumption of the Classical Linear Regression Model (CLRM) is that the econometric model used in the analysis is correctly specified (Gujarati, 1995: 472). Thus in estimating the various functional forms for the postulated models (generally two-variable in nature and may exclude other possible explanatory variables for overall output growth and productivity growth), the Ramsey RESET test (1969) will be used to ascertain, if indeed, the models postulated suffer from either the omission of any possible variables or, more importantly, an incorrect functional form. Important to note in specifying the correct form of a model in econometric study, is that a statistical relationship between variables does not necessarily imply causation, but rather should be determined a priori, or by way of theoretical consideration (Gujarati, 1995: 21).

A distinct advantage of the RESET test is that it is relatively simple to apply, but a possible drawback is that it does not specify the alternative model to be used. Thus knowing that a model is mis-specified does not assist in specifying a more suitable alternative (Gujarati, 1995: 466). However in general, model mis-specification does not seem to be a problem in this study as shown by the results reported later in this chapter.

The following test is a general test for regression specification error, namely, RESET (Ramsey, 1969). The functional form of the model to be run and the steps are adapted from Gujarati (1995: 464 – 466).

1. From the estimated equation, obtain the predicted Y_i or $\hat{Y}_i$.
2. The OLS regression is now run with $\hat{Y}_i$ included as an additional regressor, but in a power form.

$$Y_i = \beta_1 + \beta_2 X_i + \beta_3 \hat{Y}_i^2 + \beta_4 \hat{Y}_i^3 + \beta_5 \hat{Y}_i^4 + u_i$$

3. From the above regression, obtain the new R^2 and this in turn will be used in conjunction with the old R^2 to calculate an F value to determine whether there is indeed a statistically significant increase in the overall fit of the new model.

$$F = \frac{\left(R^2_{new} - R^2_{old}\right) / \, number\ of\ new\ regressors}{\left(1 - R^2_{new}\right) / \left(n - number\ of\ parameters\ in\ the\ new\ model\right)}$$

4. The critical values of the F distribution (RESET test) for the two-variable model postulated in all three laws as well as the three-variable models postulated in laws two and three, are given in Appendix B, Table B.1. The null hypothesis for all RESET tests is that the model is correctly specified.

   Note that the sample size for law one is 52 observations, whereas the sample size for laws two and three are 26 observations respectively. In Table B.1, DF_1 refers to the degrees of freedom in the numerator and DF_2 refers to the degrees of freedom in the denominator. Critical values for the F distribution are given at the 1, 5 and 10 percent levels and are approximate values.

4.2.3 Durbin–Watson *d* Test for Autocorrelation

The term autocorrelation can be defined, in the modelling of time series data, as the correlation between members of series of observations ordered in time (Gujarati, 1995: 400). Simply put, "the classical model assumes that the disturbance term relating to any observation is not influenced by the disturbance term relating to any other observation." (Gujarati, 1995: 401) In the presence of autocorrelation, OLS estimators are still linear and unbiased as well as consistent (due to the OLS procedure), but are no longer efficient or no longer have minimum variance among all estimators (Gujarati, 1995: 410). Thus they are no longer 'best' or best-linear-unbiased-estimators (BLUE). A test for autocorrelation or serial correlation is that formulated by Durbin and Watson (1951) and will be performed to check for the presence of positive first-order serial autocorrelation.

The following test procedure is adapted from Gujarati (1995: 423).

1. Run the original OLS regression and save all residuals.
2. Calculate the d statistic using the following formula: Note, SHAZAM econometric package calculates this value routinely, as well as specifying the relevant RHO value.

$$d = \frac{\sum_{t=2}^{n}\left(\hat{u}_t - \hat{u}_{t-1}\right)^2}{\sum_{t=1}^{n}\hat{u}_t^2}$$

3. For law one, given the sample size (n) of 52 observations and number of explanatory variables excluding the constant term ($k' = 1$), the approximate critical limits for the lower and upper bounds at the 5 percent ($\alpha = 0.05$) level are $d_L = 1.503$ and $d_U = 1.585$. For laws two and three, where n is 26 observations, the critical limits for the lower and upper bounds at $\alpha = 0.05$ for $k' = 1$ are $d_L = 1.302$ and $d_U = 1.461$. Alternately, the critical limits for the lower and upper bounds at $\alpha = 0.05$ for $k' = 2$ are $d_L = 1.224$ and $d_U = 1.553$.

4.2.4 Remedial Measures: When the Structure of Autocorrelation Is Known

In reporting econometric results, the presence of serial correlation (autocorrelation) in the disturbances (u_t) has a direct bearing on the *reliability* of the estimated regression coefficients, as the OLS estimators are inefficient. Thus under OLS estimation that disregards autocorrelation, the usual t and F tests of significance are no longer valid, and may hence give erroneous conclusions regarding the statistical significance of the estimated regression coefficients (Gujarati, 1995: 411).

Since, for our purposes, the structure of autocorrelation (ρ) is known (as SHAZAM uses the Cochrane-Orcutt iterative procedure to estimate ρ, (Cochrane and Orcutt, 1949)) we can apply the method of GLS to transform all observations. Note that, the other procedures for estimating ρ yield "quite similar" results (Gujarati, 1995: 435) Hence using the procedure undertaken by SHAZAM is more than adequate for our purposes.

The OLS procedure can now be applied to the transformed variables. As the mathematical derivation of the GLS procedure is beyond the scope of this thesis, the reader can refer to Gujarati (1995: 427) for further details. The GLS regression is used to obtain more reliable or efficient OLS estimators. The procedure is given as follows, and will be applied where level-form regression results exhibit serial correlation. Note, that on observation of both the OLS (level-form variables) and GLS (transformed variables) regression results reported, there is generally no significant difference in the predictive power (R^2) of the models, coefficients, t and F tests, but rather that the problem of serial correlation is now corrected for.

$$Y_t^* = \beta_1^* + \beta_2^* X_{1t}^* + \beta_3^* X_{2t}^* + \varepsilon_t$$

Where:

$$\beta_1^* = \beta_1(1-\rho)$$
$$Y_t^* = (Y_t - \rho Y_{t-1})$$
$$X_{1t}^* = (X_{1t} - \rho X_{1t-1})$$
$$X_{2t}^* = (X_{2t} - \rho X_{2t-1})$$

Note, to avoid the loss of one observation (as the above process clearly uses a first-difference procedure) the first observation for Y, X_{1t} and X_{2t} can be transformed as shown below and uses the Prais-Winsten (1954) transformation. This is especially important when dealing with the regression results reported in small samples:

$$Y_1\sqrt{1-\rho^2} \quad ; \quad X_{1t}\sqrt{1-\rho^2} \quad ; \quad X_{2t}\sqrt{1-\rho^2}$$

4.2.5 Summary

This section has outlined the various econometric tests that will be performed on all estimated regressions. The Ramsey RESET test is used to check for model specification error whilst the Durbin-Watson test for autocorrelation is used to indicate the presence of serial correlation. If an estimated regression suffers from autocorrelation, the method of generalised least-squares will be used as a remedial measure to correct for autocorrelation and provide estimated results that are now BLUE.

4.3 Analysis of Empirical Results

4.3.1 Introduction

The following three sections discuss the estimated econometric results as obtained from SHAZAM for the three Kaldor growth laws. This section only presents the summarised results for models that are not autocorrelated or, where autocorrelation is detected, remedial measures have been taken and the summarised results are reported. However the results of all regressions undertaken are reported in Appendix D. All estimated regression models are appropriately labelled so as to accord with the equation numbers in chapter three. Further, note that variables with a star (*) represent autocorrelated-adjusted variables (tantamount to performing the GLS procedure) with the corresponding autocorrelated regression results being posted in Appendix D. Likewise, results for the RESET test that have two stars (**) indicate *acceptance* of the null (model is correctly specified) at the 1 percent level of significance whilst a cross (†) indicates *rejection* of the null hypothesis. The estimated regression results reported for all three of Kaldor's growth laws, generally support the Kaldorian approach. This means that economic growth in the South African context can be explained, to a large degree, by the Kaldorian model.

4.3.2 Kaldor's First Law

$$\hat{g}_{GDP} = 1.178 + 0.469 g_m \qquad (1.1)$$

$$\begin{array}{lll} se & (0.261) & (0.039) \\ t & (4.521) & (12.02) \end{array}$$

$$R^2 = 0.743 \qquad df = 50$$

$$F = 144.598 \qquad DW = 2.195$$

$$Reset\ (2) = 1.911,\ Reset\ (3) = 0.937,\ Reset\ (4) = 1.782$$

The regression results obtained for the first law support the view that the manufacturing sector is the 'engine of growth'. The regression results for equation (1.1) confirm the a priori prediction that b_1^1 is greater than zero. A regression coefficient significantly less than unity (0.469) shows that the greater the *excess* of the rate of growth of manufacturing output over the rate of growth of the economy as a *whole*, the faster the overall growth rate (Thirlwall, 1987: 186). The reported results in equation (1.1) are quite similar to those found by Kaldor (1966) and Drakopoulos and Theodossiou (1991). Hence a 1 percent growth in manufacturing output leads to a roughly 0.47 percent growth in overall GDP. Setting g_{GDP} = g_m it can be shown that, on average, annual growth rates above 2.2 percent for South Africa, over the study period 1946/47 – 1997/98, are representative of years where the rate of growth of manufacturing is in *excess* of the overall growth rate of the economy.

The overall fit of the model (R^2) is good with manufacturing explaining 74 percent of the growth in overall GDP, ceteris paribus. The overall model fit is substantiated by a high value for F of 144.598 and both values for t show that the estimated coefficients are statistically significant. The DW statistic of 2.195 indicates the absence of first-order serial correlation. Further, the model is correctly specified at the 5 percent level as shown by the low values for all RESET tests. Thus from the estimated regression results, it seems evident that *manufacturing* is the driving force behind economic growth. This result supports the original finding by Kaldor (1966: 285).

$$\hat{g}_{nm} = 1.673 + 0.432 g_m \qquad (1.2)$$

$$\begin{array}{lll} se & (0.397) & (0.059) \\ t & (4.219) & (7.275) \end{array}$$

$$R^2 = 0.514 \qquad df = 50$$

$$F = 52.929 \qquad DW = 2.58$$

$$Reset\ (2) = 0.786,\ Reset\ (3) = 0.536,\ Reset\ (4) = 0.355$$

The regression results posted for equation (1.2) also support the a priori prediction that b_1^2 is greater than zero. A regression coefficient (0.432) with a reasonably high R^2 of 51 percent is not dissimilar to that found by Kaldor (Thirlwall, 1987: 187). Hence a 1 percent growth in manufacturing output leads to a roughly 0.43 percent growth in non-manufacturing output, ceteris paribus. Also, note that the estimated regression results for equation (1.1) and (1.2) are very similar, thus supporting the finding of Thirlwall (1983).

The overall model fit is substantiated by a high value for F of 52.929 and both values for t indicate that the estimated coefficients are statistically significant. The DW statistic of 2.58 indicates the absence of first-order serial correlation. Further, the model is correctly specified at the 5 percent level as shown by the low values for all RESET tests. Thus the growth in manufacturing is a strong determinant of growth in the non-manufacturing sector a result that is consistent with the finding of Kaldor (1966: 304).

$$\hat{g}_{GDP} = 2.774 + 0.44(g_m - g_{nm}) \qquad (1.3)$$

$$\begin{array}{lll} se & (0.31) & (0.083) \\ t & (8.959) & (5.322) \end{array}$$

$$R^2 = 0.362 \qquad df = 50$$

$$F = 28.322 \qquad DW = 1.856$$

$$Reset\ (2) = 6.464^{**},\ Reset\ (3) = 3.283^{**},\ Reset\ (4) = 5.134^{\dagger}$$

The regression results reported for equation (1.3) likewise support the a priori prediction that b_1^3 is greater than zero. The estimated regression results are quite similar to that found by Drakopoulos and Theodossiou (1991: 1686). A regression coefficient (0.44) implies that there is a positive association between the overall rate of economic growth and the *excess* of the rate of growth of manufacturing output over the rate of growth of non-manufacturing output. This result supports the earlier finding of Kaldor (1966: 304).

A lower value for the R^2 of 36 percent is also similar to that estimated by Kaldor (1966), but lower than the overall fit estimated by Drakopoulos and Theodossiou (1991: 1686) for the Greek economy of 0.66. Hence a 1 percent growth in the difference between manufacturing and non-manufacturing output leads to a roughly 0.44 percent growth in overall GDP, ceteris paribus. The overall model fit is substantiated by a high value for F of 28.322 and both values for t indicate that the estimated coefficients are statistically significant. The DW statistic of 1.856 indicates the absence of first-order serial correlation. Further, note the model is correctly specified at the 1 percent level for the RESET (2) and (3) tests whereas the RESET (4) indicates that the model is not correctly specified. Thus despite possible evidence of mis-specification, there is a positive association between the overall growth in GDP, and the difference in growth of manufacturing and non-manufacturing output.

$$\hat{g}^{\bullet}_{GDP} = 0.072 + 0.948 g^{\bullet}_{Tertiary} \qquad (1.4)$$

$$se \quad (0.329)\ (0.112)$$

$$t \quad (0.219)\ (8.496)$$

$$R^2 = 0.591 \qquad df = 50$$

$$F = 72.179 \qquad DW = 1.911$$

$$Reset\ (2) = 0.000,\ Reset\ (3) = 1.071,\ Reset\ (4) = 0.752$$

The regression results reported for equation (1.4) support the hypothesis that there is a correlation between the growth of GDP and the growth of services (tertiary sector of the economy). The result is quite similar to that of Kaldor (1966: 305) and is nearly one-to-one with a constant that is not statistically different from zero. This result is also similar to the finding of Drakopoulos and Theodossiou (1991: 1686) in studying the Greek economy. Hence the fact that the constant term is not statistically different from zero and the coefficient of the services variable is very close to one, suggests that the causal relationship is from the rate of growth of GDP to the rate of growth of output of services (Kaldor, 1966: 305). Thus as the economy grows, the services sector tends to grow at roughly the same rate, ceteris paribus. The predictive power of the model is reasonably high with an R^2 of 59 percent. The GLS procedure now implies that there is no evidence of positive first-order serial correlation with a DW of 1.911. The model is also correctly specified at the 5 percent level as shown by the reported values for all RESET tests.

$$\hat{g}^{*}_{Tetiary} = 1.692 + 0.277 g^{*}_{m} \qquad (1.5)$$

$$se \quad (0.283) \; (0.051)$$

$$t \quad (5.971) \; (5.452)$$

$$R^2 = 0.373 \qquad df = 50$$

$$F = 29.725 \qquad DW = 1.665$$

$$Reset\ (2) = 5.461^{**},\ Reset\ (3) = 3.123,\ Reset\ (4) = 4.429^{\dagger}$$

The regression results reported for equation (1.5) support the statement that, demand for services, is derived from the demand for manufacturing output. This result is supported by a positive expected coefficient for g^{*}_{m} of 0.277 that is statistically significant. Overall, 37 percent of the growth in the services or tertiary sector can be explained by the growth in the manufacturing sector. The DW statistic of 1.665 indicates the absence of positive first-order serial correlation using the GLS procedure. However the model is correctly specified at the 1 percent level for the RESET (2) test, and correctly specified at the 5 percent level for the RESET (3) test. However RESET (4) implies that the model is not correctly specified, but note that this decision is marginal. Thus since the decision on model specification for equation (1.5) is indecisive, we can say, prima facie, that a reasonably strong relationship exists between the growth of services, and the growth of manufacturing output.

In light of the structure of the South African economy, and its dependence on the primary sector (agriculture and mining and quarrying activities) the discussion now focuses on analysing regression results to this end. Note, g_{aff} and g_{mq} represent the growth in agriculture, forestry and fishing and mining and quarrying respectively.

$$\hat{g}^{*}_{GDP} = 1.674 + 0.225 g^{*}_{Primary} \qquad (1.6)$$

$$se \quad (0.283) \; (0.058)$$

$$t \quad (5.920) \; (3.874)$$

$$R^2 = 0.231 \qquad df = 50$$

$$F = 15.009 \qquad DW = 1.863$$

$$Reset\ (2) = 1.028,\ Reset\ (3) = 3.154,\ Reset\ (4) = 2.464$$

$$\hat{g}^{\bullet}_{GDP} = 1.595 + 0.059 g^{\bullet}_{aff} \qquad (1.7)$$

$$\begin{array}{lll} se & (0.289) & (0.019) \\ t & (5.510) & (3.061) \end{array}$$

$R^2 = 0.158 \quad df = 50$

$F = 9.371 \quad DW = 1.976$

$Reset\ (2) = 1.473,\ Reset\ (3) = 0.81,\ Reset\ (4) = 0.564$

$$\hat{g}^{\bullet}_{GDP} = 1.929 + 0.172 g^{\bullet}_{mq} \qquad (1.8)$$

$$\begin{array}{lll} se & (0.317) & (0.087) \\ t & (6.087) & (1.984) \end{array}$$

$R^2 = 0.073 \quad df = 50$

$F = 3.936 \quad DW = 1.898$

$Reset\ (2) = 2.435,\ Reset\ (3) = 3.623^{**},\ Reset\ (4) = 2.811$

From the regression results reported for equation (1.6), it is evident that there is no strong relationship between the growth of primary sector output (explanatory variable) and overall growth in GDP (dependent variable). This result is reinforced by equations (1.7) and (1.8) in which the overall predictive power of both models is low. Hence the growth of output in agriculture, forestry and fishing and mining and quarrying, do not adequately explain or predict overall GDP growth, a fact noted and supported by similar findings (Thirlwall, 1987; Drakopoulos and Theodossiou, 1991). This may be deemed a surprising result considering that the agricultural and mining sectors are important activities in the South African economy. However regarding the results reported in equation (1.8), we might expect the gold sector to have a relatively strong relationship with overall GDP, but this relationship may be dampened due to the aggregation of the overall mining and quarrying sector. Note that the low predictive power of the models is not due to incorrect functional form or specification bias, as all RESET values reported for equations (1.6) and (1.7) imply that these models are correctly specified at the 5 percent level. Equation (1.8) is correctly specified at the 5 percent level for the RESET (2) and (4) tests, but correctly specified at the 1 percent level for the RESET (3) test.

A final test of law one is to regress overall GDP growth on overall industrial or secondary sector growth. This regression is used to negate any doubt as to what the term *manufacturing* really encompasses.

$$\hat{g}^{\bullet}_{GDP} = 1.252 + 0.447 g^{\bullet}_{Secondary} \qquad (1.9)$$
$$se \quad (0.265)\ (0.043)$$
$$t \quad (4.724)\ (10.28)$$
$$R^2 = 0.679 \qquad df = 50$$
$$F = 105.78 \qquad DW = 1.734$$
$$Reset\ (2) = 9.211^{\dagger},\ Reset\ (3) = 4.515^{**},\ Reset\ (4) = 3.659^{**}$$

From the regression results reported for equation (1.9) the overall predictive power and coefficient for $g^{*}_{Secondary}$ are quite similar in nature to that reported in equation (1.1) and help substantiate the earlier statement that manufacturing is a good *proxy* for the overall industrial sector in South Africa. However note the RESET (2) test implies that the model is not correctly specified, but the RESET (3) and (4) tests imply that the model is correctly specified at the 1 percent level. Notwithstanding the results given in equation (1.9) and possible specification bias, the results still indicate support for the statement that the choice of using *only* manufacturing or the overall secondary sector (for analysing law one) is irrelevant (Thirlwall, 1983).

4.3.3 Kaldor's Second Law

McCombie (1983: 415) shows the full specification and a priori expectations, for a_2^1 and b_2^1 using the formulation proposed in equations (2.1) and (2.2) in chapter three.

$$p_m = a_2^1 + b_2^1 g_m \qquad b_2^1 > 0 \qquad (2.1)$$

or

$$e_m = -a_2^1 + (1 - b_2^1) g_m \qquad b_2^1 > 0 \qquad (2.2)$$

From the above equations we can now estimate the econometric models that constitute the above mathematical relationships. Note that for equations (2.1) and (2.2) above to hold, then all level-form variables must be in percentage *change* format, an issue discussed in chapter three.

The results obtained support the view that there is a *reasonably* strong relation between the rate of growth of productivity in manufacturing, and the growth of manufacturing output for the South African economy.

$$\hat{p}_m = 0.044 + 0.538 g_m \qquad (2.1)$$
$$se \quad (0.494)\ (0.094)$$
$$t \quad (0.089)\ (5.710)$$
$$R^2 = 0.576 \qquad df = 24$$
$$F = 32.605 \qquad DW = 1.506$$
$$Reset\ (2) = 0.698,\ Reset\ (3) = 0.604,\ Reset\ (4) = 3.545^{**}$$

$$\hat{e}_m = -0.044 + 0.462 g_m \qquad (2.2)$$
$$se \quad (0.494)\ (0.094)$$
$$t \quad (-0.089)(4.895)$$
$$R^2 = 0.5 \qquad df = 24$$
$$F = 23.956 \qquad DW = 1.506$$
$$Reset\ (2) = 0.698,\ Reset\ (3) = 0.604,\ Reset\ (4) = 3.544^{**}$$

The estimated regression results for equations (2.1) and (2.2) are consistent with those of McCombie (1983: 415). In terms of equation (2.1), we can conclude that some kind of Verdoorn relation was exhibited by the South African economy during the period 1970 – 1996. The slope coefficient has the correct magnitude and sign of 0.538 and accords with the a priori prediction (Thirlwall, 1999: 79). Thus a 1 percent increase in the growth of manufacturing output leads to a roughly 0.54 percent increase in the growth of productivity in manufacturing, ceteris paribus. Overall, the growth in manufacturing output explains about 58 percent of the growth of productivity in manufacturing, a satisfactory result and in accordance with the finding of Kaldor (1966) in which the R^2, excluding Japan, was 0.536 or approximately 54 percent (Thirlwall, 1983: 353). The DW statistic shows that there is no evidence of positive first-order serial correlation, and the model is correctly specified at the 5 percent level for the RESET (2) and (3) tests and correctly specified at the 1 percent level for the RESET (4) test.

In terms of equation (2.2), it is shown that the size and sign for the coefficient of g_m is equal to $1-b_2$. The magnitude of a_2^1 in equation (2.2) is equal to a_2^1 in equation (2.1) and has a negative sign, as predicted. Thus a 1 percent increase in the growth of manufacturing output leads to a roughly 0.46 percent increase in the growth of employment in manufacturing, ceteris paribus. This result accords with the finding of Kaldor (1975: 893) that a *sufficient* condition for the presence of static or dynamic economies is a statistically significant relationship between e_m and g_m and slope coefficient that is significantly less than unity.

Overall, the growth in manufacturing output explains about 50 percent of the growth of employment in manufacturing. The DW statistic shows that there is no evidence of positive first-order serial correlation whilst the model is correctly specified at the 5 percent level for the RESET (2) and (3) tests and correctly specified at the 1 percent level for the RESET (4) test.

4.3.4 Kaldor's Third Law

Law three essentially considers the relationship between the growth of manufacturing sector output and productivity outside of manufacturing. Thus the focus now shifts to analysing how the manufacturing sector affects the non-manufacturing sector.

$$\hat{p}_{nm} = 1.649 + 0.166 g_m \qquad (3.1)$$

$$se \quad (0.411)\ (0.078)$$

$$t \quad (4.017)\ (2.121)$$

$$R^2 = 0.158 \qquad df = 24$$

$$F = 4.5 \qquad DW = 2.341$$

$$Reset\ (2) = 1.024,\ Reset\ (3) = 1.10,\ Reset\ (4) = 0.74$$

The first test of law three would involve analysing the literal relation between p_{nm} and g_m even though Thirlwall (1999: 80) says that a direct test of this nature may be difficult on the basis of measuring productivity growth in service activities. However if we consider the GVA contribution of the services sector, and employment in the services sector, on an annual basis, this may be suitable for our purposes.

Although the results given in regression equation (3.1) indicate low predictive power with an R^2 of about 16 percent, the estimated regression coefficient is statistically significant and has the correct sign. The F value shows that the model is significant at the 5 percent level. Therefore the faster the growth of manufacturing output, the faster the rate of labour being transferred from non-manufacturing to manufacturing activities and a 1 percent increase in manufacturing output leads to a 0.166 percent increase in non-manufacturing productivity. There is no indication of positive first-order serial correlation, given a DW of 2.341, and the model is correctly specified at the 5 percent level for all RESET tests.

Due to the relatively poor predictive power given in equation (3.1), some other method of estimating law three must be sought. Thirlwall (1999: 80) proposes using overall productivity growth (p_{GDP}) and regressing this against employment change in non-manufacturing activities (e_{nm}) whilst holding constant the effect of output growth in manufacturing.

$$\hat{p}_{GDP} = 0.975 + 0.369 g_m - 0.696 e_{nm} \qquad (3.2)$$

$$\begin{array}{llll} se & (0.23) & (0.049) & (0.126) \\ t & (4.233) & (7.54) & (-5.514) \end{array}$$

$$R^2 = 0.732 \quad df = 23$$

$$F = 31.342 \quad DW = 2.433$$

$$Reset\ (2) = 0.528,\ Reset\ (3) = 0.287,\ Reset\ (4) = 0.761$$

The above specification for law three reveals convincing results with regard to the South African economy. The R^2 is very high with 73 percent of overall productivity growth being explained by employment change in non-manufacturing activities whilst holding output growth in manufacturing constant, ceteris paribus. All coefficients are statistically significant and the coefficient on e_{nm} is significantly negative as is the a priori prediction (Thirlwall, 1999: 80; Cripps and Tarling, 1973). Thus the slower employment growth outside of manufacturing, the faster overall productivity grows in the South African economy, over the study period. Once again, the model exhibits no positive first-order serial correlation, and the model is correctly specified at the 5 percent level for all RESET tests. The results reported in equation (3.2) are similar in nature to that found for the Chinese economy over a similar study period, 1965 – 1991 (Hansen and Zhang, 1996).

A final specification used to reconcile the predictions made above, is to check whether overall productivity growth is positively correlated with employment growth in manufacturing and negatively correlated with the growth of employment in non-manufacturing.

$$\hat{p}_{GDP} = 1.458 + 0.379e_m - 0.538e_{nm} \qquad (3.3)$$

$$se \quad (0.325)\ (0.113) \quad (0.19)$$

$$t \quad (4.480)(3.363) \quad (-2.838)$$

$$R^2 = 0.375 \qquad df = 23$$

$$F = 6.908 \qquad DW = 1.664$$

$$Reset\ (2) = 0.015,\ Reset\ (3) = 0.071,\ Reset\ (4) = 1.245$$

The final specification for law three given in equation (3.3) above, shows a weaker relationship (R^2 of 0.375) between overall productivity growth and employment growth in manufacturing and non-manufacturing respectively. However note that the signs for the two slope coefficients on e_m and e_{nm} are consistent with the a priori predictions made in chapter three, and hence support the a priori predictions made by Thirlwall (1987: 193) and Drakopoulos and Theodossiou (1991: 1685). Despite a low F value, the model as a *whole* is statistically significant at the 5 percent level, and hence employment change in manufacturing and non-manufacturing jointly explain approximately 38 percent of the change in overall productivity. Likewise, the model exhibits no evidence of positive first-order serial correlation, and the model is correctly specified at the 5 percent level for all RESET tests.

4.3.5 Summary

This section has presented and discussed all the estimated econometric results for Kaldor's three laws of growth. None of the models presented in this chapter exhibit first-order serial correlation and hence OLS estimators are BLUE. The general finding is that the estimated regression results support the Kaldorian approach in explaining economic growth. Regarding the debate concerning whether manufacturing, in the strictest sense, or the overall industrial sector are used in the study of Kaldorian growth theory, it must be noted that the present author found very similar estimated regression results for the South African economy using both approaches. Hence in light of the South African economy, one could say that the manufacturing sector is a good *proxy* for the overall industrial sector. In conclusion, from the regression specifications used, and estimated regression results, there is substantial evidence to suggest that the manufacturing sector has been an engine of growth in the South African economy over the study period.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

This final chapter presents all the empirical results estimated for Kaldor's three laws of growth as applied to the South African economy. The results for each law are briefly summarised and conclusions are made regarding their application to South Africa. From the conclusions drawn we then detail proposed policy recommendations for the future South African economy.

5.1 Summary and Conclusions

Table 3: Summary of Empirical Results for South Africa

Eq.	Dep.	Intercept	Independent Variables											
			g_m	g_m-g_{nm}	$g_{Tertiary}$	$g_{Primary}$	g_{aff}	g_{mq}	$g_{Secondary}$	e_m	e_{nm}	R^2	F	DW
1.1	g_{GDP}	1.178 (4.52)	0.469 (12.02)									0.74	144.60	2.20
1.2	g_{nm}	1.673 (4.22)	0.432 (7.28)									0.51	52.93	2.58
1.3	g_{GDP}	2.774 (8.96)		0.44 (5.32)								0.36	28.32	1.86
1.4	g_{GDP}	0.072 (0.22)			0.948 (8.50)							0.59	72.18	1.91
1.5	$g_{Tertiary}$	1.692 (5.97)	0.277 (5.45)									0.37	29.73	1.67
1.6	g_{GDP}	1.674 (5.92)				0.225 (3.87)						0.23	15.01	1.86
1.7	g_{GDP}	1.595 (5.51)					0.059 (3.06)					0.16	9.37	1.98
1.8	g_{GDP}	1.929 (6.09)						0.172 (1.98)				0.07	3.94	1.90
1.9	g_{GDP}	1.252 (4.72)							0.447 (10.28)			0.68	105.78	1.73
2.1	p_m	0.044 (0.09)	0.538 (5.71)									0.58	32.61	1.51
2.2	e_m	-0.044 (-0.09)	0.462 (4.90)									0.50	23.96	1.51
3.1	p_{nm}	1.649 (4.02)	0.166 (2.12)									0.16	4.50	2.34
3.2	p_{GDP}	0.975 (4.23)	0.369 (7.54)								-0.696 (-5.51)	0.73	31.34	2.43
3.3	p_{GDP}	1.458 (4.48)								0.379 (3.36)	-0.538 (-2.84)	0.38	6.91	1.66

The summarised empirical results reported in Table 3 above represent the output obtained from SHAZAM for the application of Kaldor's three laws of growth to the South African economy (note that t values are shown in brackets and calculated values for the t and F tests have been rounded-off to two decimal places to facilitate the construction of this table). Brief conclusions will be drawn for each law in light of the empirical results obtained, and then conclude as to the relevance of Kaldorian growth theory with respect to the South African economy.

5.1.1 Kaldor's First Law

The objective with respect to Kaldor's first law is to test whether there is a strong positive correlation between the growth of manufacturing output (g_m) as the independent variable and the growth of overall GDP (g_{GDP}) as the dependent variable. Equations (1.1) to (1.9) are the estimated results for Kaldor's first law as applied to South Africa. From the results reported, all estimated values accord with the a priori predictions, as detailed in chapter three. The a priori prediction is that the regression coefficient for equation (1.1) is positive as the growth of manufacturing output, as the independent variable, is positively related to the growth of overall GDP. A reasonably high R^2 value for equation (1.1) indicates a strong correlation between the growth of manufacturing output and the growth of overall GDP, which is the crux of Kaldor's first law. The a priori prediction for equations (1.2) to (1.9) is that all regression coefficients are positive. Hence equations (1.2) and (1.5) are expected to show that the growth of manufacturing output, as the independent variable, is positively related to the growth of non-manufacturing output (g_{nm}) and the growth of services ($g_{Tertiary}$) respectively. However equations (1.3), (1.4) and (1.6) to (1.9) should indicate that the growth of overall GDP, as the dependent variable, is positively related to the difference in the growth of manufacturing and non-manufacturing output (g_m-g_{nm}), the growth of services, the growth of the overall primary sector ($g_{Primary}$), the growth of agriculture, forestry and fishing (g_{aff}), the growth of mining and quarrying (g_{mq}) and the growth of the overall secondary sector ($g_{Secondary}$) respectively. The regression coefficient for equation (1.4) is expected to approximate unity in that the growth in services should almost match the growth of overall GDP. However there should be no correlation between the growth of overall GDP and the growth of agriculture, forestry and fishing in equation (1.7) or the growth of mining and quarrying in equation (1.8), as growth in the Kaldorian model is industry-led. The results reported for equation (1.9) are expected to approximate those of equation (1.1) as, the choice of term, whether to use the growth of manufacturing sector output only or the growth of overall secondary sector output, is irrelevant to the argument at hand (Thirlwall, 1983).

All estimated regression coefficients are statistically significant except for equation (1.8), as the growth of mining and quarrying is not related to the growth of overall GDP, which supports the a priori prediction made in chapter three. The regression coefficient for equation (1.7) is significant, however the R^2 is low and the coefficient, although significantly different from zero, is low at 0.059. This tends to support the a priori expectation that there should be no correlation between the growth of overall GDP and the growth of agriculture, forestry and fishing. Equation (1.5) indicates that the growth of manufacturing output does determine the growth of services to a large extent. Equation (1.4) shows that the growth of services does almost match the growth of overall GDP as the regression coefficient is close to unity. Equations (1.3) and (1.2) support the a priori predictions made in that the regression coefficients are positive. Hence the difference in the growth of manufacturing and non-manufacturing output is positively related to the growth of overall GDP and the growth of manufacturing output is positively related to the growth of non-manufacturing output.

The crux of law one is captured in equation (1.1) and the estimated results are similar to those found by Kaldor (1966) and Drakopoulos and Theodossiou (1991) for the Greek economy. If we set the growth of overall GDP equal to the growth of manufacturing output ($g_{GDP} = g_m$), it is shown that annual growth rates for *real* GDP above 2.2 percent, over the study period 1946/47 – 1997/98, are on average representative of years where the rate of growth of manufacturing is in *excess* of the overall growth rate of the economy or where the share of the manufacturing sector in the overall economy is increasing. The conclusion is that there is a strong positive correlation (as indicated by a relatively high R^2 of 0.74) between the growth of manufacturing output and the growth of overall GDP for the South African economy.

5.1.2 Kaldor's Second Law

The objective with respect to Kaldor's second law is to test whether there is a strong positive correlation between the growth of manufacturing output (g_m) as the independent variable and the growth of productivity in the manufacturing sector (p_m) as the dependent variable. Equations (2.1) and (2.2) are the estimated results for Kaldor's second law as applied to South Africa. Once again, the estimated results reported for both specifications of law two, accord with a priori predictions for the study period 1970/71 – 1995/96. The regression coefficient for equation (2.1) should approximate a value of 0.5, which is consistent with Verdoorn's law, after P.J. Verdoorn who first found such a relationship for Eastern European countries in the 1940's. The Verdoorn law states that faster growth of manufacturing output generates faster growth of productivity in the manufacturing sector. Kaldor (1975: 893) believes that a *sufficient* condition for the presence of static or dynamic economies of scale, is the existence of a statistically significant relationship between the growth of employment in manufacturing (e_m) and the growth of manufacturing output, given in equation (2.2), where the regression coefficient is positive and significantly less than unity.

Both estimated regression coefficients are statistically significant. The regression coefficient for equation (2.1) is consistent with the Verdoorn law as it has a value of 0.538, indicating that a 1 percent growth of manufacturing output leads to a roughly 0.54 percent growth of productivity in the manufacturing sector. The regression coefficient for equation (2.2) is 0.462 and significantly less than zero, indicating that a 1 percent growth of manufacturing output leads to a roughly 0.46 percent growth of employment in manufacturing. From equation (2.1) as manufacturing output increases, productivity in the manufacturing sector increases as well, but equation (2.2) shows that manufacturing output increases at a faster rate than employment in manufacturing. Hence overall productivity in manufacturing has been increasing in South Africa. The results for both equations are consistent with earlier findings by Kaldor (1966), Kaldor (1975) and McCombie (1983). The predictive power of both models is good with values for R^2 of 0.58 and 0.50 respectively. The conclusion is that there is a relatively strong positive correlation between the growth of manufacturing output and the growth of productivity in the manufacturing sector for the South African economy.

5.1.3 Kaldor's Third Law

The objective with respect to Kaldor's third law is to test whether there is a strong positive correlation between the growth of manufacturing output as the independent variable and the growth of productivity in the non-manufacturing sector (p_{nm}) or overall productivity growth (p_{GDP}) as the dependent variable. Equations (3.1) to (3.3) are the estimated results for Kaldor's third law as applied to South Africa. The estimated results reported for all specifications of law three, accord with the a priori predictions for the study period 1970/71 – 1995/96. The regression coefficient for equation (3.1) is assumed to be positive as the growth of manufacturing output and growth of productivity in the non-manufacturing sector are positively related. However Thirlwall (1999: 80) proposes an alternative approach to estimating law three as it may be difficult to estimate productivity growth in activities such as services. Equations (3.2) and (3.3) therefore use overall productivity growth or growth of GDP per employed person (p_{GDP}) as the dependent variable. The regression coefficients for the growth of manufacturing output in both equations (3.1) and (3.2) are assumed to be positive. Using the approach followed by Cripps and Tarling (1973), equation (3.2) uses the growth of employment in non-manufacturing activities (e_{nm}) as an additional independent variable, which is assumed to be negative as growth in overall GDP is negatively related to employment growth in the non-manufacturing sector. An alternative specification for law three is given by equation (3.3), which uses the growth of employment in manufacturing (e_m) and growth of employment in non-manufacturing, as independent variables. The regression coefficient for the growth of employment in manufacturing is assumed to be positive whereas the regression coefficient for the growth of employment in non-manufacturing is assumed to be negative.

All estimated regression coefficients are statistically significant. Despite a lower R^2 for equation (3.1) of 0.16, the estimated regression coefficient for the growth of manufacturing output is statistically significant and has the correct positive sign. This finding is also supported by the positive regression coefficient estimated for the growth of manufacturing output in equation (3.2). Hence as manufacturing output increases, productivity in the non-manufacturing sector or GDP per employed person increases as well, and this result accords with the a priori prediction. The estimated regression results for equations (3.2) and (3.3) are very encouraging. The R^2 for equation (3.2) is high at 0.73 and equation (3.3) also indicates sound model prediction with an R^2 of 0.38. Most importantly, the regression coefficients for the growth of employment in non-manufacturing (both equations) are consistent with the a priori prediction in that they have the correct negative sign. Hence the slower employment growth outside of manufacturing, the faster overall productivity grows in South Africa. The results for all three equations (equations (3.2) and (3.3) in particular) are consistent with earlier findings by Cripps and Tarling (1973), Thirlwall (1987), Drakopoulos and Theodossiou (1991) and Thirlwall (1999). The conclusion is that there is a strong positive correlation between the growth of manufacturing output and the growth of productivity in the non-manufacturing sector for the South African economy.

5.1.4 Conclusion

From the study undertaken and the results obtained, there is broad agreement for the application of Kaldor's growth laws to the South African economy. Therefore this study supports Kaldorian growth theory in the South African context. With reference to Thirlwall (1983: 357) we can conclude as follows:

1. Manufacturing growth can be considered as an engine of GDP growth in South Africa;
2. The faster the rate of manufacturing growth, the faster the rate of productivity growth in the South African manufacturing sector;
3. The faster the rate of manufacturing growth, the faster the overall rate of productivity growth in South Africa as, more labour used in the manufacturing sector, does not necessarily detract from growth elsewhere in the South African economy.

5.2 Recommendations

From the conclusions drawn, the following recommendations can be considered. An initial recommendation relates to industrial development or development of the manufacturing sector. This study has shown that the manufacturing sector is a driving force behind economic growth in South Africa. Therefore manufacturing is key to growth in the 21st century (Jones, 2002: 70). If the manufacturing sector is to continue driving economic growth for the years to come, investment and foreign direct investment in particular, must be targeted at promoting and expanding the domestic manufacturing sector.

Another recommendation relates to economic transformation and structural change. The South African economy must continue to transform itself from an agriculture and primary sector-based economy to a more industrialised economy that focuses on manufacturing activity. This process entails reallocating resources from the lower-productivity primary sector to the higher-productivity industrial or manufacturing sector. This may be obvious in light of the declining share of agriculture and the overall primary sector in the GDP, but with the declining share of manufacturing in the GDP throughout the 1990's, there may be cause for concern. Hence government policy and labour legislation should be geared towards creating an environment that is conducive to promoting resource allocation and employment in the manufacturing sector.

It is generally accepted that the continued growth in manufacturing is dependent on the sector's ability to grow in an export-oriented manner (McCarthy, 1994: 82). Therefore a recommendation that leads on from the study undertaken, and one supported by McCarthy (1999: 161), is that, continued industrialisation may require considerable growth in manufactured exports. This is an important policy recommendation as manufactured exports represent a crucial demand constraint for the South African manufacturing sector.

BIBLIOGRAPHY

Abramovitz, M. (1956) 'Resource and Output Trends in the United States since 1870', *American Economic Review*, Vol. 46, No. 2, May, pp. 5 – 23.

Agapitos, G. (1989) Development and Structural Problems of the Greek Economy (1950 – 1987), Smpilia, Athens, in Drakopoulos, S.A., Theodossiou, I. (1991) 'Kaldorian Approach to Greek Economic Growth', *Applied Economics*, Vol. 23, No. 10, October, pp. 1683 – 1689.

Aghion, P., Howitt, P. (1998) *Endogenous Growth Theory*. Cambridge: MIT Press.

Arrow, K.J. (1962) 'The Economic Implications of Learning by Doing', *Review of Economic Studies*, Vol. 29, June, pp. 155 – 173.

Bairam, E. (1991) 'Economic Growth and Kaldor's Law: The Case of Turkey, 1925 – 78', *Applied Economics*, Vol. 23, No. 8, August, pp. 1277 – 1280.

Baumol, W. (1986) 'Productivity Growth, Convergence and Welfare: What the Long Run Data Show', *American Economic Review*, Vol. 76, December, pp. 1072 – 1085.

Becker, R., Burmeister, E. (1991) *Growth Theory: Volume I*. Hants: Edward Elgar Publishing.

Black, A., Stanwix, J. (1987) 'Manufacturing Development and the Economic Crisis: Restructuring in the Eighties', *Social Dynamics*, Vol. 13, No. 1, pp. 47 – 59.

Bulletin of Statistics (1995) *Central Statistical Services*, Vol. 29, No. 4, December, Pretoria: CSS.

Bulletin of Statistics (1996) *Central Statistical Services*, Vol. 30, No. 4, December, Pretoria: CSS.

Bulletin of Statistics (1997) *Central Statistical Services*, Vol. 31, No. 4, December, Pretoria: CSS.

Chenery, H. (1986) 'Growth and Transformation' in Chenery, H., Robinson, S., Syrquin, M., *Industrialisation and Growth: A Comparative Study*, New York: Oxford University Press.

Cochrane, D., Orcutt, G.H. (1949) 'Application of Least-Squares Regression to Relationships Containing Autocorrelated Error Terms', *Journal of the American Statistical Association*, Vol. 44, No. 245, March, pp. 32 – 61.

Cornwall, J. (1976) 'Diffusion, Convergence and Kaldor's Laws', *Economic Journal*, Vol. 86, June, pp. 307 – 314.

Cornwall, J. (1977) Modern Capitalism: Its Growth and Transformation, London: Martin Robertson, in Bairam, E. (1991) 'Economic Growth and Kaldor's Law: The Case of Turkey, 1925 – 78', *Applied Economics*, Vol. 23, No. 8, August, pp. 1277 – 1280.

Cripps, T.F., Tarling, R.J. (1973) *Growth in Advanced Capitalist Economies 1950 – 1970*, Cambridge: Cambridge University Press.

Delivani, E. (1992) 'A Kaldorian Approach to Greek Economic Growth: A Comment', *Applied Economics*, Vol. 24, No. 12, December, pp. 1357 – 1359.

De Mello, L. (1996) Foreign Direct Investment, International Knowledge Transfers and Endogenous Growth: Time Series Evidence, (Department of Economics, University of Kent, Studies in Economics), in Thirlwall, A.P. (1999) *Growth and Development*, London: MacMillan Press Ltd., (6th Edition).

Denison, E.F. (1962) Sources of Economic Growth in the United States and the Alternatives Before Us, Supplementary Paper 13, New York: Committee for Economic Development, in Chenery, H., Robinson, S., Syrquin, M. (1986) *Industrialisation and Growth: A Comparative Study*, New York: Oxford University Press.

Department of Statistics (1981) *Standard Industrial Classification of All Economic Activities (SIC)*, Pretoria: Government Printer (3rd Edition).

Dixon, R., Thirlwall, A.P. (1975) 'A Model of Regional Growth-Rate Differences on Kaldorian Lines', *Oxford Economic Papers*, Vol. 27, No. 2, July, pp. 201 – 214.

Dixon, R., Thirlwall, A.P. (1979) An Exported Growth Model With a Balance of Payments Constraint, in Bowers, J. (ed.) *Inflation, Development and Integration: Essays in Honour of A.J. Brown*, London: University of Leeds Press.

Domar, E.D. (1947) 'Expansion and Employment', *American Economic Review*, Vol. 37, No. 1, March, pp. 34 – 55.

Dornbusch, R., Fischer, S., Mohr, P., Rogers, C. (1998) *Macroeconomics*, Johannesburg: Lexicon (3rd Edition).

Drakopoulos, S.A., Theodossiou, I. (1991) 'Kaldorian Approach to Greek Economic Growth', *Applied Economics*, Vol. 23, No. 10, October, pp. 1683 – 1689.

Drakopoulos, S.A., Theodossiou, I. (1992) 'A Kaldorian Approach to Greek Economic Growth: A Reply', *Applied Economics*, Vol. 24, No. 12, December, pp. 1360 – 1361.

Durbin, J., Watson, G.S. (1951) 'Testing for Serial Correlation in Least-Squares Regression', *Biometrika*, Vol. 38, pp. 159 – 178.

Fourie, F.C. v N. (1999) *How to Think and Reason in Macroeconomics*, Kenwyn: Juta & Co. Ltd..

Gelb, S. (1991) 'South Africa's Economic Crisis: An Overview', in Gelb, S. (ed.) *South Africa's Economic Crisis*, Cape Town: David Philip.

Grossman, G.M., Helpman, E. (1990) 'Trade, Innovation, and Growth', *American Economic Review*, Vol. 80, No. 2, May, pp. 86 – 91.

Grossman, G.M., Helpman, E. (1991) *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT Press.

Gujarati, D.N. (1995) *Basic Econometrics*, New York: McGraw-Hill, Inc. (3rd Edition).

Hansen, J.D., Zhang, J. (1996) 'A Kaldorian Approach to Regional Economic Growth in China', *Applied Economics*, Vol. 28, No. 6, June, pp. 679 – 685.

Harberger, A.C. (1984) *World Economic Growth: Case Studies of Developed and Developing Nations*, San Francisco: ICS Press.

Harrod, R.F. (1939) 'An Essay in Dynamic Theory', *Economic Journal*, Vol. 49, March, pp. 14 – 33.

Heng, T.M., Siang, T.C. (1999) 'A Neoclassical Analysis of the ASEAN and East Asian Growth Experience', *ASEAN Economic Bulletin*, Vol. 16, No. 2, August, p. 149.

International Monetary Fund (1998) 'South Africa: Selected Issues', *IMF Staff Country Report No. 98/96*, September, Washington: International Monetary Fund.

Jones, S., Müller, A. (1992) *The South African Economy, 1910 – 90*, London: Macmillan.

Jones, S. (2002) 'The Decline of the South African Economy 1980 – 2000', *South African Journal of Economic History*, Vol. 17, No. 1, September, pp. 49 – 81.

Kaldor, N. (1957) 'A Model of Economic Growth', *Economic Journal*, Vol. 67, December, pp. 591 – 624.

Kaldor, N. (1966) 'Causes of the Slow Rate of Growth of the United Kingdom', Cambridge: Cambridge University Press, in Targetti, F., Thirlwall, A.P. (eds.) (1989) *The Essential Kaldor*, London: Duckworth.

Kaldor, N. (1968) 'Productivity and Growth in Manufacturing Industry: A Reply', *Economica*, Vol. 35, November, pp. 385 – 391.

Kaldor, N. (1975) 'Economic Growth and the Verdoorn Law – A Comment on Mr. Rowthorn's Article', *Economic Journal*, Vol. 85, December, pp. 891 – 896.

Kaldor, N. (1978) *Further Essays on Economic Theory*, London: Duckworth.

Kennedy, K.A. (1971) *Productivity and Industrial Growth: The Irish Experience*, Oxford: Clarendon Press.

Kennedy, C., Thirlwall, A.P. (1979) 'Import Penetration, Export Performance and Harrod's Trade Multiplier', *Oxford Economic Papers*, Vol. 31, No. 2, July, pp. 303 - 323.

Lewis, W.A. (1954) 'Economic Development with Unlimited Supplies of Labour', *Manchester School of Economic and Social Studies*, Vol. 22, No. 2, May, pp. 139 – 191.

Lewis, W.A. (1958) 'Unlimited Labour: Further Notes', *Manchester School of Economic and Social Studies*, Vol. 26, No. 1, January, pp. 1 – 32.

Lucas, R.E. (1988) 'On the Mechanics of Economic Development', *Journal of Monetary Economics*, Vol. 22, No. 1, July, pp. 3 – 42.

Marais, G. (1981) 'Structural Changes in Manufacturing Industry, 1916 to 1975', *South African Journal of Economics*, Vol. 49, No. 1, March, pp. 26 – 45.

McCarthy, C.L., (1988) 'Structural Development of South African Manufacturing Industry – A Policy Perspective', *South African Journal of Economics*, Vol. 56, No. 1, March, pp. 1 – 23.

McCarthy, C.L., (1994) 'The 1980's – A Lost Decade for the South African Manufacturing Sector?', *South African Journal of Economic History*, Vol. 9, No. 2, September, pp. 66 – 83.

McCarthy, C.L. (1999) 'The Manufacturing Sector During the 1970's', *South African Journal of Economic History*, Vol. 14, No. 1, September, pp. 143 – 161.

McCombie, J.S.L., de Ridder, J.R. (1983) 'Increasing Returns, Productivity, and Output Growth: The Case of the United States', *Journal of Post Keynesian Economics*, Vol. 5, No. 3, Spring, pp. 373 – 387.

McCombie, J.S.L. (1983) 'Kaldor's Laws in Retrospect', *Journal of Post Keynesian Economics*, Vol. 5, No. 3, Spring, pp. 414 – 429.

Mizuno, Y., Ghosh, D. (1984) Kaldor's Growth Laws and Their Implications for the Japanese Economy, University of Sterling Discussion Paper, pp. 1 – 16, in Drakopoulos, S.A., Theodossiou, I. (1991) 'Kaldorian Approach to Greek Economic Growth', *Applied Economics*, Vol. 23, No. 10, October, pp. 1683 – 1689.

Parikh, A. (1978) 'Differences in Growth Rates and Kaldor's Laws', *Economica*, Vol. 45, February, pp. 83 – 91.

Parkin, M. (1990) *Economics*. Reading: Addison-Wesley Publishing.

Phelps, E.S. (1965) 'Second Essay on the Golden Rule of Accumulation', *American Economic Review*, Vol. 55, No. 4, September, pp. 793 – 814.

Prais, S., Winsten, C. (1954) 'Trend Estimation and Serial Correlation', Cowles Commission Discussion Paper 383, Chicago in Verbeek, M. (2000) *A Guide to Modern Econometrics*, Chichester: Wiley.

Ramsey, J.B. (1969) 'Tests for Specification Errors in Classical Linear Least-Squares Regression Analysis', *Journal of the Royal Statistical Society*, Vol. 31, No. 2, pp. 350 – 371.

Romer, P.M. (1986) 'Increasing Returns and Long-Run Growth', *Journal of Political Economy*, Vol. 94, No. 5, October, pp. 1002 – 1037.

Romer, P.M. (1990) 'Endogenous Technological Change', *Journal of Political Economy*, Vol. 98, No. 5, October, pp. 71 – 102.

Scott, M.F. (1989) *A New View of Economic Growth*, Oxford: Clarendon Press.

Shaw, G.K. (1992) Policy Implications of Endogenous Growth Theory, *Economic Journal*, Vol. 102, May, pp. 611 – 621, in Snowdon, B., Vane, H.R. (eds.) (2001) *A Macroeconomics Reader*, London: Routledge.

Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*, London: Macmillan edn., 1936.

Solow, R.M. (1956) 'A Contribution to the Theory of Economic Growth', *Quarterly Journal of Economics*, Vol. 70, No. 1, February, pp. 65 – 94.

Solow, R.M. (1957) 'Technical Change and the Aggregate Production Function', *Review of Economics and Statistics*, Vol. 39, No. 3, August, pp. 312 – 320.

Solow, R.M. (1970) *Growth Theory: An Exposition*, Oxford: Oxford University Press.

Solow, R.M. (1988) 'Growth Theory and After', *American Economic Review*, Vol. 78, No. 3, June, pp. 307 – 317.

South African Labour Statistics (1986) *Central Statistical Services*, Pretoria: CSS.

South African Labour Statistics (1993) *Central Statistical Services*, Pretoria: CSS.

South African Labour Statistics (1995) *Central Statistical Services*, Pretoria: CSS.

South African Reserve Bank (1999) 'South Africa's National Accounts 1946 – 1998: An Overview of Sources & Methods', *Supplement to the South African Reserve Bank Quarterly Bulletin*, June.

Stoneman, P. (1979) 'Kaldor's Law and British Economic Growth (1800 – 1970)', *Applied Economics*, Vol. 11, No. 3, September, pp. 309 – 319.

Symposium on Kaldor's Growth Laws (1983), *Journal of Post Keynesian Economics*, Vol. 5., No. 3, Spring.

Targetti, F., Thirlwall, A.P. (eds.) (1989) *The Essential Kaldor*, London: Duckworth.

The Economist (1995) *How does your economy grow?* Vol. 336, No. 7934, 30 September, p. 110.

Thirlwall, A.P. (1979) The Balance of Payments Constraint as an Explanation of International Growth Rate Differences, *Banca Nazionale del Lavoro Quarterly Review*, March, in Thirlwall, A.P. (1983) 'A Plain Man's Guide to Kaldor's Growth Laws', *Journal of Post Keynesian Economics*, Vol. 5, No. 3, Spring, pp. 345 – 358.

Thirlwall, A.P., Vines, D. (1982) The Harrod Trade Multiplier and the Importance of Export Led Growth, *Pakistan Journal of Applied Economics*, Vol. 1, No. 1, Summer, in Thirlwall, A.P. (1983) 'A Plain Man's Guide to Kaldor's Growth Laws', *Journal of Post Keynesian Economics*, Vol. 5, No. 3, Spring, pp. 345 – 358.

Thirlwall, A.P. (1983) 'A Plain Man's Guide to Kaldor's Growth Laws', *Journal of Post Keynesian Economics*, Vol. 5, No. 3, Spring, pp. 345 – 358.

Thirlwall, A.P. (1987) *Grand Masters in Economics: Nicholas Kaldor*, Sussex: Wheatsheaf Books.

Thirlwall, A.P. (1999) *Growth and Development*, London: MacMillan Press Ltd., (6th Edition).

Todaro, M.P. (1982) *Economic Development in the Third World*, New York: Longman, (2nd Edition).

Todaro, M.P. (2000) *Economic Development*, Reading, Massachusetts: Addison-Wesley, (7th Edition).

Verdoorn, P.J. (1949) Fattori che Regolano lo Sviluppo della Produttivita del Lavoro, *L'Industria*, Vol. 1, pp. 3 – 10 in Drakopoulos, S.A., Theodossiou, I. (1991) 'Kaldorian Approach to Greek Economic Growth', *Applied Economics*, Vol. 23, No. 10, October, pp. 1683 – 1689.

Verdoorn, P.J. (1980) 'Verdoorn's Law in Retrospect: A Comment', *Economic Journal*, Vol. 90, June, pp. 382 – 385.

Viljoen, S.P. (1983) 'The Industrial Achievement of South Africa', *South African Journal of Economics*, Vol. 51, No. 1, pp. 29 – 57.

Young, A. (1928) 'Increasing Returns and Economic Progress', *Economic Journal*, Vol. 38, December, pp. 527 – 542.

Appendix A:
Contribution to GDP, 1946 – 1998

Table A.1: Contribution to GDP, 1946 – 1998

Year	Agriculture	Mining	Primary	Secondary	Manufacturing	Tertiary
1946	7.1	15.9	23.3	15.6	10.6	61.1
1947	8.1	15.2	23.3	17.5	11.5	59.2
1948	8.2	14.9	23.1	18.7	11.8	58.3
1949	7.0	15.2	22.4	19.3	12.3	58.3
1950	7.7	15.0	23.1	19.8	12.7	57.1
1951	8.0	14.8	22.7	20.5	13.3	56.8
1952	7.6	14.9	22.5	21.3	13.6	56.2
1953	7.9	14.4	22.4	21.2	13.9	56.4
1954	7.9	14.9	22.8	21.5	14.3	55.7
1955	7.7	15.4	23.2	21.7	14.6	55.1
1956	7.8	16.0	24.0	21.5	14.6	54.5
1957	7.2	16.2	23.7	21.8	14.7	54.6
1958	6.5	16.4	23.4	21.9	14.8	54.7
1959	6.8	17.4	24.6	21.7	14.7	53.7
1960	6.8	17.2	24.5	21.7	14.9	53.8
1961	6.8	17.5	24.8	21.7	15.0	53.6
1962	6.8	17.8	25.1	21.7	15.1	53.2
1963	6.6	17.5	24.6	23.0	16.2	52.4
1964	5.4	17.4	23.6	24.9	17.4	51.5
1965	5.1	17.0	22.8	25.7	17.8	51.4
1966	5.3	16.8	22.8	26.1	18.3	51.1
1967	6.3	15.7	22.4	26.5	18.5	51.2
1968	5.2	15.4	21.2	26.5	18.5	52.2
1969	5.2	14.8	20.5	27.6	19.2	51.9
1970	4.6	14.5	19.6	28.3	19.4	52.1
1971	5.2	13.3	18.9	29.0	19.7	52.1
1972	5.0	12.3	17.6	29.7	19.9	52.6
1973	4.2	11.7	16.2	30.6	20.8	53.2
1974	5.1	10.1	15.4	31.0	20.9	53.7
1975	4.6	9.4	14.0	31.2	21.1	54.8
1976	4.3	9.8	14.3	30.9	21.0	54.8
1977	4.9	10.0	15.0	30.1	20.4	54.9
1978	4.9	9.8	14.8	30.6	21.3	54.5
1979	4.6	9.7	14.4	31.6	22.1	54.0
1980	4.8	8.9	13.7	32.4	22.5	53.9
1981	4.8	8.4	13.1	32.9	23.3	53.9
1982	4.4	8.4	12.9	32.3	22.2	54.8

1983	3.5	8.6	12.2	30.9	22.1	56.8
1984	3.7	8.5	12.3	30.6	22.4	57.1
1985	4.4	8.5	13.0	29.5	21.8	57.4
1986	4.7	8.2	12.9	29.3	21.7	57.8
1987	4.7	7.7	12.4	29.1	21.7	58.5
1988	4.7	7.6	12.4	29.0	22.5	58.7
1989	5.3	7.4	12.6	29.0	22.4	58.4
1990	5.0	7.3	12.2	28.6	22.0	59.1
1991	5.2	7.2	12.4	27.8	21.2	59.8
1992	3.9	7.5	11.4	27.7	20.9	60.9
1993	4.7	7.6	12.3	27.1	20.6	60.5
1994	5.0	7.4	12.4	27.2	20.5	60.5
1995	3.9	7.0	10.8	27.9	21.2	61.3
1996	4.6	6.6	11.2	27.3	20.7	61.5
1997	4.6	6.6	11.2	27.3	20.7	61.5
1998	4.5	6.5	11.0	26.9	20.2	62.1

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the SARB Quarterly Bulletin, June 1999.

Appendix B:

Critical *F* Values for Ramsey's RESET Test

Table B.1: Critical *F* Values for Ramsey's RESET Test

Law 1					
52 Observations (1 explanatory variable)					
Critical F (≈)	1%	5%	10%	DF_1	DF_2
RESET (2)	7.31	4.08	2.84	1	49
RESET (3)	5.18	3.23	2.44	2	48
RESET (4)	4.31	2.84	2.23	3	47

Laws 2 & 3					
26 Observations (1 explanatory variable)					
Critical F (≈)	1%	5%	10%	DF_1	DF_2
RESET (2)	7.885	4.28	2.94	1	23
RESET (3)	5.72	3.44	2.56	2	22
RESET (4)	4.88	3.075	2.365	3	21

Law 3					
26 Observations (2 explanatory variables)					
Critical F (≈)	1%	5%	10%	DF_1	DF_2
RESET (2)	7.95	4.30	2.95	1	22
RESET (3)	5.785	3.465	2.575	2	21
RESET (4)	4.94	3.10	2.38	3	20

Source: Gujarati (1995)

Appendix C:

Data

Table C.1: GVA by Kind of Economic Activity (R millions), 1946 – 1998

GROSS VALUE ADDED BY KIND OF ECONOMIC ACTIVITY (R millions)

At constant 1995 prices

Date	GDP	Primary	AFF	MQ	Secondary	M	EGW	C	Tertiary	WRtCA	TSC	FilReBs	CSPs	GVA
1946	102043	21283	6469	14554	14303	9670	858	2844	55872	10062	6096	13371	25588	96066
1947	103995	21594	7448	14100	16150	10602	909	3720	54737	11458	6307	13830	22415	97551
1948	111647	22727	8071	14664	18380	11662	1017	4781	57436	12507	6711	14668	22842	103980
1949	114168	22842	7159	15458	19671	12560	1129	4949	59431	13131	7083	14668	23691	107208
1950	119857	24842	8253	16130	21239	13667	1258	5140	61393	13205	7177	15132	24947	113122
1951	125554	25378	8879	16476	22889	14878	1356	5347	63407	13384	7690	15815	25728	117987
1952	129355	26137	8797	17230	24661	15810	1465	6037	65137	13557	8164	15995	26475	122520
1953	135158	27023	9596	17437	25675	16825	1568	5746	68196	14527	8472	16747	27416	127580
1954	143993	29215	10104	19056	27478	18332	1725	5653	71287	15353	8690	17894	28464	135574
1955	152183	31209	10298	20730	29208	19601	1902	5746	74133	15655	9080	18649	30030	142968
1956	160711	33966	11103	22640	30468	20640	2011	5701	77144	16309	9459	19169	31606	151221
1957	168018	35033	10620	23979	32195	21734	2135	6104	80704	16843	9855	20024	33468	157742
1958	172769	35560	9906	24999	33414	22519	2244	6338	83304	17754	9957	20660	34666	162060
1959	180767	39116	10812	27563	34387	23286	2406	6219	85323	18289	10048	21300	35364	170440
1960	186174	40326	11210	28368	35689	24497	2551	5940	88641	19288	10512	22824	34370	176538
1961	193332	42305	11626	29861	37029	25597	2684	5869	91511	19640	10652	23653	35978	183517
1962	205276	45423	12285	32211	39293	27362	2835	5993	96143	20872	11249	24624	37910	194771
1963	220412	47515	12683	33821	44472	31229	3023	6758	101150	23312	11975	26024	38403	207780
1964	237912	48959	11231	36236	51714	36162	3246	8506	107096	25267	12940	27863	39691	222729
1965	252479	50362	11356	37423	56742	39189	3481	10093	113422	27475	13793	29289	41683	235599
1966	263685	52527	12249	38726	59971	42058	3593	9992	117681	28232	14327	30294	43439	246038
1967	282661	54626	15312	38331	64639	45257	3858	10890	125027	30821	15007	32093	45898	26049
1968	294401	54671	13480	39755	68414	47703	4173	11628	134666	34058	15899	35044	48645	27268
1969	308285	55967	14121	40455	75448	52478	4424	13287	141582	35988	17092	38506	49120	28799
1970	324466	56645	13182	41783	81615	55959	4888	15242	150204	38898	18910	40254	51051	30285
1971	338349	56999	15655	40239	87737	59516	5203	17294	157551	41482	19970	41431	53542	31607
1972	343948	54756	15555	38267	92230	61776	5696	18816	163403	42932	20760	43127	55243	32218
1973	359674	52778	13586	37946	99317	67507	6221	18851	172834	46669	22357	45898	56776	33447
1974	381653	52886	17712	34931	106605	71887	6719	20903	184827	50668	25108	47904	59632	35244
1975	388124	49709	16193	33177	110652	74652	7116	21412	194130	55138	25902	48982	62712	35952
1976	396856	52082	15801	35639	112401	76524	7394	20585	199694	55207	26551	50210	66103	36983
1977	396483	54412	17658	36366	109191	73961	7787	19475	199231	51797	27074	50322	67821	36976
1978	408435	55311	18366	36653	114359	79327	8229	17874	203571	51391	28260	51524	69856	38029
1979	423917	55984	17968	37568	122589	85877	8801	18112	209678	49545	30755	54157	71773	39520
1980	451983	56549	19761	36731	133992	92905	9564	19643	223161	55291	32921	57495	74130	41949

1981	476213	57267	20903	36525	143490	101468	10659	20731	234842	60498	35006	60501	76271	440514
1982	474387	55859	19138	36570	140337	96170	11286	19913	237872	60587	33921	61992	79362	437509
1983	465627	52384	14792	36676	132269	94442	11271	18833	243190	62716	31931	64049	83367	427971
1984	489370	55334	16479	38098	137694	100713	11996	19298	257405	68521	34441	66600	86843	450379
1985	483441	58247	19830	38228	132156	97399	12812	18329	256894	65601	34869	67666	87347	448739
1986	483528	57898	21137	36924	131224	97240	13160	16847	258766	63211	34272	69199	90183	448782
1987	493685	56469	21675	35213	133057	99384	13613	15733	267493	65042	34507	71750	93960	455810
1988	514421	58123	22283	35827	136429	105851	14350	16242	275974	67754	36157	73172	96887	473121
1989	526740	60567	25559	35451	139632	107828	14881	17611	281509	68031	37732	74546	99344	484728
1990	525066	58677	23735	35171	137163	105405	15141	17774	283290	68560	37745	74720	100761	481077
1991	519720	58762	24795	34397	132052	100590	15436	16942	283851	67349	36919	75875	102750	475697
1992	508613	53014	18036	34978	128700	97291	15520	15889	283445	65768	37620	76199	103858	465159
1993	514887	58148	22366	35782	128051	97114	16133	14804	285471	66121	38507	76580	104263	471670
1994	531538	60071	24125	35946	132008	99706	17069	15233	293703	67780	40281	79378	106264	485782
1995	548100	54147	19317	34830	139362	106180	17408	15774	306845	71768	44538	82162	108377	500354
1996	570857	58492	23949	34543	142143	107648	18403	16092	320151	74416	47368	87669	110698	520786
1997	585149	59628	24596	35032	145857	110199	19169	16489	327871	74816	50464	91462	111129	533356
1998	588344	59196	24304	34892	144393	108258	19296	16839	332929	73791	53573	94565	111000	536518

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the SARB Quarterly Bulletin, June 1999.

Table C.2: *Growth* in GVA by Kind of Economic Activity (R millions), 1947 – 1998

GROSS VALUE ADDED BY KIND OF ECONOMIC ACTIVITY (R millions)

At constant 1995 prices

Date	GDP	Primary	AFF	MQ	Secondary	M	EGW	C	Tertiary	WRtCA	TSC	FilReBs	CSPs
1947	1.913	1.461	15.134	-3.119	12.913	9.638	5.944	30.802	-2.031	13.874	3.461	3.433	-12.400
1948	7.358	5.247	8.365	4.000	13.808	9.998	11.881	28.522	4.931	9.155	6.406	6.059	1.905
1949	2.258	0.506	-11.300	5.415	7.024	7.700	11.013	3.514	3.473	4.989	5.543	0.000	3.717
1950	4.983	8.756	15.281	4.347	7.971	8.814	11.426	3.859	3.301	0.564	1.327	3.163	5.302
1951	4.753	2.158	7.585	2.145	7.769	8.861	7.790	4.027	3.281	1.356	7.148	4.514	3.131
1952	3.027	2.991	-0.924	4.576	7.742	6.264	8.038	12.904	2.728	1.293	6.164	1.138	2.903
1953	4.486	3.390	9.083	1.201	4.112	6.420	7.031	-4.820	4.696	7.155	3.773	4.701	3.554
1954	6.537	8.112	5.294	9.285	7.022	8.957	10.013	-1.619	4.533	5.686	2.573	6.849	3.823
1955	5.688	6.825	1.920	8.785	6.296	6.922	10.261	1.645	3.992	1.967	4.488	4.219	5.502
1956	5.604	8.834	7.817	9.214	4.314	5.301	5.731	-0.783	4.062	4.178	4.174	2.788	5.248
1957	4.547	3.141	-4.350	5.914	5.668	5.300	6.166	7.069	4.615	3.274	4.186	4.460	5.891
1958	2.828	1.504	-6.723	4.254	3.786	3.612	5.105	3.834	3.222	5.409	1.035	3.176	3.580
1959	4.629	10.000	9.146	10.256	2.912	3.406	7.219	-1.878	2.424	3.013	0.914	3.098	2.014
1960	2.991	3.093	3.681	2.921	3.786	5.201	6.027	-4.486	3.889	5.462	4.618	7.155	-2.811
1961	3.845	4.908	3.711	5.263	3.755	4.490	5.214	-1.195	3.238	1.825	1.332	3.632	4.678
1962	6.178	7.370	5.668	7.870	6.114	6.895	5.626	2.113	5.062	6.273	5.605	4.105	5.370
1963	7.373	4.606	3.240	4.998	13.180	14.133	6.631	12.765	5.208	11.690	6.454	5.686	1.300
1964	7.940	3.039	-11.448	7.141	16.284	15.796	7.377	25.866	5.878	8.386	8.058	7.067	3.354
1965	6.123	2.866	1.113	3.276	9.723	8.371	7.240	18.657	5.907	8.739	6.592	5.118	5.019
1966	4.438	4.299	7.864	3.482	5.691	7.321	3.217	-1.001	3.755	2.755	3.872	3.431	4.213
1967	7.196	3.996	25.006	-1.020	7.784	7.606	7.375	8.987	6.242	9.170	4.746	5.938	5.661
1968	4.153	0.082	-11.964	3.715	5.840	5.405	8.165	6.777	7.710	10.503	5.944	9.195	5.985
1969	4.716	2.371	4.755	1.761	10.282	10.010	6.015	14.267	5.136	5.667	7.504	9.879	0.976
1970	5.249	1.211	-6.650	3.283	8.174	6.633	10.488	14.714	6.090	8.086	10.637	4.540	3.931
1971	4.279	0.625	18.760	-3.695	7.501	6.356	6.444	13.463	4.891	6.643	5.605	2.924	4.879
1972	1.655	-3.935	-0.639	-4.901	5.121	3.797	9.475	8.801	3.714	3.495	3.956	4.094	3.177
1973	4.572	-3.612	-12.658	-0.839	7.684	9.277	9.217	0.186	5.772	8.704	7.693	6.425	2.775
1974	6.111	0.205	30.369	-7.946	7.338	6.488	8.005	10.885	6.939	8.569	12.305	4.371	5.030
1975	1.696	-6.007	-8.576	-5.021	3.796	3.846	5.909	2.435	5.033	8.822	3.162	2.250	5.165
1976	2.250	4.774	-2.421	7.421	1.581	2.508	3.907	-3.862	2.866	0.125	2.506	2.507	5.407
1977	-0.094	4.474	11.752	2.040	-2.856	-3.349	5.315	-5.392	-0.232	-6.177	1.970	0.223	2.599
1978	3.015	1.652	4.010	0.789	4.733	7.255	5.676	-8.221	2.178	-0.784	4.381	2.389	3.001
1979	3.791	1.217	-2.167	2.496	7.197	8.257	6.951	1.332	3.000	-3.592	8.829	5.110	2.744
1980	6.621	1.009	9.979	-2.228	9.302	8.184	8.669	8.453	6.430	11.598	7.043	6.164	3.284
1981	5.361	1.270	5.779	-0.561	7.088	9.217	11.449	5.539	5.234	9.417	6.333	5.228	2.888

1982	-0.383	-2.459	-8.444	0.123	-2.197	-5.221	5.882	-3.946	1.290	0.147	-3.099	2.464	4.053
1983	-1.847	-6.221	-22.709	0.290	-5.749	-1.797	-0.133	-5.424	2.236	3.514	-5.867	3.318	5.046
1984	5.099	5.631	11.405	3.877	4.101	6.640	6.432	2.469	5.845	9.256	7.861	3.983	4.170
1985	-1.212	5.264	20.335	0.341	-4.022	-3.291	6.802	-5.021	-0.199	-4.261	1.243	1.601	0.580
1986	0.018	-0.599	6.591	-3.411	-0.705	-0.163	2.716	-8.086	0.729	-3.643	-1.712	2.266	3.247
1987	2.101	-2.468	2.545	-4.634	1.397	2.205	3.442	-6.612	3.373	2.897	0.686	3.686	4.188
1988	4.200	2.929	2.805	1.744	2.534	6.507	5.414	3.235	3.171	4.170	4.782	1.982	3.115
1989	2.395	4.205	14.702	-1.049	2.348	1.868	3.700	8.429	2.006	0.409	4.356	1.878	2.536
1990	-0.318	-3.121	-7.136	-0.790	-1.768	-2.247	1.747	0.926	0.633	0.778	0.034	0.233	1.426
1991	-1.018	0.145	4.466	-2.201	-3.726	-4.568	1.948	-4.681	0.198	-1.766	-2.188	1.546	1.974
1992	-2.137	-9.782	-27.260	1.689	-2.538	-3.280	0.544	-6.215	-0.143	-2.347	1.899	0.427	1.078
1993	1.234	9.684	24.008	2.299	-0.504	-0.182	3.950	-6.829	0.715	0.537	2.358	0.500	0.390
1994	3.234	3.307	7.865	0.458	3.090	2.669	5.802	2.898	2.884	2.509	4.607	3.654	1.919
1995	3.116	-9.862	-19.930	-3.105	5.571	6.493	1.986	3.552	4.475	5.884	10.568	3.507	1.988
1996	4.152	8.024	23.979	-0.824	1.996	1.383	5.716	2.016	4.336	3.690	6.354	6.703	2.142
1997	2.504	1.942	2.702	1.416	2.613	2.370	4.162	2.467	2.411	0.538	6.536	4.327	0.389
1998	0.546	-0.724	-1.187	-0.400	-1.004	-1.761	0.663	2.123	1.543	-1.370	6.161	3.393	-0.116

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the SARB Quarterly Bulletin, June 1999.

Table C.3: Gross Employment by Kind of Economic Activity, 1970 – 1996

GROSS EMPLOYMENT BY KIND OF ECONOMIC ACTIVITY									
Date	Agriculture	MQ	M	EGW	C	WRtCA	TSC	FilReBs	CSPs
1970	1639300	655346	1068921	22481	317814	620268	338320	85994	700484
1971	1638800	652294	1107000	24200	344400	650307	347458	90895	733636
1972	1505700	623067	1127275	26157	343958	672227	356843	95478	761528
1973	1468100	684743	1189000	28200	403700	691404	366482	99950	807101
1974	1454200	674140	1259800	29900	476178	656897	376381	104071	838818
1975	1433500	639473	1307600	32700	483600	724439	386547	106814	898374
1976	1280000	671240	1355205	37300	466409	734349	396988	108107	927875
1977	1247000	712006	1317200	38700	376700	725458	407711	105991	911645
1978	1292900	658261	1312100	40800	315857	730448	418793	106959	922023
1979	1320000	686599	1332743	42600	315100	737764	419955	112346	918926
1980	1235200	709042	1421400	45300	364164	756319	428789	120636	941693
1981	1146300	722918	1508322	48900	414100	764722	438635	132419	976135
1982	1138900	702041	1542618	54700	446866	774259	454993	140811	996975
1983	1131600	700901	1465827	60000	428100	758091	435152	149549	1045755
1984	1223900	711511	1477940	63600	424300	764603	432163	157592	1077951
1985	1323700	724587	1428988	66200	410100	755712	425454	160857	1064495
1986	1351600	756637	1415536	63760	402500	747908	409247	159730	1111144
1987	1354600	763319	1427826	56840	407600	754944	387794	161351	1183331
1988	1219600	732522	1448531	57170	413800	786421	378765	171553	1231782
1989	1202000	706810	1458831	52400	417200	806255	373540	178974	1267552
1990	1184700	692900	1462118	50920	417500	791108	361268	186280	1276235
1991	1115300	653134	1430818	47940	391000	784600	343340	186545	1300772
1992	1051200	607950	1394419	45890	373700	777769	334995	190503	1312925
1993	1093300	561655	1405552	42480	374529	762000	303072	193076	1314777
1994	921700	613584	1399513	39975	366173	730005	280642	193793	1568331
1995	891000	599885	1417398	39684	359126	751629	284348	200981	1581637
1996	914500	563396	1433649	40112	325926	757175	283275	215250	1627373

Source: *Agricultural Censuses and Surveys*, *Bulletin of Statistics* and *South African Labour Statistics*, Central Statistical Service of South Africa (various issues).

Table C.4: *Growth* in Gross Employment by Kind of Economic Activity, 1971 – 1996

GROSS EMPLOYMENT BY KIND OF ECONOMIC ACTIVITY									
Date	Agriculture	MQ	M	EGW	C	WRtCA	TSC	FilReBs	CSPs
1971	-0.031	-0.466	3.562	7.646	8.365	4.843	2.701	5.699	4.733
1972	-8.122	-4.481	1.832	8.087	-0.128	3.371	2.701	5.042	3.802
1973	-2.497	9.899	5.476	7.811	17.369	2.853	2.701	4.684	5.984
1974	-0.947	-1.548	5.955	6.028	17.953	-4.991	2.701	4.123	3.930
1975	-1.423	-5.142	3.794	9.365	1.559	10.282	2.701	2.636	7.100
1976	-10.708	4.968	3.641	14.067	-3.555	1.368	2.701	1.211	3.284
1977	-2.578	6.073	-2.804	3.753	-19.234	-1.211	2.701	-1.957	-1.749
1978	3.681	-7.548	-0.387	5.426	-16.152	0.688	2.718	0.913	1.138
1979	2.096	4.305	1.573	4.412	-0.240	1.002	0.277	5.037	-0.336
1980	-6.424	3.269	6.652	6.338	15.571	2.515	2.104	7.379	2.478
1981	-7.197	1.957	6.115	7.947	13.713	1.111	2.296	9.767	3.657
1982	-0.646	-2.888	2.274	11.861	7.913	1.247	3.729	6.337	2.135
1983	-0.641	-0.162	-4.978	9.689	-4.199	-2.088	-4.361	6.205	4.893
1984	8.157	1.514	0.826	6.000	-0.888	0.859	-0.687	5.378	3.079
1985	8.154	1.838	-3.312	4.088	-3.347	-1.163	-1.552	2.072	-1.248
1986	2.108	4.423	-0.941	-3.686	-1.853	-1.033	-3.809	-0.701	4.382
1987	0.222	0.883	0.868	-10.853	1.267	0.941	-5.242	1.015	6.497
1988	-9.966	-4.035	1.450	0.581	1.521	4.169	-2.328	6.323	4.094
1989	-1.443	-3.510	0.711	-8.344	0.822	2.522	-1.379	4.326	2.904
1990	-1.439	-1.968	0.225	-2.824	0.072	-1.879	-3.285	4.082	0.685
1991	-5.858	-5.739	-2.141	-5.852	-6.347	-0.823	-4.963	0.142	1.923
1992	-5.747	-6.918	-2.544	-4.276	-4.425	-0.871	-2.431	2.122	0.934
1993	4.005	-7.615	0.798	-7.431	0.222	-2.027	-9.529	1.351	0.141
1994	-15.696	9.246	-0.430	-5.897	-2.231	-4.199	-7.401	0.371	19.285
1995	-3.331	-2.233	1.278	-0.728	-1.925	2.962	1.321	3.709	0.848
1996	2.637	-6.083	1.147	1.079	-9.245	0.738	-0.377	7.100	2.892

Source: *Bulletin of Statistics* and *South African Labour Statistics*, Central Statistical Service of South Africa (various issues).

Table C.5: Variables used in the regression analysis for Law 1, 1947 – 1998*

Date	g_{GDP}	g_m	g_{nm}	g_m-g_{nm}
1947	1.913	9.638	0.432	9.206
1948	7.358	9.998	6.328	3.670
1949	2.258	7.700	2.354	5.346
1950	4.983	8.814	4.554	4.260
1951	4.753	8.861	3.763	5.098
1952	3.027	6.264	3.216	3.048
1953	4.486	6.420	3.877	2.543
1954	6.537	8.957	5.349	3.608
1955	5.688	6.922	4.817	2.106
1956	5.604	5.301	5.271	0.030
1957	4.547	5.300	4.263	1.038
1958	2.828	3.612	2.842	0.770
1959	4.629	3.406	4.329	-0.923
1960	2.991	5.201	2.320	2.881
1961	3.845	4.490	3.628	0.862
1962	6.178	6.895	5.727	1.168
1963	7.373	14.133	5.420	8.713
1964	7.940	15.796	5.757	10.039
1965	6.123	8.371	5.827	2.544
1966	4.438	7.321	3.585	3.736
1967	7.196	7.606	6.280	1.326
1968	4.153	5.405	5.448	-0.044
1969	4.716	10.010	5.087	4.923
1970	5.249	6.633	5.265	1.368
1971	4.279	6.356	4.731	1.625
1972	1.655	3.797	2.376	1.421
1973	4.572	9.277	3.290	5.987
1974	6.111	6.488	6.151	0.337
1975	1.696	3.846	2.677	1.170
1976	2.250	2.508	2.534	-0.026
1977	-0.094	-3.349	0.292	-3.641
1978	3.015	7.255	1.384	5.871
1979	3.791	8.257	2.313	5.944
1980	6.621	8.184	5.839	2.344
1981	5.361	9.217	5.092	4.125
1982	-0.383	-5.221	0.522	-5.743

1983	-1.847	-1.797	0.268	-2.065
1984	5.099	6.640	5.760	0.880
1985	-1.212	-3.291	0.703	-3.993
1986	0.018	-0.163	0.073	-0.236
1987	2.101	2.205	1.902	0.303
1988	4.200	6.507	3.180	3.327
1989	2.395	1.868	2.890	-1.023
1990	-0.318	-2.247	0.121	-2.368
1991	-1.018	-4.568	0.229	-4.797
1992	-2.137	-3.280	-1.761	-1.518
1993	1.234	-0.182	1.818	-2.000
1994	3.234	2.669	3.076	-0.407
1995	3.116	6.493	2.098	4.396
1996	4.152	1.383	4.811	-3.429
1997	2.504	2.370	2.425	-0.055
1998	0.546	-1.761	1.206	-2.967

*Namely, *growth* in overall GDP (g_{GDP}), *growth* in manufacturing output (g_m), *growth* in non-manufacturing output (g_{nm}) and *growth* in the difference between manufacturing and non-manufacturing output (g_m-g_{nm}).

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the SARB Quarterly Bulletin, June 1999.

Table C.6: Variables used in the regression analysis for Laws 2 & 3, 1971 – 1996*

Date	p_m	e_m	p_{nm}	g_m	e_{nm}	p_{GDP}
1971	2.794	3.562	2.403	6.356	2.328	1.708
1972	1.966	1.832	4.541	3.797	-2.165	3.028
1973	3.801	5.476	-0.467	9.277	3.757	0.464
1974	0.534	5.955	4.812	6.488	1.339	3.816
1975	0.052	3.794	0.619	3.846	2.057	-0.735
1976	-1.133	3.641	4.302	2.508	-1.768	2.841
1977	-0.545	-2.804	2.392	-3.349	-2.100	2.166
1978	7.642	-0.387	2.250	7.255	-0.866	3.772
1979	6.684	1.573	0.814	8.257	1.499	2.275
1980	1.532	6.652	4.788	8.184	1.051	4.301
1981	3.102	6.115	4.158	9.217	0.934	3.204
1982	-7.495	2.274	-0.887	-5.221	1.409	-2.004
1983	3.181	-4.978	0.277	-1.797	-0.008	-0.612
1984	5.814	0.826	2.650	6.640	3.110	2.531
1985	0.022	-3.312	-0.852	-3.291	1.555	-1.630
1986	0.778	-0.941	-1.376	-0.163	1.448	-0.893
1987	1.337	0.868	0.557	2.205	1.344	0.861
1988	5.057	1.450	4.722	6.507	-1.542	5.085
1989	1.157	0.711	2.628	1.868	0.263	2.031
1990	-2.472	0.225	0.997	-2.247	-0.876	0.309
1991	-2.427	-2.141	3.017	-4.568	-2.787	1.622
1992	-0.736	-2.544	0.887	-3.280	-2.648	0.487
1993	-0.980	0.798	2.884	-0.182	-1.066	1.873
1994	3.099	-0.430	1.583	2.669	1.492	2.188
1995	5.215	1.278	2.223	6.493	-0.125	2.920
1996	0.236	1.147	4.414	1.383	0.398	3.581

*Namely, *growth* of productivity in manufacturing (p_m), *growth* of employment in manufacturing (e_m), *growth* of productivity in non-manufacturing (p_{nm}), *growth* in manufacturing output (g_m), *growth* of employment in non-manufacturing (e_{nm}) and *growth* of overall productivity (p_{GDP}).

Source: *South Africa's National Accounts 1946 – 1998*, Supplement to the SARB Quarterly Bulletin, June 1999 and *Bulletin of Statistics* and *South African Labour Statistics*, Central Statistical Service of South Africa (various issues).

Appendix D:

SHAZAM Command and Output Files

Command File: Equation (1.1)

```
file 11 c:\kaldor.txt
read(11) D G M / skiplines=1
sample 1 52
ols G M / Rstat
test
test G=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.1) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.7431     R-SQUARE ADJUSTED =   0.7379
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.6621
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2892
SUM OF SQUARED ERRORS-SSE=   83.104
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -85.9750

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M          0.46929    0.3903E-01   12.02     0.000 0.862      0.8620     0.6593
CONSTANT    1.1779     0.2605      4.521     0.000 0.539      0.0000     0.3407

DURBIN-WATSON = 2.1952    VON NEUMANN RATIO = 2.2383    RHO = -0.18424
RESIDUAL SUM =  0.23453E-13  RESIDUAL VARIANCE =   1.6621
SUM OF ABSOLUTE ERRORS=   51.364
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.7431
RUNS TEST:   30 RUNS,   25 POS,     0 ZERO,   27 NEG  NORMAL STATISTIC =  0.8524

:_TEST VALUE =  0.46929     STD. ERROR OF TEST VALUE  0.39027E-01
T STATISTIC =   12.024873     WITH    50 D.F.     P-VALUE= 0.00000
F STATISTIC =   144.59756     WITH     1 AND    50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   144.59756     WITH     1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.00692

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G                52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.469293640565       1.17789069909

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   1.9112     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=  0.93695     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   1.7815     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.2)

```
file 11 c:\kaldor.txt
read(11) D N M / skiplines=1
sample 1 52
ols N M / Rstat
test
test N=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.2) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = N
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.5142     R-SQUARE ADJUSTED =   0.5045
VARIANCE OF THE ESTIMATE-SIGMA**2 =   3.8525
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.9628
SUM OF SQUARED ERRORS-SSE=   192.62
MEAN OF DEPENDENT VARIABLE =   3.7726
LOG OF THE LIKELIHOOD FUNCTION = -107.832

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M          0.43227    0.5942E-01   7.275     0.000 0.717      0.7171     0.5564
CONSTANT   1.6734     0.3967       4.219     0.000 0.512      0.0000     0.4436

DURBIN-WATSON = 2.5801    VON NEUMANN RATIO = 2.6307    RHO = -0.29468
RESIDUAL SUM = -0.91732E-13  RESIDUAL VARIANCE =    3.8525
SUM OF ABSOLUTE ERRORS=   77.949
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5142
RUNS TEST:   31 RUNS,   30 POS,    0 ZERO,   22 NEG  NORMAL STATISTIC =  1.3248

:_TEST VALUE =  0.43227      STD. ERROR OF TEST VALUE  0.59416E-01
T STATISTIC =   7.2752386     WITH   50 D.F.     P-VALUE= 0.00000
F STATISTIC =   52.929096     WITH    1 AND    50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   52.929096     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.01889

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = N                52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.432269149823       1.67343376216

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.78552     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=  0.53606     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=  0.35455     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.3)

```
file 11 c:\kaldor.txt
read(11) D G N / skiplines=1
sample 1 52
ols G N / Rstat
test
test G=0
test N=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.3) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.3616     R-SQUARE ADJUSTED =   0.3488
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.1296
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.0321
SUM OF SQUARED ERRORS-SSE=   206.48
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -109.638


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
N         0.43955     0.8259E-01   5.322     0.000 0.601     0.6013     0.1975
CONSTANT   2.7740     0.3096       8.959     0.000 0.785     0.0000     0.8025

DURBIN-WATSON = 1.8559    VON NEUMANN RATIO = 1.8923    RHO =  0.01170
RESIDUAL SUM =  0.00000      RESIDUAL VARIANCE =   4.1296
SUM OF ABSOLUTE ERRORS=   84.067
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.3616
RUNS TEST:   25 RUNS,   25 POS,     0 ZERO,    27 NEG  NORMAL STATISTIC = -0.5503

:_TEST VALUE =  0.43955      STD. ERROR OF TEST VALUE  0.82595E-01
T STATISTIC =   5.3218066      WITH   50 D.F.    P-VALUE= 0.00000
F STATISTIC =   28.321625      WITH    1 AND    50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   28.321625     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.03531

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.439552892249      2.77399608596

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   6.4644     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   3.2829     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   5.1337     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.4)

```
file 11 c:\kaldor.txt
read(11) D G T / skiplines=1
sample 1 52
ols G T / Rstat
test
test G=0
test T=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.4) Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.6239     R-SQUARE ADJUSTED =   0.6163
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.4331
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.5598
SUM OF SQUARED ERRORS-SSE=   121.66
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -95.8835

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
T          0.95188     0.1045      9.107     0.000 0.790      0.7899     0.9673
CONSTANT  0.11296     0.4262      0.2651     0.792 0.037      0.0000     0.0327

DURBIN-WATSON = 1.1992    VON NEUMANN RATIO = 1.2227    RHO =  0.34171
RESIDUAL SUM = -0.65503E-13  RESIDUAL VARIANCE =   2.4331
SUM OF ABSOLUTE ERRORS=   61.975
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6239
RUNS TEST:   18 RUNS,   27 POS,    0 ZERO,    25 NEG  NORMAL STATISTIC = -2.5140

:_TEST VALUE =  0.95188      STD. ERROR OF TEST VALUE  0.10453
T STATISTIC =   9.1066942     WITH   50 D.F.    P-VALUE= 0.00000
F STATISTIC =   82.931880     WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   82.931880     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.01206

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.951880905008      0.112959905426

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.36181E-01 - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   7.9662     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   5.4284     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.4) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.5908     R-SQUARE ADJUSTED =   0.5826
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.1233
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.4572
SUM OF SQUARED ERRORS-SSE=   106.17
MEAN OF DEPENDENT VARIABLE =   2.2768
LOG OF THE LIKELIHOOD FUNCTION = -92.3423

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
T          0.94838     0.1116       8.496     0.000 0.769      0.7686     0.9684
CONSTANT  0.71887E-01 0.3289      0.2186     0.828 0.031      0.0000     0.0316

DURBIN-WATSON = 1.9106    VON NEUMANN RATIO = 1.9481    RHO = -0.01976
RESIDUAL SUM = -0.10236E-12  RESIDUAL VARIANCE =   2.1233
SUM OF ABSOLUTE ERRORS=   57.658
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5908
RUNS TEST:   24 RUNS,   28 POS,    0 ZERO,   24 NEG  NORMAL STATISTIC = -0.8021

:_TEST VALUE =  0.94838      STD. ERROR OF TEST VALUE  0.11163
T STATISTIC =   8.4958043     WITH   50 D.F.    P-VALUE= 0.00000
F STATISTIC =   72.178691     WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   72.178691     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.01385

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G                 52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.948377095289       0.718866525710E-01

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.92447E-04  - F WITH DF1=   1 AND DF2=  49
 RESET(3)=    1.0706     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=  0.75172      - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.5)

```
file 11 c:\kaldor.txt
read(11) D T M / skiplines=1
sample 1 52
ols T M / Rstat
test
test T=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.5) Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = T
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.4204     R-SQUARE ADJUSTED =   0.4088
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.5815
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.6067
SUM OF SQUARED ERRORS-SSE=   129.07
MEAN OF DEPENDENT VARIABLE =   3.5129
LOG OF THE LIKELIHOOD FUNCTION = -97.4225

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M         0.29291     0.4864E-01   6.022     0.000 0.648      0.6484     0.4049
CONSTANT   2.0905     0.3247       6.438     0.000 0.673      0.0000     0.5951

DURBIN-WATSON = 1.1762    VON NEUMANN RATIO = 1.1993    RHO =  0.22508
RESIDUAL SUM = -0.39233E-13  RESIDUAL VARIANCE =   2.5815
SUM OF ABSOLUTE ERRORS=   57.396
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.4204
RUNS TEST:   19 RUNS,   26 POS,    0 ZERO,   26 NEG  NORMAL STATISTIC = -2.2409

:_TEST VALUE =  0.29291      STD. ERROR OF TEST VALUE  0.48638E-01
T STATISTIC =   6.0222834      WITH   50 D.F.     P-VALUE= 0.00000
F STATISTIC =   36.267898      WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   36.267898     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.02757

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = T              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.292909213075      2.09050057808

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   4.0021     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   1.9736     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   3.3193     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.5) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = T
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.3728     R-SQUARE ADJUSTED =   0.3603
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.2879
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.5126
SUM OF SQUARED ERRORS-SSE=   114.39
MEAN OF DEPENDENT VARIABLE =   2.7299
LOG OF THE LIKELIHOOD FUNCTION = -94.2832

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M         0.27681     0.5077E-01   5.452     0.000 0.611     0.6106     0.3803
CONSTANT   1.6917     0.2833       5.971     0.000 0.645     0.0000     0.6197

DURBIN-WATSON = 1.6648    VON NEUMANN RATIO = 1.6975    RHO = -0.00428
RESIDUAL SUM =  0.17784E-13  RESIDUAL VARIANCE =   2.2879
SUM OF ABSOLUTE ERRORS=   56.595
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.3728
RUNS TEST:    23 RUNS,   24 POS,     0 ZERO,   28 NEG  NORMAL STATISTIC = -1.0839

:_TEST VALUE =  0.27681     STD. ERROR OF TEST VALUE  0.50772E-01
T STATISTIC =   5.4520572     WITH   50 D.F.     P-VALUE= 0.00000
F STATISTIC =   29.724928     WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   29.724928     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.03364

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = T               52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.276810897239       1.69165743571

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   5.4609     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   3.1234     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   4.4292     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.6)

```
file 11 c:\kaldor.txt
read(11) D G P / skiplines=1
sample 1 52
ols G P / Rstat
test
test G=0
test P=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.6) Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.2326     R-SQUARE ADJUSTED =   0.2173
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.9640
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.2280
SUM OF SQUARED ERRORS-SSE=   248.20
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -114.423

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
P         0.27369     0.7030E-01   3.893     0.000 0.482     0.4823     0.1649
CONSTANT   2.8866     0.3419       8.442     0.000 0.767     0.0000     0.8351

DURBIN-WATSON = 1.1082    VON NEUMANN RATIO = 1.1299    RHO =  0.44101
RESIDUAL SUM = -0.31086E-13  RESIDUAL VARIANCE =    4.9640
SUM OF ABSOLUTE ERRORS=   90.902
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.2326
RUNS TEST:   19 RUNS,   26 POS,    0 ZERO,   26 NEG  NORMAL STATISTIC = -2.2409

:_TEST VALUE =  0.27369     STD. ERROR OF TEST VALUE  0.70301E-01
T STATISTIC =   3.8931654     WITH   50 D.F.     P-VALUE= 0.00029
F STATISTIC =   15.156736     WITH    1 AND   50 D.F.  P-VALUE= 0.00029
WALD CHI-SQUARE STATISTIC =   15.156736      WITH    1 D.F.  P-VALUE= 0.00010
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.06598

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G               52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.273693890317       2.88661384193

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.84449     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=    1.6075     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=    1.0577     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.6) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =    0.2309    R-SQUARE ADJUSTED =    0.2155
VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.9234
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.9808
SUM OF SQUARED ERRORS-SSE=   196.17
MEAN OF DEPENDENT VARIABLE =    1.9332
LOG OF THE LIKELIHOOD FUNCTION = -108.306

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
P          0.22457    0.5797E-01   3.874     0.000 0.480     0.4805     0.1342
CONSTANT   1.6737     0.2827       5.920     0.000 0.642     0.0000     0.8658

DURBIN-WATSON = 1.8632    VON NEUMANN RATIO = 1.8997    RHO =  0.06036
RESIDUAL SUM =  0.71054E-14  RESIDUAL VARIANCE =    3.9234
SUM OF ABSOLUTE ERRORS=   80.972
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.2309
RUNS TEST:    23 RUNS,    28 POS,     0 ZERO,    24 NEG  NORMAL STATISTIC = -1.0839

:_TEST VALUE =  0.22457      STD. ERROR OF TEST VALUE  0.57967E-01
T STATISTIC =    3.8740997     WITH    50 D.F.     P-VALUE= 0.00031
F STATISTIC =    15.008648     WITH     1 AND    50 D.F.  P-VALUE= 0.00031
WALD CHI-SQUARE STATISTIC =    15.008648      WITH     1 D.F.  P-VALUE= 0.00011
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.06663

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G                  52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.224568031321       1.67367412319

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   1.0284     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   3.1536     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   2.4641     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.7)

```
file 11 c:\kaldor.txt
read(11) D G A / skiplines=1
sample 1 52
ols G A / Rstat
test
test G=0
test A=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.7) Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.0847     R-SQUARE ADJUSTED =   0.0663
VARIANCE OF THE ESTIMATE-SIGMA**2 =   5.9211
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.4333
SUM OF SQUARED ERRORS-SSE=   296.06
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -119.007

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
A         0.61550E-01 0.2862E-01   2.150     0.036 0.291     0.2910     0.0583
CONSTANT   3.2553     0.3502       9.295     0.000 0.796     0.0000     0.9417

DURBIN-WATSON = 0.9584    VON NEUMANN RATIO = 0.9772    RHO =  0.51236
RESIDUAL SUM =  0.40412E-13  RESIDUAL VARIANCE =   5.9211
SUM OF ABSOLUTE ERRORS=   100.37
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.0847
RUNS TEST:   21 RUNS,   27 POS,    0 ZERO,   25 NEG  NORMAL STATISTIC = -1.6724

:_TEST VALUE =  0.61550E-01 STD. ERROR OF TEST VALUE  0.28622E-01
T STATISTIC =   2.1504218     WITH   50 D.F.    P-VALUE= 0.03638
F STATISTIC =   4.6243138     WITH    1 AND   50 D.F.  P-VALUE= 0.03638
WALD CHI-SQUARE STATISTIC =   4.6243138     WITH    1 D.F.  P-VALUE= 0.03152
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.21625

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G               52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.615504467152E-01   3.25531401935

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   2.7965     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   2.5810     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   1.7366     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.7) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.1578     R-SQUARE ADJUSTED =   0.1410
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.3093
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.0759
SUM OF SQUARED ERRORS-SSE=   215.47
MEAN OF DEPENDENT VARIABLE =   1.6859
LOG OF THE LIKELIHOOD FUNCTION = -110.745

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
A         0.59111E-01 0.1931E-01   3.061     0.004 0.397     0.3973     0.0541
CONSTANT   1.5946     0.2894       5.510     0.000 0.615     0.0000     0.9459

DURBIN-WATSON = 1.9757    VON NEUMANN RATIO = 2.0144    RHO = -0.00007
RESIDUAL SUM =  0.24869E-13  RESIDUAL VARIANCE =   4.3093
SUM OF ABSOLUTE ERRORS=   83.802
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.1578
RUNS TEST:   23 RUNS,   28 POS,    0 ZERO,   24 NEG  NORMAL STATISTIC = -1.0839

:_TEST VALUE =  0.59111E-01 STD. ERROR OF TEST VALUE  0.19310E-01
T STATISTIC =    3.0612134     WITH    50 D.F.     P-VALUE= 0.00354
F STATISTIC =    9.3710277     WITH     1 AND    50 D.F.  P-VALUE= 0.00354
WALD CHI-SQUARE STATISTIC =    9.3710277     WITH     1 D.F.  P-VALUE= 0.00220
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.10671

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G                 52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.591107403187E-01   1.59462568344

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   1.4732      - F WITH DF1=   1 AND DF2=  49
 RESET(3)=  0.81008      - F WITH DF1=   2 AND DF2=  48
 RESET(4)=  0.56444      - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.8)

```
file 11 c:\kaldor.txt
read(11) D G Q / skiplines=1
sample 1 52
ols G Q / Rstat
test
test G=0
test Q=0
end
Diagnos / RESET
stop
```

Output File: Equation (1.8) Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.1313     R-SQUARE ADJUSTED =   0.1139
VARIANCE OF THE ESTIMATE-SIGMA**2 =   5.6196
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.3706
SUM OF SQUARED ERRORS-SSE=   280.98
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -117.648

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
Q          0.22401     0.8150E-01   2.749     0.008 0.362     0.3623     0.1151
CONSTANT   3.0590      0.3592       8.517     0.000 0.769     0.0000     0.8849

DURBIN-WATSON = 1.2180    VON NEUMANN RATIO = 1.2419    RHO =  0.38829
RESIDUAL SUM = -0.20428E-13  RESIDUAL VARIANCE =   5.6196
SUM OF ABSOLUTE ERRORS=   93.759
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.1313
RUNS TEST:   19 RUNS,   29 POS,    0 ZERO,   23 NEG  NORMAL STATISTIC = -2.1734

:_TEST VALUE =  0.22401     STD. ERROR OF TEST VALUE  0.81497E-01
T STATISTIC =   2.7487025     WITH   50 D.F.    P-VALUE= 0.00830
F STATISTIC =   7.5553654     WITH    1 AND   50 D.F.  P-VALUE= 0.00830
WALD CHI-SQUARE STATISTIC =   7.5553654     WITH    1 D.F.  P-VALUE= 0.00598
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.13236

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.224010742195       3.05901200106

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   3.2936     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   3.2327     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   2.1366     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.8) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.0730     R-SQUARE ADJUSTED =   0.0544
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.7577
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.1812
SUM OF SQUARED ERRORS-SSE=   237.88
MEAN OF DEPENDENT VARIABLE =   2.1157
LOG OF THE LIKELIHOOD FUNCTION = -113.319

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
Q          0.17196     0.8667E-01   1.984     0.053 0.270     0.2702     0.0884
CONSTANT   1.9286     0.3168       6.087     0.000 0.652     0.0000     0.9116

DURBIN-WATSON = 1.8984    VON NEUMANN RATIO = 1.9356    RHO =  0.04131
RESIDUAL SUM = -0.40856E-13  RESIDUAL VARIANCE =   4.7577
SUM OF ABSOLUTE ERRORS=   88.612
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.0730
RUNS TEST:   24 RUNS,   31 POS,    0 ZERO,   21 NEG  NORMAL STATISTIC = -0.5934

:_TEST VALUE =  0.17196     STD. ERROR OF TEST VALUE  0.86669E-01
T STATISTIC =   1.9840567     WITH   50 D.F.    P-VALUE= 0.05275
F STATISTIC =   3.9364809     WITH    1 AND   50 D.F.  P-VALUE= 0.05275
WALD CHI-SQUARE STATISTIC =   3.9364809     WITH    1 D.F.  P-VALUE= 0.04725
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.25403

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.171956243771       1.92858799055

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   2.4349     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   3.6231     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   2.8113     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (1.9)

```
file 11 c:\kaldor.txt
read(11) D G S / skiplines=1
sample 1 52
ols G S / Rstat
test
test G=0
test S=0
end
Diagnos / RESET
Stop
```

Output File: Equation (1.9) Indecisive

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.6967     R-SQUARE ADJUSTED =   0.6906
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.9621
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.4008
SUM OF SQUARED ERRORS-SSE=   98.107
MEAN OF DEPENDENT VARIABLE =   3.4568
LOG OF THE LIKELIHOOD FUNCTION = -90.2899

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
S         0.44526     0.4155E-01   10.72     0.000 0.835      0.8347     0.5991
CONSTANT   1.3857     0.2740       5.057     0.000 0.582      0.0000     0.4009

DURBIN-WATSON = 1.5326    VON NEUMANN RATIO = 1.5627    RHO =  0.09404
RESIDUAL SUM =  0.82268E-13  RESIDUAL VARIANCE =   1.9621
SUM OF ABSOLUTE ERRORS=   51.960
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6967
RUNS TEST:   27 RUNS,   25 POS,    0 ZERO,   27 NEG  NORMAL STATISTIC =  0.0108

:_TEST VALUE =  0.44526     STD. ERROR OF TEST VALUE  0.41550E-01
T STATISTIC =   10.716342     WITH   50 D.F.    P-VALUE= 0.00000
F STATISTIC =   114.83998     WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   114.83998     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.00871

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G              52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.445259641623       1.38573384541

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   8.7528     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=   4.4146     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=   4.2555     - F WITH DF1=   3 AND DF2=  47
```

Output File: Equation (1.9) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
 OLS ESTIMATION
      52 OBSERVATIONS     DEPENDENT VARIABLE = G
...NOTE..SAMPLE RANGE SET TO:      1,     52

R-SQUARE =   0.6790     R-SQUARE ADJUSTED =   0.6726
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.9142
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.3835
SUM OF SQUARED ERRORS-SSE=   95.710
MEAN OF DEPENDENT VARIABLE =   3.1325
LOG OF THE LIKELIHOOD FUNCTION = -89.6468

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      50 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
S          0.44658     0.4342E-01   10.28     0.000 0.824      0.8240     0.6003
CONSTANT   1.2520      0.2650       4.724     0.000 0.555      0.0000     0.3997

DURBIN-WATSON = 1.7342    VON NEUMANN RATIO = 1.7682    RHO = -0.00311
RESIDUAL SUM =  0.35305E-13  RESIDUAL VARIANCE =   1.9142
SUM OF ABSOLUTE ERRORS=   52.535
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6790
RUNS TEST:    29 RUNS,    24 POS,     0 ZERO,    28 NEG  NORMAL STATISTIC =  0.6070

:_TEST VALUE =  0.44658      STD. ERROR OF TEST VALUE  0.43421E-01
T STATISTIC =   10.284930     WITH   50 D.F.     P-VALUE= 0.00000
F STATISTIC =   105.77978     WITH    1 AND   50 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   105.77978     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.00945

REQUIRED MEMORY IS PAR=     6 CURRENT PAR=   500
DEPENDENT VARIABLE = G               52 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.446580806805       1.25196745331

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=    9.2105     - F WITH DF1=   1 AND DF2=  49
 RESET(3)=    4.5149     - F WITH DF1=   2 AND DF2=  48
 RESET(4)=    3.6592     - F WITH DF1=   3 AND DF2=  47
```

Command File: Equation (2.1)

```
file 11 c:\kaldor.txt
read(11) D P M / skiplines=1
sample 1 26
ols P M / Rstat
test
test P=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (2.1) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     2 CURRENT PAR=   500
 OLS ESTIMATION
      26 OBSERVATIONS     DEPENDENT VARIABLE = P
...NOTE..SAMPLE RANGE SET TO:      1,     26

R-SQUARE =   0.5760     R-SQUARE ADJUSTED =   0.5583
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.7103
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.1703
SUM OF SQUARED ERRORS-SSE=   113.05
MEAN OF DEPENDENT VARIABLE =   1.4698
LOG OF THE LIKELIHOOD FUNCTION = -55.9985

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      24 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M         0.53845     0.9430E-01   5.710     0.000 0.759     0.7590     0.9701
CONSTANT  0.43909E-01 0.4935      0.8898E-01 0.930 0.018     0.0000     0.0299

DURBIN-WATSON = 1.5056    VON NEUMANN RATIO = 1.5659    RHO =  0.24449
RESIDUAL SUM =  0.11102E-13  RESIDUAL VARIANCE =   4.7103
SUM OF ABSOLUTE ERRORS=   43.946
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5760
RUNS TEST:    9 RUNS,   13 POS,    0 ZERO,   13 NEG  NORMAL STATISTIC = -2.0016

:_TEST VALUE =  0.53845     STD. ERROR OF TEST VALUE  0.94298E-01
T STATISTIC =   5.7101032     WITH   24 D.F.    P-VALUE= 0.00001
F STATISTIC =   32.605278     WITH    1 AND   24 D.F.  P-VALUE= 0.00001
WALD CHI-SQUARE STATISTIC =   32.605278     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.03067

REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
DEPENDENT VARIABLE = P              26 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.538450048698      0.439091248874E-01

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.69804     - F WITH DF1=   1 AND DF2=  23
 RESET(3)=  0.60411     - F WITH DF1=   2 AND DF2=  22
 RESET(4)=   3.5445     - F WITH DF1=   3 AND DF2=  21
```

Command File: Equation (2.2)

```
file 11 c:\kaldor.txt
read(11) D E M / skiplines=1
sample 1 26
ols E M / Rstat
test
test E=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (2.2) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     2 CURRENT PAR=   500
 OLS ESTIMATION
      26 OBSERVATIONS     DEPENDENT VARIABLE = E
...NOTE..SAMPLE RANGE SET TO:      1,     26

R-SQUARE =   0.4995     R-SQUARE ADJUSTED =   0.4787
VARIANCE OF THE ESTIMATE-SIGMA**2 =   4.7104
STANDARD ERROR OF THE ESTIMATE-SIGMA =   2.1703
SUM OF SQUARED ERRORS-SSE=   113.05
MEAN OF DEPENDENT VARIABLE =   1.1785
LOG OF THE LIKELIHOOD FUNCTION = -55.9988

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      24 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M         0.46155     0.9430E-01   4.895     0.000 0.707     0.7068     1.0372
CONSTANT -0.43789E-01 0.4935     -0.8873E-01 0.930-0.018     0.0000    -0.0372

DURBIN-WATSON = 1.5056    VON NEUMANN RATIO = 1.5658    RHO =  0.24450
RESIDUAL SUM = -0.27756E-14  RESIDUAL VARIANCE =   4.7104
SUM OF ABSOLUTE ERRORS=   43.947
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.4995
RUNS TEST:    9 RUNS,   13 POS,    0 ZERO,   13 NEG  NORMAL STATISTIC = -2.0016

:_TEST VALUE =  0.46155     STD. ERROR OF TEST VALUE  0.94299E-01
T STATISTIC =   4.8945218     WITH   24 D.F.     P-VALUE= 0.00005
F STATISTIC =   23.956344     WITH    1 AND   24 D.F.  P-VALUE= 0.00005
WALD CHI-SQUARE STATISTIC =   23.956344     WITH    1 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.04174

REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
DEPENDENT VARIABLE = E              26 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.461548157009     -0.437889887073E-01

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.69793     - F WITH DF1=   1 AND DF2=  23
 RESET(3)=  0.60414     - F WITH DF1=   2 AND DF2=  22
 RESET(4)=   3.5440     - F WITH DF1=   3 AND DF2=  21
```

Command File: Equation (3.1)

```
file 11 c:\kaldor.txt
read(11) D P M / skiplines=1
sample 1 26
ols P M / Rstat
test
test P=0
test M=0
end
Diagnos / RESET
stop
```

Output File: Equation (3.1) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     2 CURRENT PAR=   500
 OLS ESTIMATION
      26 OBSERVATIONS     DEPENDENT VARIABLE = P
...NOTE..SAMPLE RANGE SET TO:      1,     26

R-SQUARE =   0.1579     R-SQUARE ADJUSTED =   0.1228
VARIANCE OF THE ESTIMATE-SIGMA**2 =   3.2602
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.8056
SUM OF SQUARED ERRORS-SSE=   78.246
MEAN OF DEPENDENT VARIABLE =   2.0898
LOG OF THE LIKELIHOOD FUNCTION = -51.2152

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      24 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M          0.16642     0.7845E-01   2.121     0.044 0.397     0.3974     0.2109
CONSTANT   1.6491      0.4106       4.017     0.001 0.634     0.0000     0.7891

DURBIN-WATSON = 2.3405    VON NEUMANN RATIO = 2.4341    RHO = -0.23083
RESIDUAL SUM =  0.35527E-14  RESIDUAL VARIANCE =   3.2602
SUM OF ABSOLUTE ERRORS=   38.433
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.1579
RUNS TEST:   16 RUNS,   11 POS,    0 ZERO,   15 NEG  NORMAL STATISTIC =  0.9472

:_TEST VALUE =  0.16642      STD. ERROR OF TEST VALUE  0.78452E-01
T STATISTIC =   2.1213035     WITH   24 D.F.    P-VALUE= 0.04442
F STATISTIC =   4.4999285     WITH    1 AND   24 D.F.  P-VALUE= 0.04442
WALD CHI-SQUARE STATISTIC =   4.4999285     WITH    1 D.F.  P-VALUE= 0.03390
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.22223

REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
DEPENDENT VARIABLE = P              26 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.166420404121       1.64913932059

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=   1.0239      - F WITH DF1=   1 AND DF2=  23
 RESET(3)=   1.0998      - F WITH DF1=   2 AND DF2=  22
 RESET(4)=  0.74042      - F WITH DF1=   3 AND DF2=  21
```

Command File: Equation (3.2)

```
file 11 c:\kaldor.txt
read(11) D P M E/ skiplines=1
sample 1 26
ols P M E/ Rstat
test
test M=0
test E=0
end
Diagnos / RESET
stop
```

Output File: Equation (3.2) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     3 CURRENT PAR=   500
 OLS ESTIMATION
      26 OBSERVATIONS     DEPENDENT VARIABLE = P
...NOTE..SAMPLE RANGE SET TO:      1,     26

R-SQUARE =   0.7316     R-SQUARE ADJUSTED =   0.7082
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.0198
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.0098
SUM OF SQUARED ERRORS-SSE=   23.454
MEAN OF DEPENDENT VARIABLE =   1.7380
LOG OF THE LIKELIHOOD FUNCTION = -35.5529

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      23 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
M         0.36926     0.4898E-01   7.540     0.000 0.844      0.9092     0.5626
E        -0.69587     0.1262      -5.514     0.000-0.755     -0.6649    -0.1237
CONSTANT  0.97519     0.2304       4.233     0.000 0.662      0.0000     0.5611

DURBIN-WATSON = 2.4325    VON NEUMANN RATIO = 2.5298    RHO = -0.44233
RESIDUAL SUM =  0.97700E-14  RESIDUAL VARIANCE =   1.0198
SUM OF ABSOLUTE ERRORS=   20.194
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.7316
RUNS TEST:   17 RUNS,   12 POS,    0 ZERO,   14 NEG  NORMAL STATISTIC =  1.2394

:_F STATISTIC =    31.342155      WITH    2 AND   23 D.F.  P-VALUE= 0.00000
WALD CHI-SQUARE STATISTIC =   62.684309     WITH    2 D.F.  P-VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.03191

REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
DEPENDENT VARIABLE = P               26 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.369257748882     -0.695874588195      0.975185616960

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.52762     - F WITH DF1=   1 AND DF2=  22
 RESET(3)=  0.28655     - F WITH DF1=   2 AND DF2=  21
 RESET(4)=  0.76103     - F WITH DF1=   3 AND DF2=  20
```

Command File: Equation (3.3)

```
file 11 c:\kaldor.txt
read(11) D P EM EN/ skiplines=1
sample 1 26
ols P EM EN/ Rstat
test
test EM=0
test EN=0
end
Diagnos / RESET
stop
```

Output File: Equation (3.3) No Autocorrelation

```
REQUIRED MEMORY IS PAR=     3 CURRENT PAR=   500
 OLS ESTIMATION
      26 OBSERVATIONS      DEPENDENT VARIABLE = P
...NOTE..SAMPLE RANGE SET TO:      1,     26

R-SQUARE =   0.3753     R-SQUARE ADJUSTED =   0.3209
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.3734
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.5406
SUM OF SQUARED ERRORS-SSE=   54.588
MEAN OF DEPENDENT VARIABLE =   1.7380
LOG OF THE LIKELIHOOD FUNCTION = -46.5348

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      23 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
EM         0.37894     0.1127      3.363     0.003 0.574     0.6093     0.2569
EN        -0.53812     0.1896     -2.838     0.009-0.509    -0.5142    -0.0957
CONSTANT   1.4577      0.3254      4.480     0.000 0.683     0.0000     0.8387

DURBIN-WATSON = 1.6635     VON NEUMANN RATIO = 1.7300     RHO =  0.14446
RESIDUAL SUM = -0.11102E-14  RESIDUAL VARIANCE =   2.3734
SUM OF ABSOLUTE ERRORS=   30.328
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.3753
RUNS TEST:   11 RUNS,   12 POS,    0 ZERO,    14 NEG  NORMAL STATISTIC = -1.1774

:_F STATISTIC =    6.9075709     WITH    2 AND    23 D.F.  P-VALUE= 0.00447
WALD CHI-SQUARE STATISTIC =   13.815142     WITH    2 D.F.  P-VALUE= 0.00100
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.14477

REQUIRED MEMORY IS PAR=     4 CURRENT PAR=   500
DEPENDENT VARIABLE = P                26 OBSERVATIONS
REGRESSION COEFFICIENTS
  0.378944015860     -0.538117512143       1.45772512804

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
 RESET(2)=  0.15439E-01  - F WITH DF1=   1 AND DF2=  22
 RESET(3)=  0.70924E-01  - F WITH DF1=   2 AND DF2=  21
 RESET(4)=   1.2453      - F WITH DF1=   3 AND DF2=  20
```