ESTIMATING A TIME VARYING NAIRU AND THE OUTPUT GAP FOR A DEVELOPING COUNTRY: A KENYAN CASE

BY

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DECLARATION

This is my original work and has never been presented for any degree in any other university.

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To: Daisy and

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ACRONYMS

NAIRU	Non-Accelerating-Inflation Rate of Unemployment
GDP	Gross Domestic Product
TFP	Total Factor Productivity
UK	United Kingdom
US	United States (of America)
EU	European Union
OECD	Organisation for Economic Co-operation and Development
PCSR	Short Run Phillips Curve
PCLR	Long Run Phillips Curve
BSE	Buffer Stock Employment
HP filter	Hodrick-Prescott filter
OLS	Ordinary Least Squares
ADF	Augmented Dickey-Fuller
PP	Phillips-Perron
VAR	Vector Auto Regressions
MSE	Mean Square Error
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KTMM	KIPPRA-Treasury Macro Model
CBS	Central Bureau of Statistics
DW	Durbin-Watson
AIC	Akaike Information Criterion
SC	Schwarz Criterion
CES	Constant Elasticity of Substitution

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May God bless you all, Amen.

ABSTRACT

This study estimates the NAIRU and the output gap for the Kenyan economy. This is very important in analysing the direction of macroeconomic policies towards attaining a sustainable non-inflationary growth. The question addressed in this study is whether these two concepts are important in directing policies in a developing country. The NAIRU has been estimated using the Phillips curve while the output gap has been obtained via the production function approach. Okun's law has also been used to investigate the relationship between the output gap and the labour market gap.

The estimated NAIRU for the year 2001 is found to be 9.03 per cent. This is less than the observed rate. This suggests that unemployment can be reduced without causing accelerating inflation. The estimated potential output growth for the year 2001 is 10.4 per cent. There is a negative output gap of – 4.29 for 2001 meaning that there is excess capacity in the economy. There is a negative relation between the two gaps and structural analysis suggests that the output gap is determined by the labour market gap. From these results, a combination of policies is suggested. Employment can be increased through an expansive fiscal policy and a loose monetary policy. This should also be coupled with a well-directed government spending so as to achieve a sustainable non-inflationary economic growth.

Alternative results obtained using an adjusted level of employment give a NAIRU level of 31 per cent in 2001. This suggests that different unemployment rates will yield different results, hence the recommendation for a detailed study using different estimation methods and better data set on unemployment to compare the results.

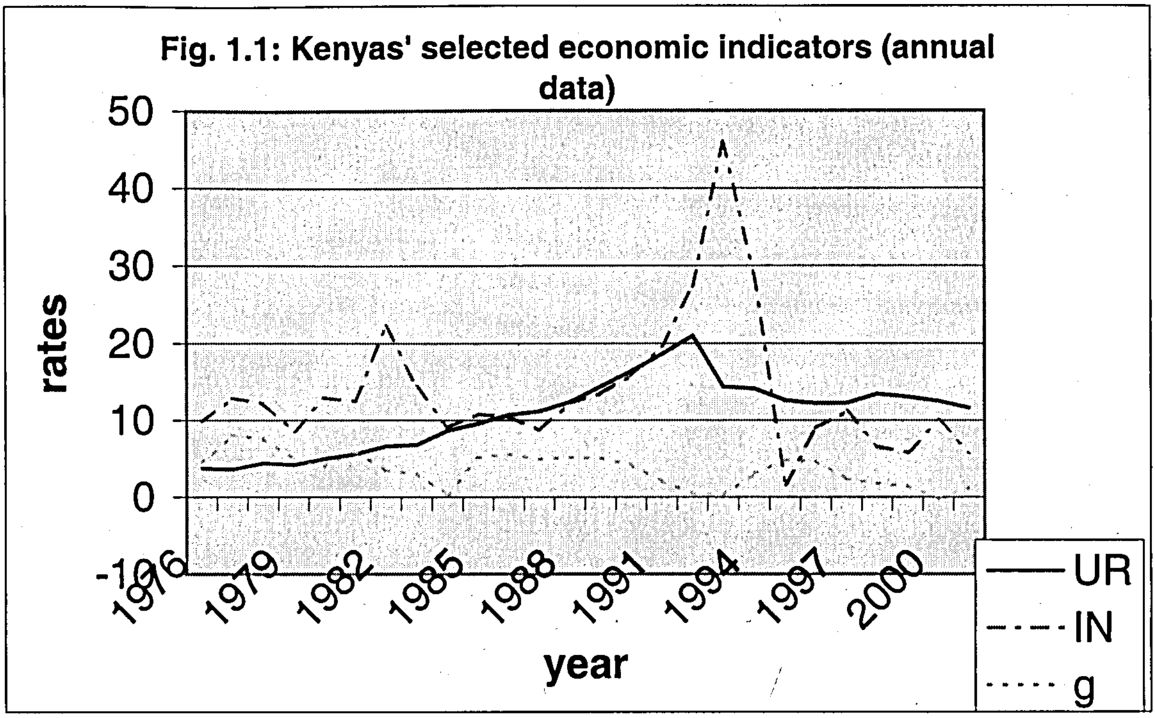
1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The NAIRU (Non-Accelerating-Inflation Rate of Unemployment) is the rate of unemployment that economists believe is attainable without causing accelerating inflation. It is not determined theoretically, but it is determined empirically. Economists look at what seems to be achievable and is historically normal, adjust that for structural and demographic changes they believe are occurring, and come with this target rate of unemployment. At this level, the expectations of inflation equal the actual level of inflation. The NAIRU is not constant but changes over time depending on the factors that determine the structural unemployment of the economy. According to Eisner (1995), the basic proposition of the NAIRU is that, policymakers cannot use deficit spending or an increase in the money supply to reduce unemployment below some 'equilibrium' rate, except at the cost of accelerating inflation.

Potential output is the maximum output an economy could sustain without generating rise in inflation. This output will be obtained through incorporating the NAIRU (to obtain the potential employment) in the production function. The output gap represents transitory movements from the potential output (difference between the actual and the potential output). When the actual output is greater than the potential output, this implies that an economy has excess demand, which is seen as a source of inflationary pressures. In presence of excess demand, macroeconomic policy makers will suggest tightening of monetary conditions. In case of excess capacity (actual output being less than the potential output), this would require easing of monetary conditions. Thus measuring the level of an economy's potential output and output gap is essential in identifying a sustainable non-inflationary growth and assessing macroeconomic policies.

The link between the NAIRU and output gap is that, the former is used in calculating the latter and both are then used in guiding policies towards a sustainable non-inflationary growth. Studies on the NAIRU and output gap have been carried out in several developed countries to guide monetary policy since they are essential in identifying a sustainable non-inflationary economic growth. The potential output trend helps determine the pace of sustainable growth. An important question we need to answer is whether these variables (NAIRU and output gap) are important in a developing country like Kenya to direct macroeconomic policies. In Kenya, there has been a debate on whether to relax the monetary policy or maintain it tight as it is. The target rate of inflation of five percent in Kenya may inhibit growth if maintained and especially if there is excess capacity in the economy. This study will contribute to this inflation debate. In figure 1.1 below, it is clear that the economic growth rate in Kenya has been low. The expected trade-off between inflation and unemployment is not quite evident from the plot but both are relatively high.



UR is the unemployment rate, IN is inflation rate and g is economic growth rate.

1.2 THE CONCEPTS OF NAIRU AND POTENTIAL OUTPUT

The concept of an equilibrium rate of unemployment became prominent in modern macroeconomics following the contributions of Phelps and especially Friedman (Rose 1988). They called it the 'Natural' rate of unemployment. It was defined as the rate of unemployment that would be observed in a Walrasian general equilibrium, given the existing structure of markets and institutions. There was no attention to distinguishing short-term to long-term equilibrium. They argued that simple Phillips curve ignores the fact that the expectations augmented Phillips curve is vertical at the 'natural' rate of unemployment, except when people are fooled by accelerating (or decelerating) inflation (Rose 1988). The fundamental idea behind the NAIRU is that macroeconomic stimulus (fiscal and monetary changes to increase aggregate demand) can lower unemployment to its 'natural' rate, but that further stimulus would result in accelerating wage-driven inflation with no permanent decrease in unemployment (Jackson 1998). The concept of the NAIRU goes beyond the older notion of a Phillips curve trade-off between inflation and unemployment to imply that unemployment below the 'natural' rate will lead not just to inflation, but to accelerating inflation[1]. According to the NAIRU, fiscal and monetary policies aimed at reducing unemployment would leave us like a dog chasing its tail (Eisner 1995). If policy were aimed at keeping total spending sufficiently high to keep unemployment below its 'natural rate', inflation would rise more and more rapidly. Ultimately, policymakers would give up in the face of runaway prices. Unemployment would then fall to its 'natural rate' and inflation would stop accelerating, but it would stay at its new, higher level until unemployment rose above the natural rate. In this view, supply-side measures could be the only ways to get unemployment down and keep it down. Such supply side measures include changing the conditions affecting the supply of labour, for instance, by cutting the minimum wages or upgrading the skills of workers (changes in labour force composition).

According to models that incorporate a Phillips curve, the unemployment rate plays a role in the transmission process from unanticipated changes in the aggregate demand for goods and services (demand shocks) to inflation. In these models, increases in demand raise the real GDP relative to its potential level, which increases the demand for labour to produce the additional goods and services, and therefore lowers the unemployment rate relative to the NAIRU. Excess demand in goods and labour markets leads to higher inflation in the goods prices and wages with a lag. Because of this, the unemployment rate can help in generating the inflation forecasts that are crucial in formulating monetary policy (Judd 1997). The NAIRU

[1] Phillips curve trade-off only says that at unemployment below the natural rate, inflation will be high but not accelerating.

makes more sense as an indicator of future inflation only when the economy is hit with demand shocks than when the economy is affected by supply shocks (like sudden increase in productivity) or unexpected changes in aggregate supply of goods and services. A sudden increase in productivity would initially raise the quantity of goods and services produced relative to the quantity demanded, and thus put downward pressure on prices. At the same time, the increase in real GDP would raise the demand for labour and reduce the unemployment rate. Based on this argument, a falling unemployment rate (because of the increased employment from the increase in demand for labour) would be associated with reduced pressure on prices (because of the increase in supply from the increased productivity). If in this case the government uses NAIRU to guide policy, it might mistakenly see the lower unemployment rate as a reason to fear higher inflation in the future, and therefore might tighten policy.

Any meaningful analysis of cyclical developments, of medium term growth prospects or of the stance of fiscal and monetary policies are all predicated on either an implicit or explicit assumption concerning the rate of potential output growth (Denis 2002). In the short run the physical productive capacity of an economy may be regarded as being quasi-fixed. Here output gap analysis shows by how much total demand can develop during that period without inducing supply constraints and inflationary pressures. In medium term, expansion of domestic demand when supported by strong upturn in the amount of productive investment may endogenously generate the productive output capacity needed for its own support. In the long run, full employment potential output is linked to future evolution of technical progress (or Total Factor Productivity (TFP)) and to the likely growth rate of potential labour.

1.3 THE PROBLEM

The Kenyan economy has been experiencing problems of unemployment[2]. Probably the NAIRU has been high hence affecting the unemployment levels. An important question that faces macroeconomic policy makers is whether the economy can absorb increases in aggregate demand without generating inflationary pressures (Rose 1988). Can the economy operate at a rate of unemployment consistent with inflation neither accelerating nor decelerating? No study has been carried out to determine this rate in Kenya. The potential output and output gap are essential in identifying a sustainable non-inflationary growth and assessing macroeconomic policies. Since the potential output is an unobservable variable, policies have been formulated based on assumptions on this potential output. Hence there's need to find this level empirically to be able to guide policy makers in policy formulation. In addition, there's a debate whether there is a case for relaxing the monetary policy in Kenya. Understanding the output potential and output gap and the NAIRU would go a long way in informing this debate.

Several studies (see table 1 below) have been carried out in some developed countries to estimate the NAIRU and potential output. Most of these studies focused on either purely statistical approach or an economic approach. Also most of these studies are for developed countries and hence need to study the relevance of these unobserved variables in a developing country. The results of the statistical approach may not be effective in guiding economic policy since they are not based on economic theory. Hence using the economic approach, the purpose of this study is to answer the question at hand, whether the issues of NAIRU and

[2] Unemployment rate has been more than a single digit (see figure 1.1)

output gap are important in formulation of fiscal and monetary policies in a developing country.

Table 1.1: Summary of some studies done on NAIRU and output gap.

STUDY/YEAR	ISSUES ADDRESSED	METHODOLOGY	MAIN FINDINGS
Rose (1988)	NAIRU in Canada and its determinants	Okun's law and Phillips curve	Found NAIRU to be around 8%.
Apel and Jansson (1998)	Potential output and NAIRU using data from Canada, the UK and the US	Okun's law and Phillips curve	Negative output gaps and positive unemployment gaps associate with falling trend inflation[3]
Richardson et al (2000)	Estimating a time varying NAIRU across 21 OECD countries	Reduced form Phillips curve using various filtering methods	Found that Kalman filtering methods provide better estimates.
Slevin (2001)	Potential output in Ireland	Various statistical methods and Cobb-Douglas production function.	Found a strong relationship between output gap and inflation
Denis et al (2002)	Potential output and Output gap for EU states and US	Production function approach	Results obeyed theoretical predictions of the model
Suchoy and Friedman (2002)	NAIRU in Israel	Phillips curve	Actual variation in unemployment has a minor effect on inflation

[3] Negative output gap occurs when actual output is less than the potential output, while positive unemployment gap is when observed unemployment is more than the NAIRU.

1.4 OBJECTIVES

The broad objective of this study is to estimate a time-varying NAIRU and the output gap and assess their relevance towards achieving a sustainable non-inflationary economic growth in Kenya.

The specific objectives are:

- Determine the NAIRU for Kenya.
- Obtain the potential output for Kenya.
- Analyse the output gap in Kenya.
- Investigate the relationship between the output gap and labour market gap (Okun's law).

1.5 SIGNIFICANCE OF THE STUDY

From theory, the NAIRU is said to influence economic policies. The NAIRU level can guide fiscal and monetary policies aimed at absorbing increase in aggregate demand. The rate of potential output growth is used to predict medium term growth through fiscal and monetary policies (Denis et al 2002). This study will help policy makers in policy formulation aimed at improving economic growth and in answering the questions they currently face on justification of blocking/tightening expansionary policies when economy is closing on 'full employment'. The NAIRU will be important in regard to measurement of potential output, which in turn will be essential in identifying a non-inflationary growth. This will also be used to compare with the actual situation hence guide policy makers on whether to tighten or ease the monetary conditions. This study will also contribute to the ongoing debate on a target inflation rate of 5%. Will this rate inhibit or enhance growth? If this target rate inhibits growth in a developing country like Kenya, then that policy should be relaxed. The NAIRU can play a more direct role in the conduct of policy and it is particularly important in an inflation targeting policy. Since Phillips curve implies that demand-induced changes in inflation tend to lag behind the movements in the unemployment rate, then the comparison between the actual unemployment rate and the NAIRU may be helpful in forecasting future changes in inflation.

1.6 ORGANISATION OF THE RESEARCH PAPER

This paper is made up of five chapters and the appendices. In chapter one, an introduction to the paper is developed to include the research problem and the objectives of the study. In chapter two, the literature on the two concepts is discussed and several papers have been reviewed. This chapter captures the economic theory behind the issues addressed in this paper. In chapter three, the methodology used in this paper is discussed. This chapter also discusses the data variables and sources. The hypotheses are also stated in this chapter. The presentation and discussion of the estimation results is done in chapter four. Chapter five concludes the paper and gives some policy implications based on the results obtained. In the appendices, the estimation results and the data used are given.

2.0 LITERATURE REVIEW

2.1 THEORETICAL LITERATURE REVIEW

2.1.1 CLASSICAL VERSUS KEYNESIAN THEORIES OF UNEMPLOYMENT

The main features of classical theory of unemployment is that labour market forces of supply and demand respond to changes in real wages such that the labour supply will fall or rise in response to changes in real wages. The demand for labour is directly related to marginal productivity of labour theory as input in the process of production. The concept of diminishing marginal productivity ensures that the short run demand for labour curve has the conventional negative slope. Hence, when these assumptions are brought together, the classical theory of the labour market states that the real wages should and would in absence of imperfections automatically adjust to bring market clearing. Thus the policy perceptions following from classical analysis of unemployment is clear, reduce government regulation and reduce trade union power in order to make labour market more competitive.

In the general Keynesian model, labour supply gives employment (N) as a function of money wage (W) and the expected price level (P^e).

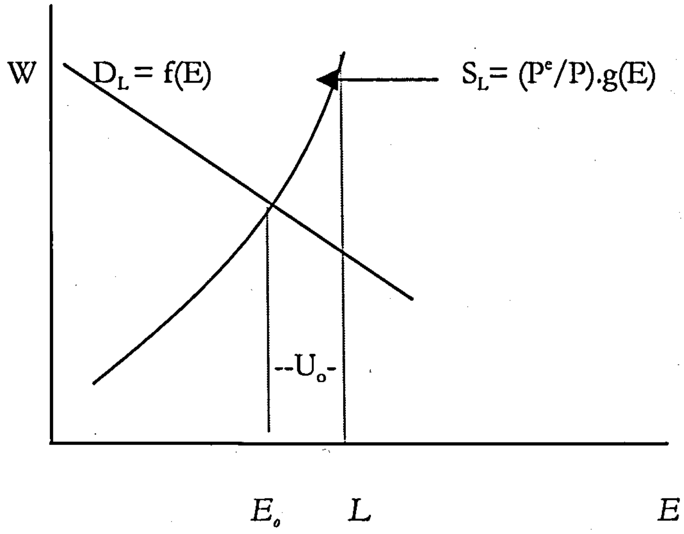
$$N = f(W, P^e) \quad \ldots (1)$$

Hence, $W = P^e.g(N)$ ....(2)

g is a function symbol.

As wages rise, the labour supply curve becomes vertical at some maximum level of employment, which will identify as the labour force. The difference between labour force (L) and equilibrium level of employment (E_o) is the level of unemployment (U_o).

$$U_o = L - E_o \quad \ldots (3)$$



D_L is Labour demand curve

S_L is Labour supply curve

E is employment

P is the price level

Fig2.1 Labour demand and supply curves

Source: Branson W (1979); 'Macroeconomic theory' p 152.

The difference between the classical case and general Keynessian model is that, the classical case assumes $P^e = P$, and with labour force level given, the U_o is determined in labour force market without reference to the demand conditions. The Keynessian model links unemployment to demand side of the economy. An expansionary monetary or fiscal policy change will raise P, shifting the supply curve in the figure above outwards. Keynes rejected the classical assumption of real wage rate being a variable capable of direct adjustment through the process of collective bargaining between workers and employers. Although he accepted the marginal productivity base theory of labour demand, he claimed that in money using economy as opposed to direct barter system, workers and firms can only negotiate about money wages and not about actual price. Expansionary macroeconomic policies, which encourage an increase in demand for goods, will raise the demand for labour in the manner described by the Keynesian multiplier and therefore reduce unemployment.

2.1.2 NAIRU THEORY VERSUS PHILLIPS CURVE

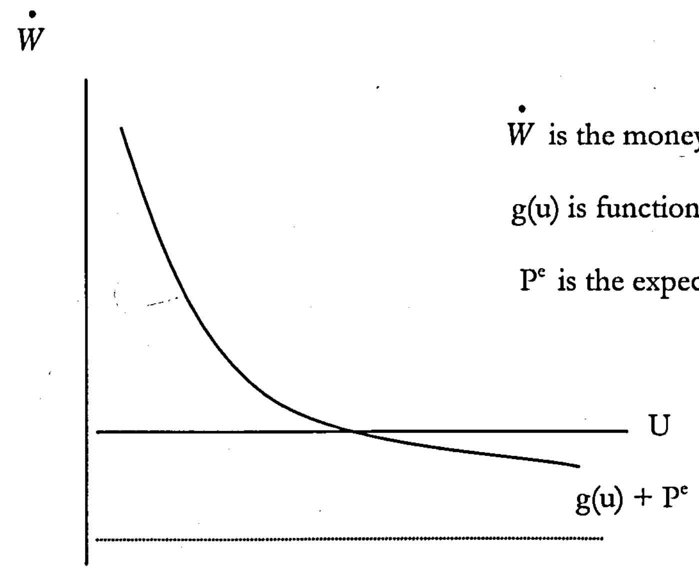
The idea that there is no long-term trade-off between inflation and unemployment and that lower unemployment cannot be purchased at the price of a one-time rise in inflation is central to NAIRU theory. The British economist Phillips, in 1958 showed that, an inverse relationship existed between the rate of unemployment and the wage rate. Since nominal wage rate changes vary with the price level, the inflation rate-unemployment relations were made.

The Phillips curve is presented as:

$$\pi = \text{Constant} - b\hat{U} \text{ --- } (4)$$

This Phillips\` curve suggests that some trade-off between inflation (π) and unemployment ($\hat{U}$) exists. Adding inflationary expectations to the Phillips curve equation so that for a given level of unemployment rate, the faster prices are expected to rise, the faster money wage demand will rise. This assumption gives us the expectations augmented Phillips curve equation as:

$$\dot{W} = g(u) + P^e \text{ --- } (5)$$



$\dot{W}$ is the money wage demand.

g(u) is function of unemployment.

P^e is the expected price level

Fig2.2 Augmented Phillips curve

Source: Branson (1979); Macroeconomic theory; p 400

As the P^e rises, the entire short run Phillips curve will shift out so that each individual Phillips curve will be a short run one. The long run Phillips curve is derived from the price equation that preserves constant income shares;

$$\dot{P} = \dot{W} - (\dot{Y/N}) + \varepsilon \text{ --- } (6)$$

Where $\dot{P}$ is price changes,

$(\dot{Y/N})$ is productivity growth

ε represents cost push disturbances and is expected to be zero in the long run.

If income shares do remain fairly constant overtime and if there are no persistent non-wage cost push disturbances, then the above equation gives us the link between wages and prices. This means that the Philips curve can be stated also in terms of prices as well as wages. Combining equation (5) and (6) above and assuming that changes in actual prices equals changes in expected prices then we obtain the long run Phillips curve relation referred by James Tobin as the NAIRU as;

$$g(u) = (\dot{Y/N}) \text{ --- } (7)$$

From this equation, for any given rate of productivity growth, this equation will give us the natural rate of unemployment.

Since real wage is what matters and due to expectations, other economists developed the expectations augmented Phillips curve by deriving it from the aggregate supply curve. Thus the Phillips curve in its modern form states that inflation rate depends on expected inflation, on deviation of unemployment from the natural rate (cyclical unemployment rate) and on aggregate supply shocks in the economy. The derived Phillips curve thus becomes;

$$\pi_{+1} = \pi^e_{+1} - b(U - U_n) + \varepsilon \text{ --- } (8)$$

Where: π_{+1} is the inflation rate in the next period

π^{e}_{+1} is expected inflation rate in the next period.

b is the coefficient determining response of inflation to a given amount of unemployment.

U is rate of unemployment in current period.

U_n is the natural rate of unemployment.

The long run Phillips curve is therefore vertical as shown below and no matter what the inflation rate is, the unemployment rate must return to its natural rate.

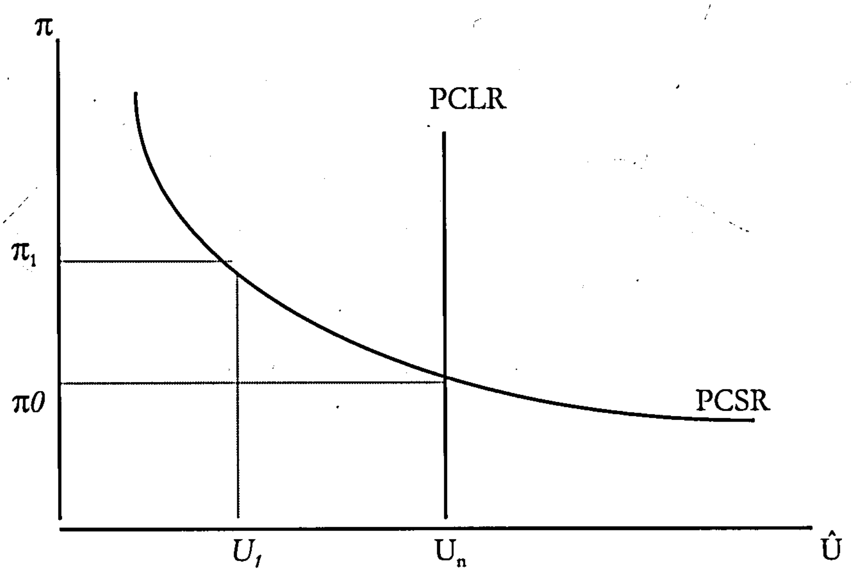


Fig2.3 Short run and long run Phillips curve trade-off.

Source: Derlome C. D. (1983), Macroeconomics

2.1.3 HYSTERESIS AND THE CIRCULARITY OF NAIRU THEORY

The idea of a supply side determined NAIRU is contradicted by the evidence that NAIRU estimates are, in fact, driven by the actual trend of unemployment, as argued many years ago by James Tobin. In other words, NAIRU is determined in part by demand side shocks to the economy and by the effects of prolonged macroeconomic restraint. Contractionary monetary policies implemented to stop unemployment from falling to below the level of NAIRU have played a particularly larger role. The concept of hysteresis, that the historical path of unemployment crucially determines the level of unemployment, is increasingly accepted and is reflected in recent analyses. The basic idea is that demand side shocks lead to involuntary unemployment, and to the erosion of worker skills. Some of the unemployment caused by changes on the demand side becomes structural in the sense that inflation will tend to increase at a higher level of unemployment than would otherwise have been the case in the absence of the prior demand side shock, including discretionary changes to monetary policy. The key problem with the ad hoc extension of NAIRU theory to include the impact of demand side changes is that the policy implication of NAIRU remains the same – that macroeconomic policy should not be stimulative once the supposed NAIRU is approached. But this argument is clearly circular. If the supposed constraints of NAIRU are not tested, the macroeconomic restraint arising from fear of inflation will result, via hysteresis, in higher unemployment and a higher NAIRU.

2.2 EMPIRICAL LITERATURE REVIEW

Pack (1974) used descriptive analysis to address the possibility of absorbing larger numbers of workers in the Kenyan manufacturing sector. He found out that existing manufacturing enterprises are relatively labour intensive and rarely do they exhibit the mechanisation levels of the developed countries. Also Productivity of labour has risen rapidly as a result of reorganisation, simple innovations and increasing utilisation of capacity. Found that there is considerable variation in feasible efficient production methods.

Kibua (1984) used descriptive analysis to discuss the causes of unemployment by condensing them into demand and supply of labour. Capital-intensive techniques, labour productivity and quantity and composition of output demanded affected demand. Supply was affected by population, wage structure and school system whose acquired skills are not in sufficient demand. He proposed solutions to this as restructuring the economy (modernising and vitalising the agricultural sector).

Rose (1988) looked at the determinants and estimates of the NAIRU in Canada. The discussion of determinants considers factors that influence the incentives to the labour force and to work; aspects of the composition of labour force; particular supply factors; and temporary structural influences in the economy. Used reduced form unemployment equations; the Phillips curve, production function and Okun's law combination. Found that the NAIRU for Canada at the end of 1987 was about 8%. Several factors have been working to increase the NAIRU. These factors include: regional imbalances caused by a combination of relative price movements and the effects of regionally extended unemployment insurance benefits; a rising ratio of unemployment insurance benefits to the industrial wage; the combined effects of rising female participation rates and the lingering problem of absorbing the 'baby boom' cohort in the labour force.

Cote' and Hostland (1996) attempted to identify the trend unemployment rate and examine whether there is a cointegrating relationship between the observed unemployment rate and various structural factors. The main findings of the study is that the degree of unionisation of the labour force and payroll taxes can best account for the stochastic trend in the Canadian unemployment rate from 1955 to 1994. Accordingly, deviations of the observed unemployment rate from the trend unemployment rate during that period are treated as containing information relevant for measuring the output gap within the multivariate filter.

Debelle (1997) investigated the possibility that the Phillips curve is indeed a curve, and shows that a convex short run Phillips curve may be a more accurate representation of reality than the traditionally used linear specification. The paper estimated both a linear and a convex (non-linear) Phillips equation and discussed policy implications of convexity in the Phillips curve. Used the Kalman filtering the Phillips equations. Found that convexity provides a strong rationale for stabilization policy. It also implies that deep recessions may have only a marginally greater disinflationary impact than shallower ones, unless they induce large credibility bonuses.

Mitchell(1997) analysed the persistence of high unemployment in most economies and the continued deterioration in ecosystem, which ultimately supports human and economic activity. Using Australian data, the paper argues that the real source of the persistently high unemployment that has bedeviled OECD economies for around 20 years is due to the fundamental change that has occurred in the way governments interact with the community. Unemployment arises because collective will has been replaced by a regime of economic rationalism. The government can approach a target of price stability through: adopting the monetarist NAIRU approach or conducting a Buffer Stock Employment (BSE) policy. The BSE model is justified because it is appealing from social welfare and altruism considerations and it is the only rational strategy for a government that supplies fiat currency and wishes to maximise the macro benefits and retain price stability. It enhances a strategy that aims to reduce the environmental problems and thus there is need to change the composition of final output towards environmentally sustainable activities.

Jackson (1998) prepared a paper on the NAIRU and Macro-Economic Policy in Canada. This paper provides a critique of NAIRU theory. While NAIRU in Canada has been imprecisely and variously estimated with reference to supply side variables, it is now generally accepted that hysteresis effects are significant, and that NAIRU is determined in large part by the actual course of unemployment. In Canada, the actual course of unemployment has been driven by macroeconomic policy, that is, by the explicit policy of disinflation adopted in 1988, and by the fiscal restraint that followed. The implication of low unemployment for a wide range of important social outcomes is that unemployment will reduce insecurity, inequality and poverty and raise aggregate economic welfare. The NAIRU doctrine does not really solve the macroeconomic policy problem of balancing growth and job creation with control of inflation, but rather abandons the goal of full employment.

Apel and Jansson (1998) proposed a theory consistent approach for estimating potential output and the NAIRU. Identification is achieved using Okun's law and a Phillips curve illustrated using data form Canada, the UK and the US. Both NAIRU and potential output are assumed to be characterised by stochastic trends. The equations are rewritten in state-space form then Kalman filter and maximum likelihood used to obtain estimates of the unknown parameters and of the time series of unobserved components. The parameter estimates of the Phillips curve and Okun's law relations have the expected signs and are significant.

Richardson et al (2000) measured the structural unemployment by estimating a time varying NAIRU across 21 OECD (organisation for economic co-operation and development) countries. In line with a number of recent empirical studies, the study uses methods which combine the estimation of reduced-form Phillips curve equations for each country using alternative filtering methods which allow identification of a time varying NAIRU indicators. Overall, Kalman filter methods are found to provide the most satisfactory results and are therefore chosen as the preferred basis for future development of OECD NAIRU indicators.

Slevin (2001) measured potential output and the output gap in Ireland using a number of statistical trend methods and a Cobb-Douglas production function. Two measures of the output gap using the Cobb-Douglas production function are estimated. One measure models technology as a linear time trend while the other method allows technology to vary over time. The relationship between output gap and inflation is examined and the results suggest that the output gap alone is insufficient to explain inflation in the Irish economy. The Cobb-Douglas production function output gap which model technology as a linear time trend is the only measure that has a significant relationship with inflation.

Denis et al (2002) estimated the potential output and output gaps using a production function approach for the EU member states and the US. For simplicity, he made assumptions of constant returns to scale and a factor price elasticity of one. To obtain this potential output one requires the NAIRU to calculate the potential employment. He estimated the NAIRU statistically using the Kalman filtering method. He used maximum likelihood in estimating the NAIRU equations. According to this study, the results obeyed the theoretical predictions of the model. A comparison of this study with those of other international organisations reveals that the estimated unemployment trends are fairly similar.

Suchoy and Friedman (2002) estimated the NAIRU in Israel using an unobserved components approach. They estimated the NAIRU for the post-stabilisation period using state-of-the-art state space models. The NAIRU is identified by a Phillips curve equation, and is assumed to follow a random walk. The basic model is augmented by an equation that captures the persistence of the unemployment gap. Also used a joint system to estimate the potential output and the NAIRU simultaneously. Confidence intervals around the NAIRU were computed by Jackknife technique. The results indicate that the actual variation of unemployment has only a minor effect on the NAIRU and that the disinflation process during the 1990's did not cause an increase in the NAIRU.

2.3 OVERVIEW OF LITERATURE

The difference between the classical and general Keynessian models is that, the classical assumes unemployment is determined in the labour market without reference to the demand conditions while the Keynessian model links unemployment to demand side of the economy. The Kenyan economy is hit by both supply and demand shocks and therefore a study that brings both schools of thought in practice is important in Kenya. Several papers have been reviewed and it's very clear that no study has been done on NAIRU for a developing country. Also some of the papers use purely statistical methods in estimating NAIRU and output gap. These statistical methods are not based on economic theory and thus may give results that are not reflecting the economic situation facing the country. Therefore a study based on economic theory and that seeks to establish the relevance of these concepts in a developing world is important.

3.0 METHODOLOGY

3.1 CONVENTIONAL FORMULATION

This study is based on the theoretical framework of the Phillips curve derived from the aggregate supply curve (to estimate the NAIRU), the Cobb-Douglas Production function (to estimate potential output) and Okun's law (to investigate the relationship between the output gap and labour market gap). Two crucial assumptions are necessary to arrive at the usual concept of the NAIRU (Eisner 1995). The first: left to itself, any given rate of inflation is self-perpetuating[4]. The second: that unemployment is a key factor in changing inflation rates specifically that, higher unemployment lowers inflation, and lower unemployment raises inflation. The general idea is that inflation is a function of a number of variables such as capacity utilisation rate (output gap issue), price movements, changes in productivity, price controls, past inflation, and current and past unemployment. The degree of slack in the labour markets (the difference between the actual and the equilibrium rate of unemployment) is important information for policy makers. However, there is a great deal of uncertainty surrounding its measurement. This uncertainty stems from the fact that the equilibrium rate cannot be observed and must be inferred from other data using presumed and uncertain economic relationships (Rose 1988). If unemployment would fall below its natural rate and output grow above its long term potential rate, inflation would start to increase as bottlenecks in production, capacity limits and tight labour market would lead workers to require higher wages and firms to increase prices as demand and costs go up.

[4] This assumption is important in estimating the expected inflation rate.

A number of techniques for measuring NAIRU and potential output have been developed. Potential output measures include Hodrick-Prescott (HP) filter, Kalman filter, linear method, multivariate decomposition method, structural Vector Autoregression method, Blanchard and Quah method, Production function approach in estimating potential output, among others. The NAIRU has been estimated using HP filter, Kalman filter and even linear method. None of these methods is completely free from difficulties, but the Kalman filter (to estimate NAIRU) and Cobb-Douglas production function (to estimate potential output) are chosen in this study (see section 3.2 below).

3.2 THE MODEL

3.2.1 A TIME VARYING NAIRU

Alternative methods of filtering that allow identification of a time varying NAIRU have been used. According to some previous studies (Debelle (1997), Denis et al (2002) and Richardson et al (2000)), the Kalman filter method (see Appendix 1 for further technical details) has been found to provide better results and therefore chosen in this paper to estimate the NAIRU.

The Phillips equation used in this study is similar to that used by Debelle (1997). According to Debelle, the standard models of short run Phillips curve that underlie most of the existing theoretical and empirical literature have been of the following form;

$$\Pi_t = \alpha\Pi_t^e + \gamma(U_t - U^*) + u_t \text{ --(1)}$$

with u_t (error term)[5] $= \Sigma_0^1\theta_i\varepsilon_{t-i}$

Where Π_t is the inflation rate

[5] Error term: 1st order moving average representation of a time series. It is a weighted sum of two adjacent values of a white noise process (ε_t). It has a constant mean, constant variance and constant autocorrelation.

Π_t^e is the expected inflation

U_t is the observed unemployment, U^* is the NAIRU.

This Phillips equation is used in this study as the measurement equation in the Kalman filter. The transition equation in this state space modeling is of the NAIRU that is modeled as a random walk[6].

$$U^* = U^*(-1) + z_t \text{ -- } (2)$$

The z (error term) is iid[7].

The assumption behind this statistical method is that, since there is no long-term trade-off between inflation and unemployment, on average unemployment should fluctuate around the NAIRU, that is, self-equilibrating forces in the economy are strong enough to bring unemployment back to trend. Though this method depends on arbitrary and sometimes implausible assumptions in order to make this decomposition, it has proved to be a better method of estimating unobserved variables.

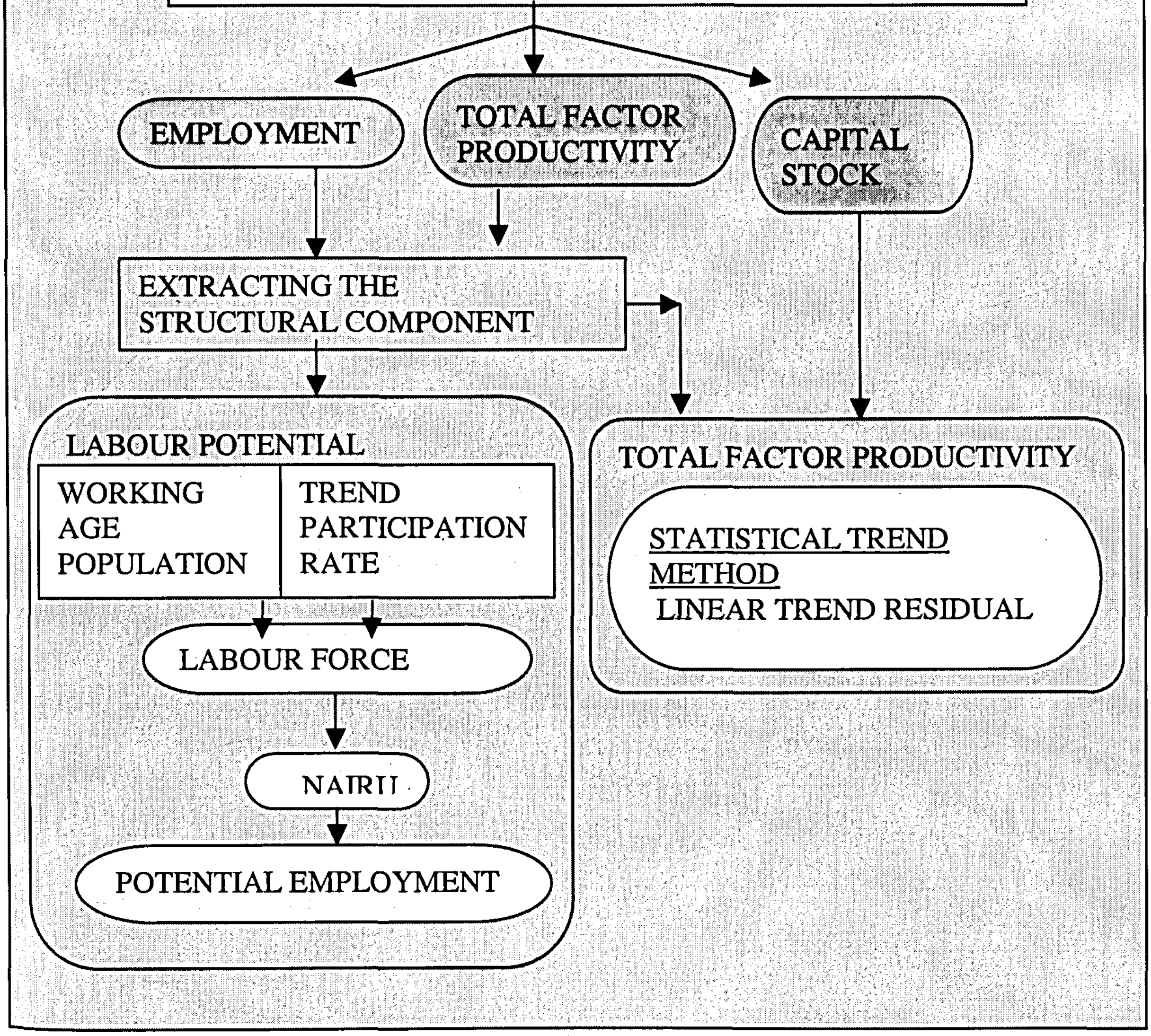
3.2.2 POTENTIAL OUTPUT AND THE OUTPUT GAP

A variety of methods can be used to estimate potential output. The most common approaches use time series techniques to decompose actual output into demand and supply components. These statistical methods include Hodrick-Prescott (HP) filter, linear method, univariate method by Beveridge-Nelson, multivariate decomposition method, structural Vector Autoregression method, Blanchard and Quah method among others. In these methods, there is no attempt to examine the inputs of the productive process, namely capital, labour and

[6] This does not mean that we necessarily believe that the NAIRU is indeed a random walk. Rather it is an empirically convenient way to model it.
[7] iid: Identical and independent distribution. The error term is identically and independently distributed normally with constant mean and constant variance.

technology, and thus they do not represent a particularly appropriate measure of potential output (Slevin 2001). The alternative to time series techniques is the production function method. Thus instead of making statistical assumptions on the time series properties of trend and their correlation with the cycle, the production function approach makes assumptions based on economic theory.

Figure 3.1: Flowchart showing the measurement of potential output using a production function approach (Denis 2002)



In this paper, the Cobb-Douglas production function approach is used to estimate the potential output[8]. The production function is preferred since it is based on economic theory.

The Cobb-Douglas production function is:

$$Y_t = AK_t^{\beta}L_t^{(1-\beta)}e^{(1-\beta)\alpha t} \text{ -- (3)}$$

Where Y is the actual output; L is the labour employed; K is the capital stock; β is the capital share; α is the rate of growth of labour augmenting, Harrod neutral technological progress. This production form assumes constant returns to scale.

In Log form, this equation becomes;

$$Log(Y_t) = Log(A) + \beta Log(K_t) + (1-\beta)Log(L_t) + (1-\beta)\alpha t \text{ ------------------------------ (4)}$$

The Total Factor Productivity (TFP) is assumed to have a linear trend. This is captured by Log (A) + $(1-\beta)\alpha t$ in equation (4) above. Thus after estimating the equation, then TFP will be given as;

$$TFP_t = Log(Y_t) - \beta^*Log(K_t) - (1-\beta^*)Log(L_t) \text{ -- (5)}$$

Where β^* is the estimated coefficient

To obtain the potential output, we use the potential employment,

$$L^*_t = LFN(1-U^*_t) \text{ -- (6)}$$

Where L^* is potential employment[9]

LFN is the labour force

U^* is the Kalman filtered NAIRU.

Thus the potential output in log form is,

$$Log(Y^*_t) = \beta^*Log(K_t) + (1-\beta^*)Log(L^*_t) + TFP_t \text{ -- (7)}$$

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[8] Cobb-Douglas production function is simple and can make sense out of the coefficients imposed. Also the assumption of constant returns to scale simplifies estimation of output elasticities, which are equated to factor shares. This greatly simplifies estimation and exposition.

[9] This is the level of employment that will maintain a non-inflationary growth.

Where Y^*_t is the potential output.

The output gap in log form is defined as;

$$GAP_t = [\,Log(Y_t) - Log(Y^*_t)] \text{ --(8)}$$

3.2.3 OKUN'S LAW

In this section, interest is on the relationship between the output gap and the labour market gap. Okun's law[10] posits a simple, direct relationship between output market gap and the labor market gap/unemployment gap (Rose 1988).

$$(U_t - U^*_t) = \theta\,[Log(Y_t) - Log(Y^*_t)] + v_t \text{ --(9)}$$

Where θ is the coefficient linking the two gaps

v is a random variable.

Okun's (1962) law was presented originally as an empirical regularity. It applies where output is essentially demand-determined and employment is the main variable firms use to adjust production to demand over the business cycle.

3.3 ESTIMATION PROCEDURE

In estimating the NAIRU, the study used maximum likelihood procedure. This method has been found to give better results in estimating an unobserved variable and therefore used for most countries (Richardson et al 2000) to carry out the Kalman filter estimation. Ordinary Least Squares (OLS) is applied in estimating the log-linear production function and Okun's law. After estimating the production function and using the NAIRU to estimate the potential employment, estimates of potential output and output gap are obtained. The technological

[10] Roughly, Okun's law states that a 3% increase in real GNP will yield a 1% decrease in unemployment rate (Branson 1979).

progress is treated as a linear trend. Since the assumption of covariance stationary process can be quite unappealing for many of the economic and financial time series because they are usually trending, then testing for stationarity in the data variables (time series) before applying OLS is important. If non-stationary data is used to carry out OLS estimation, then this will lead to spurious regression and also violate the assumptions of a classical linear regression model. In this study non-stationarity (presence of unit roots) has been tested using Augmented Dickey-Fuller (ADF) test and Phillip-Perron test to take care of structural breaks and markov switching regimes.

To investigate the dynamic interrelationship between the labour market gap and output gap, a Vector stochastic process has been estimated. This is estimated by OLS since the right hand side of the Vector Autoregressive (VAR) model has lagged variables (predetermined) which are not correlated with the current values of the error term. The order of the VAR (optimum number of lags to be included in the model) was selected by the criteria based on the objective of minimising forecast Mean Square Error (MSE). Since there is no cointegrating vector, the estimated VAR model is then used for structural analysis (Granger causality, impulse response functions and variance decomposition).

3.4 HYPOTHESES

(i) Increasing the NAIRU in Kenya will not lead to an increase in inflation rate.

(ii) Potential output does not change as the level of NAIRU changes.

(iii) An increase in output gap does not lead to a reduction in the labour market gap.

3.5 DATA VARIABLES, SOURCES AND EXPECTATIONS

INFLATION RATE

The actual increase in the general price level has been used. This has been obtained from the various economic surveys. This variable is expected to have a stochastic trend with one unit root. The expected inflation is modeled by taking the annualised five-month moving average[11].

UNEMPLOYMENT RATE

The unemployment level has been calculated by deducting total number of people employed from the total labour force. The unemployment rate is the ratio of the unemployment level to the total labour force expressed as a percentage. The total labour force (economically active population) is obtained by multiplying the labour force participation rate (proportion of economically active to the working age population) by the working population. The working population and labour force participation rate are obtained from the various issues of labour force surveys. The participation rates are 59.77, 75.7 and 77.4 as percentages for the years 1977, 1988 and 1998 respectively. These have been used to interpolate for the other years and then smoothed using the HP filter. The working population is calculated by multiplying the working age proportion of total population (as calculated by CBS) by the total population (as calculated in KTMM). The working age proportions are 0.478, 0.482, 0.487 and 0.524 for the years 1969, 1979, 1989 and 1999 respectively. These proportions have been used to interpolate for the other years. The employment in small-scale farming is estimated using their recorded proportion of the total labour force, then added to the recorded total employment[12]. To

[11] The choice of five months was discretionary. The assumption is that agents will form expectations based on what happened five months ago.

[12] The proportion of labour force engaged in the traditional sector includes the underemployed. Therefore, the obtained unemployment rate is actually the 'not employed' rate (open unemployment). This is used as a proxy for the unemployment.

obtain the total employment in this study, we have added wage employment (both private and public), self–employed & unpaid family workers, informal sector employment and the traditional sector employment. Proportions of employment in the traditional sector have been obtained from (Geda et al, 2001). The proportions are 0.70 (1970 – 1980), 0.684 (1981 – 1990), 0.513 (1991 – 1995) and 0.40 (1996 – 2001).

A different series of unemployment has also been used in this study to obtain the alternative results. The total employment here is calculated by subtracting half of the employment in the informal sector (1993 – 2001) from the total employment calculated above. This has been done because previous studies show that approximately half (56 per cent) of those employed in the expanding informal sector are below the poverty line and there was a significant increase of this sector employment in 1993 (see Oiro et al, 2003).

Unemployment rate is expected to have an inverse relationship with inflation rate as postulated by Phillips (1958) and has a stochastic trend integrated of order one.

OUTPUT

The actual output is proxied by the actual/real GDP (Gross Domestic Product). The potential GDP is captured through the production function. NAIRU is expected to impact negatively on the output. Real GDP is expected to have a stochastic trend.

CAPITAL STOCK

The annual capital stock has been used in this study as factor input in the production function. The value of invested capital is equal to previous year's capital stock plus current year's investment minus depreciation (an economy wide depreciation rate of 5.5 per cent is used as assumed in the KTMM)[13].

This study has used secondary data (1972 – 2001) obtained from the CBS publications (Economic Surveys, Statistical Abstracts, Labour Force Surveys and the Integrated Rural Survey of 1976-1979), Geda et al (2001) and the KIPPRA Analytical Data Compendium by Ryan (2002).

[13]An alternative to this would be to use the perpetual inventory method to measure capital stock. This method also takes some assumptions.

4.0 ESTIMATION RESULTS AND DISCUSSION

4.1 ESTIMATE OF THE NAIRU

In the estimation of the Phillips curve, the coefficient of the expected inflation was not set to unit. This is because the restriction of that coefficient was not giving plausible results and thus it was allowed to take a value through the estimation. Hence the assumption that inflation is self-perpetuating was not emphasized in this study. The results obtained in this study are not consistent from one year to another and this is attributed to various reasons. First, the Kalman filter NAIRU is sensitive to the sample period since it is generated using the available information. This means that if we change (increase or decrease) the sample size, then the results for the NAIRU will also be different for the same economy. Increasing the sample size by only one observation can significantly change the estimated NAIRU. Second, the Kalman filter is also sensitive to the initial values of the state vector (NAIRU) and its covariance matrix. In this estimation, the study uses the inbuild initial values in Econometric Views estimation software. Third, the lack of actual and reliable data on unemployment might have led to the sharp differences in results between consecutive years.

From the estimated Phillips curve (see appendix 2.1), the results are summarised below.

$$\Pi = 0.77*\Pi^e - 0.6*(U - U*)$$

(0.032)	(0.124)	(standard error)
(23.97)	(-4.87)	(t-statistic)

From the above results, the coefficient of the unemployment gap is negative. This suggests that there is some trade off between inflation and unemployment in Kenya. Increasing unemployment gap by 1 unit leads to a decrease in inflation rate by 0.6 units. This coefficient is also very significant (Probability value of 0.0001) at 1 percent level. This means that unemployment is a very important variable in explaining inflation. Also, inflation is highly explained by the expected inflation (coefficient of 0.77). This coefficient is positive and highly significant (probability value of 0.0000) at 1 percent. This means that the expected inflation significantly influences the actual inflation level. The coefficient tests show that the expected inflation and unemployment are jointly very significant in explaining inflation. Most of the variations in inflation are due to the explanatory variables (Adjusted $R^2 = 0.99$). In testing the presence of autocorrelation using the obtained DW value of 2.79, it was established that, this test was inconclusive. This is because this DW value lies within the indifference region (region between no autocorrelation and negative autocorrelation).

The generated series of the smoothed NAIRU for the year 2000 and 2001 is as shown below

Year	Unemployment rate in percentages	
	Observed	NAIRU
2000	12.54	20.03
2001	11.67	9.03

This NAIRU is higher than the observed rate of unemployment in 2000 but less in 2001. This sharp difference in the values of NAIRU for the two years can be attributed to nature of the unemployment data used. The unemployment data does not have a smooth trend and this could be the reason for that significant difference in the two values. On average the NAIRU has been higher than the observed rate of unemployment for the last 20 years (see figure 2.1). This means that on average there is a negative unemployment gap (actual unemployment minus the NAIRU). This negative unemployment gap is seen as a source of inflationary pressures. Based on the results for 2001, the observed/actual unemployment rate is greater than the NAIRU, hence a positive unemployment gap. This positive unemployment gap suggests that, unemployment can be decreased without accelerating the inflation rate.

The unemployment gap (difference between actual and NAIRU) is on average negative, but positive for 2001 (see figure 2.2). This positive gap implies that employment can be increased as long as the unemployment does not go below the NAIRU. In such a case the inflation rate will not be accelerating. As unemployment is decreased, then the NAIRU will in the long run also go down (because of the hysteresis and circularity of NAIRU theory of unemployment causing itself), and hence encourage more employment. This can be well implemented as long as the NAIRU is below the observed rate of unemployment.

Some previous studies show that, the estimation of NAIRU is usually limited by several factors. Rose (1988) obtained different estimates of NAIRU for Canada using different methods. The paper noted that, the results are quite sensitive to methodology, to measurement of variables and to the estimation sample period. In reaching at the estimate of NAIRU of 8 percent, considerable judgment was applied. According to Debelle et al (1997), the confidence bounds on the NAIRU for Australia were 5.2 and 8.6. He concluded that a considerable uncertainty exists regarding the 'correct' level of the NAIRU in Australia. This uncertainty over the size of NAIRU complicates its effectiveness as a tool for determining the appropriate stance of monetary policy. The study also found out that the results were sensitive to changes in the model specification, for instance in employing the different specifications on the expected inflation. Also Richardson (2000) observed that, using different methods and different sample periods generated different results for EU member countries and the US.

4.2 ESTIMATED COBB-DOUGLAS PRODUCTION FUNCTION

The estimation of the production function faced various limitations and assumptions. These limitations have been enhanced by the uncretainty sorrounding the measurement of the NAIRU. This is because in estimating the Cobb – Douglas production function, the NAIRU obtained in the previous section has to be used to obtain the potential employment. This might render the results obtained in this section also ineffective in policy formulation.

The estimated equation is as shown below ;

$$\text{Log}(Y) = 9.08 + 0.24^{*}\text{Log}(K) + 0.76^{*}\text{Log}(L) + (0.76)^{*}(-0.0014)^{*}T + 1.09\varepsilon_{t-1}$$

(2.73)	(0.048)	(0.048)	(0.048)	(0.0015)	(0.09)	(standard error)
(3.32)	(5.07)	(15.83)	(15.83)	(-0.937)	(11.65)	(t-statistic)

T is the trend (years) and ε_{t-1} is the lagged error term to correct for autocorrelation.

From the above results, the share of capital and labour to total output is 24 per cent and 76 per cent respectively. Labour takes a higher share of the total output and this conforms to expectations. The elasticity of output to labour is 0.76 while the elasticity of output to capital is 0.24. This means that output is more responsive to a change in labour than to a change in capital. For a developing country like Kenya, this is highly expected since it is more labour intensive in its production due to cheap labour. These production function results are similar to the results obtained in other studies done in Europe and the US, which show that labour has a higher share in total production. From the study done by Denis et al (2002), the share of labour to total production in most of the European countries is 0.62. Since the developing countries are more labour intensive than the developed countries, then the labour share in the developing countries is expected to be higher than in the developed countries. Also, according to Mankiw (2000), using the US data from 1960 to 1996, the labour share in the US was found to be 0.7 despite the many changes in the economy.

According to the adjusted R^2 (0.99), capital and labour explain most of the variations in output and are individually and jointly significant. Autocorrelation has been corrected by including a lagged error term although concrete decision could not be arrived at since testing the DW value of 1.2 does not show absence of autocorrelation or presence of negative autocorrelation.

The estimated potential output is higher than the actual output in 2001. This means that the economy is operating under excess capacity. Thus measures need to be taken to optimally utilise the available resources of labour and capital. This is the output that will not lead to inflationary growth. The estimated potential output growth for the year 2000 and 2001 is as shown below (see appendix 2.2 for graphical analysis). The output gap has been expressed as a percentage of the potential output.

Table 4.1: Output results in percentages.

Year	Actual growth	Potential growth	output gap
2000	-0.24	-0.22	4.39
2001	1.23	10.40	-4.29

The potential growth is higher than the actual growth for 2001 but less in 2000. The output gap in 2001 is negative meaning that the economy is operating under excess capacity. In this case, relaxing the monetary policy will not lead to demand pull inflation. Output therefore can be increased through more government spending that will be coupled by increased employment. Thus can reduce the unemployment levels, loosen the monetary policies, increase output and maintain inflation at low levels.

4.3 ESTIMATED OKUN'S EQUATION

In estimating the Okun's equation, this study applied simple time series analyses to capture the relation between the two gaps. The Okun's equation has been estimated in levels to test for cointegration. The estimated equation (see appendix 2.3) is,

UGAP = -0.95*GAP

(0.025) (standard error)

(-38.7) (t-statistic)

UGAP is the labour market gap, GAP is the output gap.

From the above results, the coefficient linking the two gaps is very significant and negatively correlated. Rose (1988) found a similar relationship for Canada. The third hypothesis is therefore rejected. This means that, increasing the output market gap leads to a reduction in the labour market gap.

From the cointegration test, the residuals are found to be non-stationary. This means that there is no cointegrating vector between the variables. Thus no need to estimate an ECM.

The estimated VAR model in first difference is;

DUGAP = -0.253*DUGAP(-1) + 0.07*DGAP(-1) + 0.22

(1.84)	(1.69)	(1.43)	(standard error)
(-0.13)	(0.04)	(0.15)	(t-statistic)

DGAP = 0.05*DUGAP(-1) - 0.23*DGAP(-1) - 0.165

(2.00)	(1.85)	(1.56)	(standard error)
(0.03)	(-0.13)	(-0.11)	(t-statistic)

DUGAP is the labour market gap in first difference

DGAP is the output gap in first difference

The optimal lag in this case is one (chosen on the basis of the minimum AIC and SC values). The lagged variables are not statistically significant and this means that they are not important in explaining the dependent variable. From the first equation, the growth of the lagged output gap leads to a growth in the unemployment gap. In the second equation, growth of the lagged unemployment gap leads to a growth in the output gap.

The structural analysis shows that the two gaps do not granger cause each other. The impulse response functions are not significant except DGAP responds negatively to DUGAP shocks up to the second horizon. Variance decomposition show that the variations in labour market gap are due to its own shocks while most of the variations in output gap are due to shocks from the labour market gap. This suggests that the output gap is the endogenous variable while the labour market gap is exogenous (see appendix 2.5).

4.4 ALTERNATIVE RESULTS

Using the adjusted employment data set as explained in section 3.5, alternative results have been obtained (see appendix 3). These give a NAIRU of 31 per cent in the year 2001. Comparing it with the adjusted unemployment rate of 28 per cent, this NAIRU is higher than the observed unemployment rate (negative unemployment gap) and this suggests reducing the level of employment so as to achieve a non-inflationary growth. This also leads to the conclusion that the monetary policy should be tightened further and some contraction of the fiscal policy. Also from this adjusted employment, the estimated Cobb-Douglas production function shows that, the share of capital to total output is 0.13 while for labour is 0.87. This share of labour seems to be too high. Using these alternative results, the output gap is positive and this suggests that the monetary policies should be tightened further. These results are less preferred to the previous ones since contracting the fiscal and monetary policies in Kenya can inhibit growth. This leads to the conclusion that depending on what level of unemployment one uses, the results will vary. Following this argument, it is suggested that these results may not be used for policy making since there is no actual and available data on the level of unemployment in Kenya and most of the developing countries.

5.0 CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

5.1 CONCLUSION

In this study, the NAIRU, potential output, unemployment gap and output gap have been estimated. The hypotheses have been tested at 5 per cent significance level. The first hypothesis has been rejected in that the coefficient linking the unemployment gap and inflation is statistically significant (using t-statistic). Thus increasing NAIRU leads to a decrease in the unemployment gap and therefore an increase in inflation. Thus to decrease inflation, the NAIRU should be decreased. The second hypothesis has been rejected in that labour in the production function is a significant variable and positively related to output meaning that increasing labour employed increases the output level. A reduction of NAIRU implies increasing the level of labour employed hence an increase in the output. The third hypothesis is also rejected. The coefficient of the output gap is negative and statistically significant. Thus a reduction in the output gap leads to an increase in the labour market gap. But structural analysis suggests that the labour market gap is the exogenous variable.

The NAIRU for Kenya in 2001 is 9.03 per cent and this is less than the observed unemployment rate. The potential growth of output in 2001 is 10.4 per cent while the output gap is –4.29. The share of capital to total output is 24 per cent while for labour is 76 per cent. The expectations of the study have been met. Inflation, unemployment, output and capital stock have been found to have a stochastic trend integrated of order one, I(1) (see appendix 2.4). Unemployment has an inverse relationship with inflation. NAIRU has a negative impact on output since decreasing employment (increasing NAIRU) leads to a decrease in output.

5.2 POLICY IMPLICATIONS

According to the NAIRU obtained, the observed unemployment rate is higher than the NAIRU. The policy implication of this is that the monetary and fiscal policies should be loosened to reduce the level of unemployment. If the level of unemployment is reduced to that of the NAIRU, then inflation will not be accelerating. Also lowering the NAIRU will ensure that the economy can maintain a low level of unemployment at the low NAIRU and still achieve stable inflation rate. This can only be achieved through a combination of policies. Increasing the level of employment can be a source of inflationary pressures and thus combining this with other policy measures aimed at reducing inflation can solve the problem. The estimated output gap can be used to solve the problem.

The potential output obtained in this study has been found to be higher than the actual output. This is the level of output that will maintain a non-inflationary economic growth. This means that the output gap is negative (actual minus potential output). Based on this outcome, the government should loosen its monetary policies so as to increase the level of output. A more expansive fiscal policy is suggested in this study so as to increase the level of employment. The Kenyan economy is usually said to be in excess capacity and hence increasing the employment rate coupled with a well directed and administered government spending will lead to a sustainable non-inflationary growth.

5.3 LIMITATIONS OF THE STUDY

(i) There is a great deal of uncertainty surrounding the measurement of NAIRU and potential output. This uncertainty stems from the fact that the equilibrium rate (NAIRU) and potential output cannot be observed and must be inferred from other data using presumed and uncertain economic relationships.

(ii) Capital stock and unemployment data are a challenge but attempts were made in this study to come up with figures close to their actual values. One expectation would be to revisit the issue when the CBS makes efforts to improve on the data.

(iii) The formulation of the Cobb-Douglas production function is based on some assumptions that may not hold for the Kenyan economy. However, internationally, the EU, OECD and US rely on the Cobb-Douglas production function to estimate the potential output (see section 2.2).

5.4 RECOMMENDATION FOR FURTHER STUDY

Further studies can estimate the NAIRU using different methods and compare the results. The estimation of potential output can be extended further to a CES production function and compare the results with those of other methods. A study on the TFP is also recommended so as to formulate policies towards increasing the level of output based on this TFP.

REFERENCES

Apel M. and Jansson P. (1998); 'A theory consistent system approach for estimating potential output and the NAIRU'; Research Department, Sveriges Riksbank, S-103 37; Stockholm, Sweden.

Branson W.H (1979); Macroeconomic theory and policy; Second edition; Universal bookstall, NewDelhi.

Cote' D. and Dong Hostland (1996); 'An econometric examination of the trend unemployment rate in Canada'; working paper 96-7; Bank of Canada; Canada.

Debelle G and James Vickery (1997); 'Is the Phillips curve a curve? Some evidence and implications for Australia'; Research Discussion paper 9706; Reserve Bank of Australia.

Denis et al (2002); 'Production function approach to estimation of potential output and output gaps for the EU member states and the US';

Derlome C.D and R.B. Ekelund (1983); Macroeconomics; Business Publications_Inc; USA.

Eisner R. (1995); Our NAIRU limit, The governing myth of economic policy; The American prospect vol. 6 No. 21, March 21.

Geda A., S.N. Karingi, Njunguna S. Ndungu, Marein van Schaaijk, Maureen Were, Willis Wasda and John Obere (2001); 'Estimation procedure and estimated results of the KTMM'; Working paper series (WP/05/2001); KIPPRA.

Greenspan A. (June 17 1999); 'NAIRU – The view from the Fed'; Joint Economic Committee; Wall street Journal.

Gross D. M. (1998); 'Youth unemployment and Youth labour market policies in Germany and Canada'; Action Programme on Youth Unemployment.

Huizinga F., A. Geda, Njunguna Ndungu and S. N. Karingi (2001); 'Theoretical Base for the Kenya Macro Model: The KTMM'; Discussion paper series (DP/11/2001); KIPPRA.

Jackson A. (1998); 'The NAIRU and Macroeconomic policy in Canada'; Canadian Labour Congress (Trade Union Advisory committee to the OECD).

Judd, John (1997); 'NAIRU: Is it useful for monetary policy?'; Federal reserve Bank of San Francisco (FRBSF); Economic letter 1997 No 35.

Kenya; Economic Survey (varoius issues); Government press

---------; Statistical Abstracts (various issues); Government press

---------; Labour force surveys (various issues); Government press

---------; The integrated Rural Survey 1976-1979; CBS

Kibua T.N (1989); 'Youth Unemployment in Kenya'; what are the possible solutions?; Central Bureau of statistics.

Lipsey R.G and C.K Alec (1995); Positive Economics; Eighth Edition; Oxford University Press; New York.

Mankiw G. N. (2000); Macroeconomics; Fourth Edition; Worth Publishers; New York, US.

Meier M.G. (1990); Leading issues in economic development; Oxford University Press; New Delhi, India.

Oiro M. W., Germano Mwabu and Damiano K. Manda (2003); 'Poverty and Employment in Kenya'; KIPPRA Discussion paper.

Pack H. (1974); 'Employment and productivity in Kenyan manufacturing'; Economic growth center; Yale university; New Haven; Connecticut.

Richardson et al (2000); 'The concept, policy use and measurement of structural unemployment: Estimating a time varying NAIRU across 21 OECD countries'; OECD; Economics Department working papers NO. 250

Rose D. (1988); 'The NAIRU in Canada: Concepts, Determinants and Estimates'; Bank of Canada; Technical report No. 50.

Slevin (2001); 'Potential output and the Output gap in Ireland'; Technical paper 5/RT/01, Central Bank of Ireland; Dublin; Ireland.

Smith S. W. (1994); <u>Labour Economics</u>; Routledge; London and Newyork.

Suchoy T. and Friedman A. (2002); 'The NAIRU in Israel: an unobserved components approach';

Ryan T. C. (2002); 'Policy Timeline and Time Series Data for Kenya: An Analytical Data Compendium'; Special Report series (SR/03/2002); KIPPRA.

Walsh C. E. (September 18, 1998); 'The natural rate, NAIRU, and monetary policy'; FRBSF <u>Economic letter</u> 1998 No 28.

World bank (1994); 'Proceedings of the World Bank, Annual Conference on Development Economics: Roundtable discussion'.

APPENDIX 1: Using the Kalman filter to estimate a time varying NAIRU (Richardson et al, 2000/Debelle, 1997)

The Kalman filter is a convenient way of working out the likelihood function for unobserved component model. For that, the system must be written in a state space form, with a **measurement equation** (the Phillips curve);

$$\Pi_t = \alpha\Pi_t^e + \gamma(U_t - U^*) + u_t \text{ ....(1)}$$

and a **transition equation (NAIRU)**

$$U^* = U^*(-1) + z_t \text{ ....(2)}$$

In our estimation, we assume that all parameters are constant except for the NAIRU that follows a random walk. Estimates of the NAIRU at each point in time can be calculated by taking the ratio between the generated series from E views and the coefficient of unemployment.
u_t and z_t are iid, normally distributed with means zero and varinces σ^2 and $\sigma^2 Q$ respectively. The ratio of the two variances is called the signal-to-noise ratio.

The Kalman filter is made up of two stages:

(I) **Filtering procedure** (one-sided estimation): This prediction mode builds up the estimates as new information becomes available. The filter computes estimates of the model parameter at time t based on information up to time t. The filter estimates through the entire sample in this manner. The Kalman filter produces estimates of this system by minimising the sum of the squared one-step prediction errors of the measurement equation.

(II) **Smoothing procedure** (two-sided estimation): The smoothing mode uses information available from the whole sample of observation. It is a backward recursion that starts at time T and produces the smoothed estimates in the order T, . . ., 1.

In order to execute the kalman filter, information on the initial values of the state vector and its initial covariance matrix, the variance of the measurement equation (variance of u_t) and the variance of the transition vector (variance of z_t) needs to be provided.

APPENDIX 2: RESULTS SUMMARY

A2.1: PHILLIPS CURVE ESTIMATION RESULTS

SSpace: NAIRU

Estimation Method: Maximum Likelihood

Model: Time-Varying Coefficient Model

Sample: 1972 2001

Included Observations: 27

Variance of observation equations: Diagonal

Variance of state equations: Diagonal

Failure to improve Likelihood after 18 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.765331	0.031927	23.97128	0.0000
C(2)	-0.601998	0.123553	-4.872404	0.0001
OBVAR(1,1)	1.644721	0.707092	2.326036	0.0296
SSVAR(1,1)	19.06537	0.747232	25.51467	0.0000
Final SV1	5.432918	4.537446	1.197351	0.2439

Log Likelihood	-82.23263

IN = C(1)*EIN +C(2)*UR +SV1

SV1 = SV1(-1)

R-squared	0.996223	Mean dependent var	13.96667
Adjusted R-squared	0.996072	S.D. dependent var	8.925676
S.E. of regression	0.559376	Sum squared resid	7.822545
Durbin-Watson stat	2.786784		

A2.2 THE NAIRU SERIES

Table A2.1: The NAIRU

Year	SV1SM	Nairu
1975	9.395717	15.60756
1976	3.278168	5.44548
1977	5.871672	9.75364
1978	2.308126	3.834109
1979	4.322466	7.1802
1980	6.605280	10.97226
1981	6.991715	11.61418
1982	10.07389	16.73409
1983	7.545789	12.53457
1984	6.692619	11.11734
1985	7.451782	12.37842
1986	11.13039	18.48908
1987	9.657854	16.043
1988	11.21181	18.62433
1989	11.82283	19.63932
1990	14.64577	24.3286
1991	15.82606	26.28922
1992	21.57826	35.8444
1993	22.85491	37.96509
1994	6.215087	10.3241
1995	7.175186	11.91895
1996	10.26504	17.05162
1997	9.496551	15.77505
1998	8.860486	14.71846
1999	11.65105	19.35397
2000	12.05735	20.02889
2001	5.432918	9.024811

SV1SM is the smoothed Time varying Parameter used to obtain the NAIRU by dividing it by 0.6 (the coefficient of the unemployment gap in the Phillips equation.

nairu is the smoothed NAIRU

Fig A2.1: Actual unemployment (UR) and NAIRU

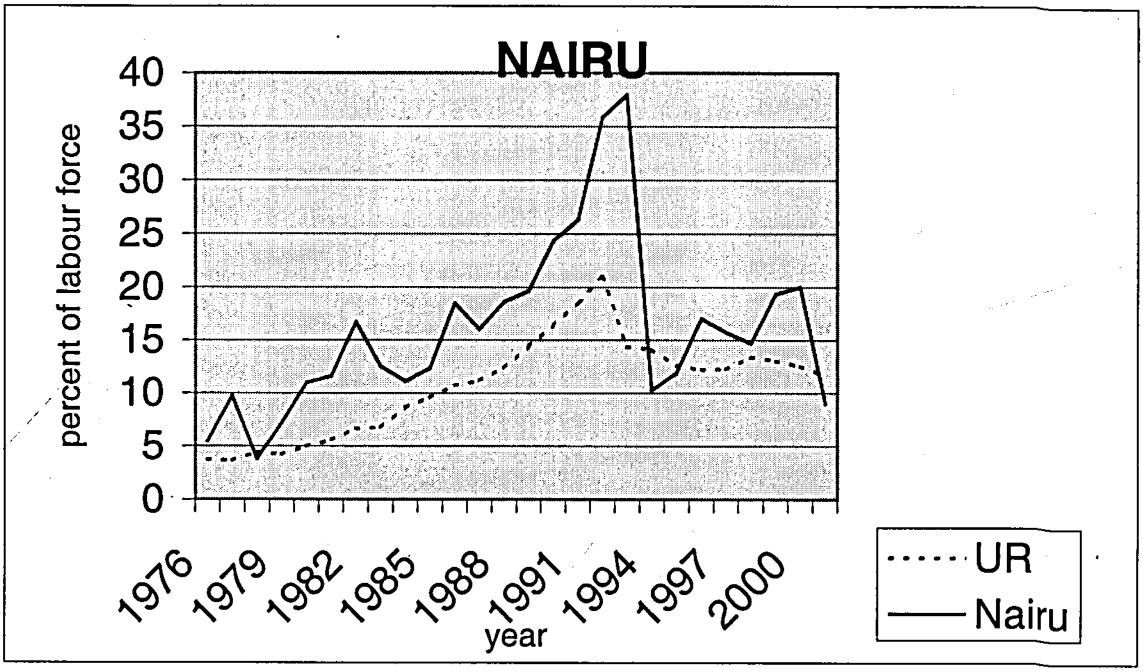
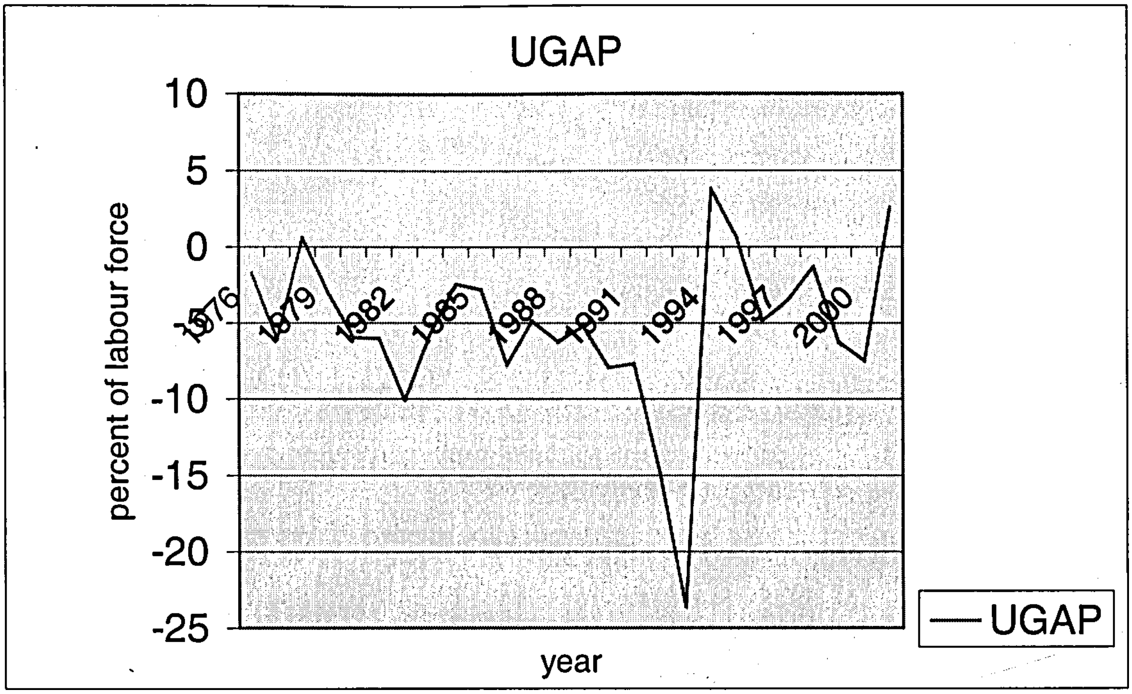


Fig A2.2: The labour Market Gap



A2.3: COBB-DOUGLAS PRODUCTION FUNCTION RESULTS

Dependent Variable: LY

Method: Least Squares

Sample(adjusted): 1973 2001

Included observations: 29 after adjusting endpoints

Convergence achieved after 12 iterations

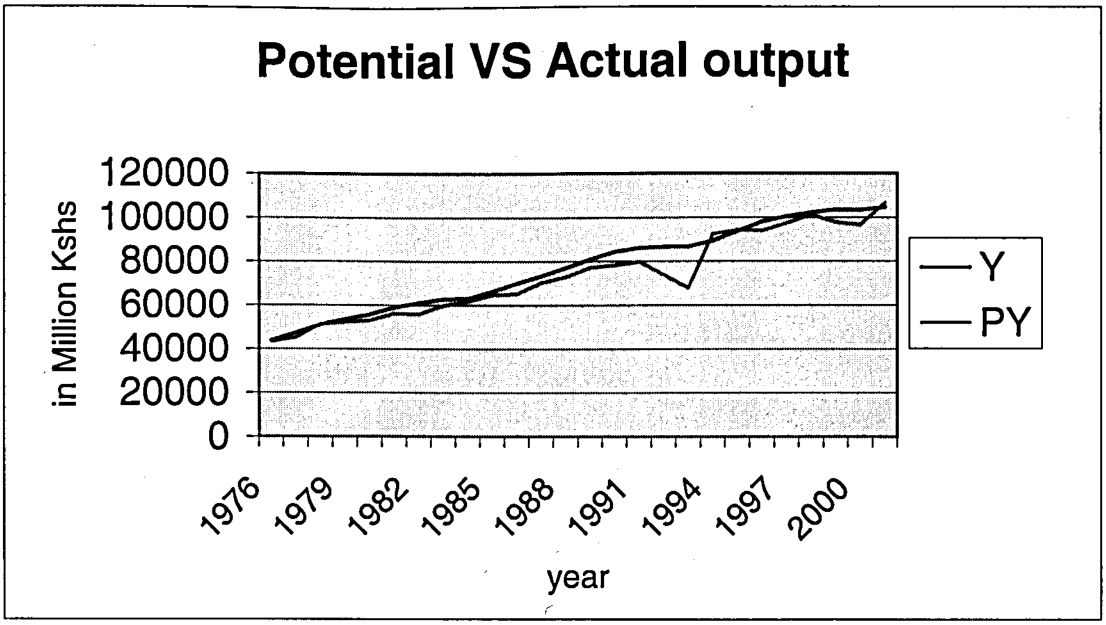
LY=C(1)+C(2)*LK+(1-C(2))*LTE+(1-

C(2))*C(3)*YEAR+C(4)*LRESID

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	9.079794	2.732813	3.322509	0.0027
C(2)	0.243603	0.048076	5.067070	0.0000
C(3)	-0.001372	0.001465	-0.936668	0.3579
C(4)	1.085317	0.093197	11.64537	0.0000

R-squared	0.994782	Mean dependent var	11.15780
Adjusted R-squared	0.994156	S.D. dependent var	0.313591
S.E. of regression	0.023974	Akaike info criterion	-4.496276
Sum squared resid	0.014368	Schwarz criterion	-4.307684
Log likelihood	69.19601	Durbin-Watson stat	1.219257

Fig A2.3: Potential output



Y is the actual output while PY is the potential output.

Fig A2.4: Growth rates of potential (PYG) and actual (g) output

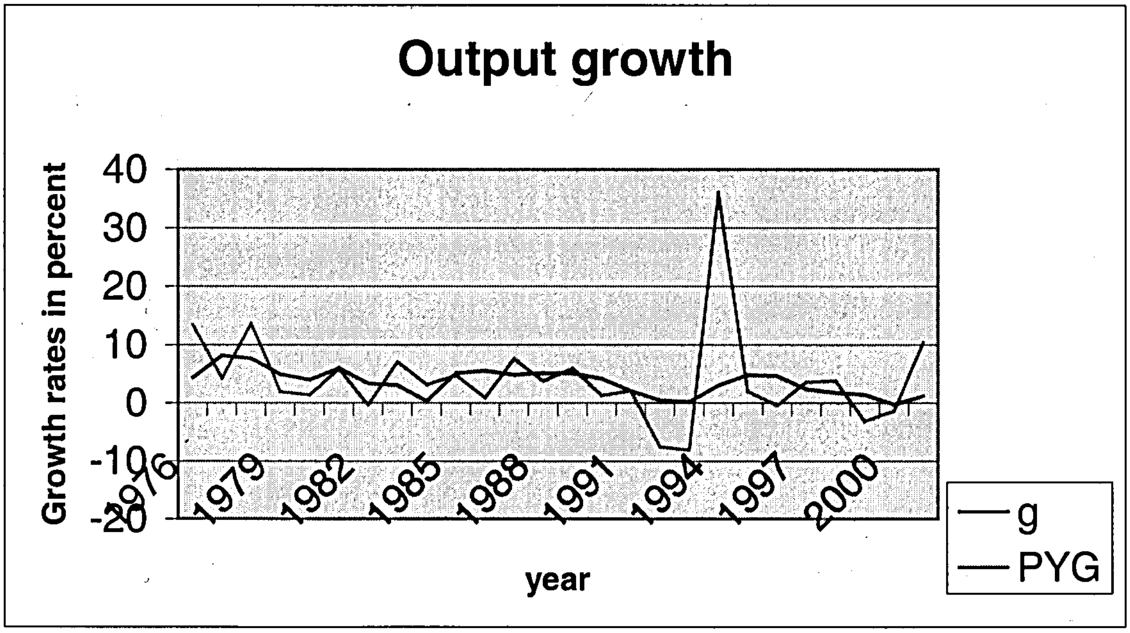
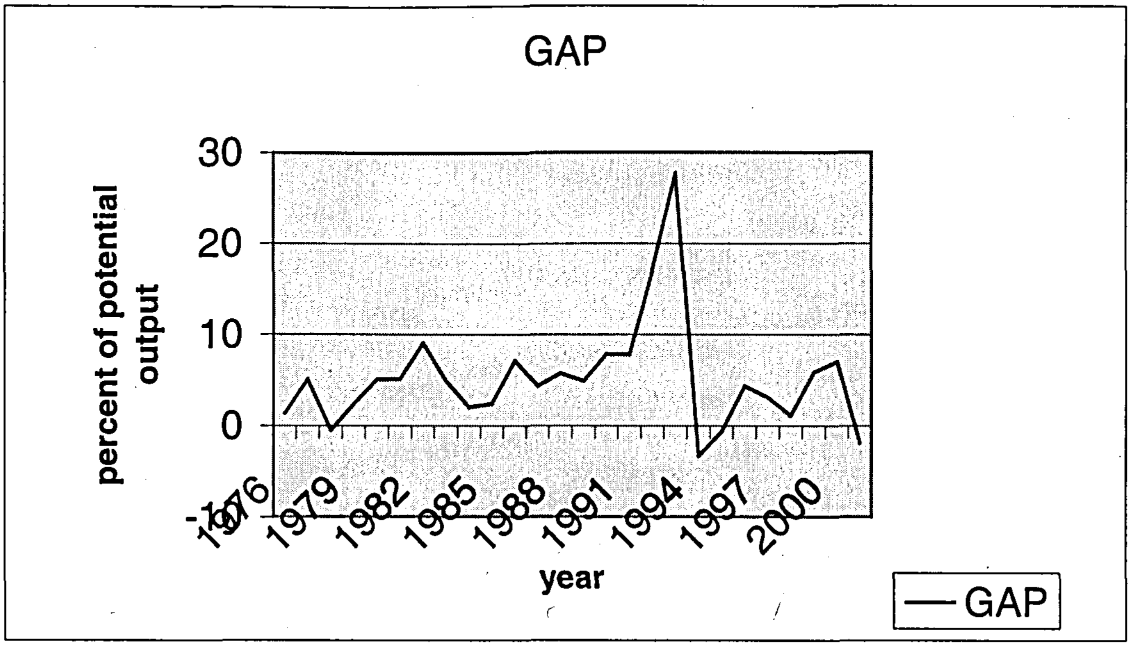


Fig A2.5: The output gap



A2.4 OKUN'S LAW RESULTS

A2.4.1 ESTIMATED COINTEGRATING VECTOR

Dependent Variable: UGAP

Method: Least Squares

UGAP=C(1)*GAP

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.949267	0.024523	-38.70857	0.0000

R-squared	0.965025	Mean dependent var	-5.518413
Adjusted R-squared	0.965025	S.D. dependent var	5.486604
S.E. of regression	1.026080	Akaike info criterion	2.925703
Sum squared resid	27.37385	Schwarz criterion	2.973696
Log likelihood	-38.49698	Durbin-Watson stat	0.714895

A2.4.2 ESTIMATED VAR MODEL

Johansen cointegration procedure (testing for cointegration)

Test assumption: Linear deterministic trend in the data

Series: UGAP GAP

Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.423122	18.83406	15.41	20.04	None *
0.183916	5.080936	3.76	6.65	At most 1 *

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Vector autoregression estimates

Standard errors & t-statistics in parentheses

	DUGAP	DGAP
DUGAP(-1)	-0.246912	0.052795
	(1.83677)	(2.00918)
	(-0.13443)	(0.02628)
DGAP(-1)	0.059764	-0.232142
	(1.69154)	(1.85033)
	(0.03533)	(-0.12546)
C	0.219702	-0.165319
	(1.42503)	(1.55880)
	(0.15417)	(-0.10606)
R-squared	0.096442	0.078595
Adj. R-squared	0.014300	-0.005169
Sum sq. resids	1112.936	1331.686
S.E. equation	7.112524	7.780178
F-statistic	1.174095	0.938292
Log likelihood	-82.92197	-85.16503
Akaike AIC	6.873758	7.053202
Schwarz SC	7.020023	7.199467
Mean dependent	0.173252	-0.128146
S.D. dependent	7.163932	7.760148
Determinant Residual Covariance		30.17348
Log Likelihood		-113.5340
Akaike Information Criteria		9.562717
Schwarz Criteria		9.855248

A2.5 UNIT ROOT TESTS

Inflation in levels with a constant and a trend

ADF Test Statistic	-3.366895	1%	Critical Value*	-4.2949
		5%	Critical Value	-3.5670
		10%	Critical Value	-3.2169

*MacKinnon critical values for rejection of hypothesis of a unit root.

PP Test Statistic	-2.683883	1%	Critical Value*	-4.2826
		5%	Critical Value	-3.5614
		10%	Critical Value	-3.2138

-Non stationary in levels

- Inflation in first difference

ADF Test Statistic	-5.810271	1%	Critical Value*	-4.3082
		5%	Critical Value	-3.5731
		10%	Critical Value	-3.2203

-Stationary in first difference. Has one unit root.

Expected inflation in levels with a constant and a trend

ADF Test Statistic	-3.154297	1%	Critical Value*	-4.2949
		5%	Critical Value	-3.5670
		10%	Critical Value	-3.2169

PP Test Statistic	-2.976750	1%	Critical Value*	-4.2826
		5%	Critical Value	-3.5614
		10%	Critical Value	-3.2138

-Non stationary in levels

- Expected inflation in first difference

ADF Test Statistic	-5.699721	1%	Critical Value*	-4.3082
		5%	Critical Value	-3.5731
		10%	Critical Value	-3.2203

-Stationary in first difference. Has one unit root.

Unemployment in levels with a constant and a trend

ADF Test Statistic	-1.184496	1% Critical Value*	-4.2949
		5% Critical Value	-3.5670
		10% Critical Value	-3.2169

PP Test Statistic	-1.372854	1% Critical Value*	-4.2826
		5% Critical Value	-3.5614
		10% Critical Value	-3.2138

-Non stationary in levels

- Unemployment in first difference

ADF Test Statistic	-4.578629	1% Critical Value*	-4.3082
		5% Critical Value	-3.5731
		10% Critical Value	-3.2203

-Stationary in first difference. Has a unit root.

Log of total employment in levels with a constant and a trend

ADF Test Statistic	-2.232999	1% Critical Value*	-4.2949
		5% Critical Value	-3.5670
		10% Critical Value	-3.2169

PP Test Statistic	-3.655486	1% Critical Value*	-4.2826
		5% Critical Value	-3.5614
		10% Critical Value	-3.2138

-PP test confirms that log of total employment is stationary but there are structural breaks or markov switching regimes.

Log of capital in levels with a constant and a trend

ADF Test Statistic	-2.253552	1% Critical Value*	-4.3226
		5% Critical Value	-3.5796
		10% Critical Value	-3.2239

PP Test Statistic	-1.608259	1% Critical Value*	-4.3082
		5% Critical Value	-3.5731
		10% Critical Value	-3.2203

-Non stationary

Log of capital in first difference

ADF Test Statistic	-3.637639	1% Critical Value*	-4.3382
		5% Critical Value	-3.5867
		10% Critical Value	-3.2279

-Stationary in first difference. Has a unit root

Log of output in levels with a constant and a trend

ADF Test Statistic	-0.760370	1% Critical Value*	-4.2949
		5% Critical Value	-3.5670
		10% Critical Value	-3.2169

PP Test Statistic	0.039830	1% Critical Value*	-4.2826
		5% Critical Value	-3.5614
		10% Critical Value	-3.2138

-Non stationary

Log of output in first difference

ADF Test Statistic	-3.831445	1% Critical Value*	-4.3082
		5% Critical Value	-3.5731
		10% Critical Value	-3.2203

-Stationary

Log output gap in levels with a constant a nd a trend

ADF Test Statistic	-3.149371	1% Critical Value*	-4.3382
		5% Critical Value	-3.5867
		10% Critical Value	-3.2279

PP Test Statistic	-3.126856	1% Critical Value*	-4.3226
		5% Critical Value	-3.5796
		10% Critical Value	-3.2239

-Non stationary

- Log of output gap in first difference

ADF Test Statistic	-4.771686	1% Critical Value*	-4.3552
		5% Critical Value	-3.5943
		10% Critical Value	-3.2321

-Stationary

Unemployment gap in levels with a constant and a trend

ADF Test Statistic	-3.051783	1% Critical Value*	-4.3382
		5% Critical Value	-3.5867
		10% Critical Value	-3.2279

PP Test Statistic	-3.039838	1% Critical Value*	-4.3226
		5% Critical Value	-3.5796
		10% Critical Value	-3.2239

-Non stationary

Unemployment gap in first difference

ADF Test Statistic	-4.849322	1% Critical Value*	-4.3552
		5% Critical Value	-3.5943
		10% Critical Value	-3.2321

-Stationary

A2.6 STRUCTURAL ANALYSIS

A2.6.1 GRANGER CAUSALITY TEST

Pairwise Granger Causality Tests

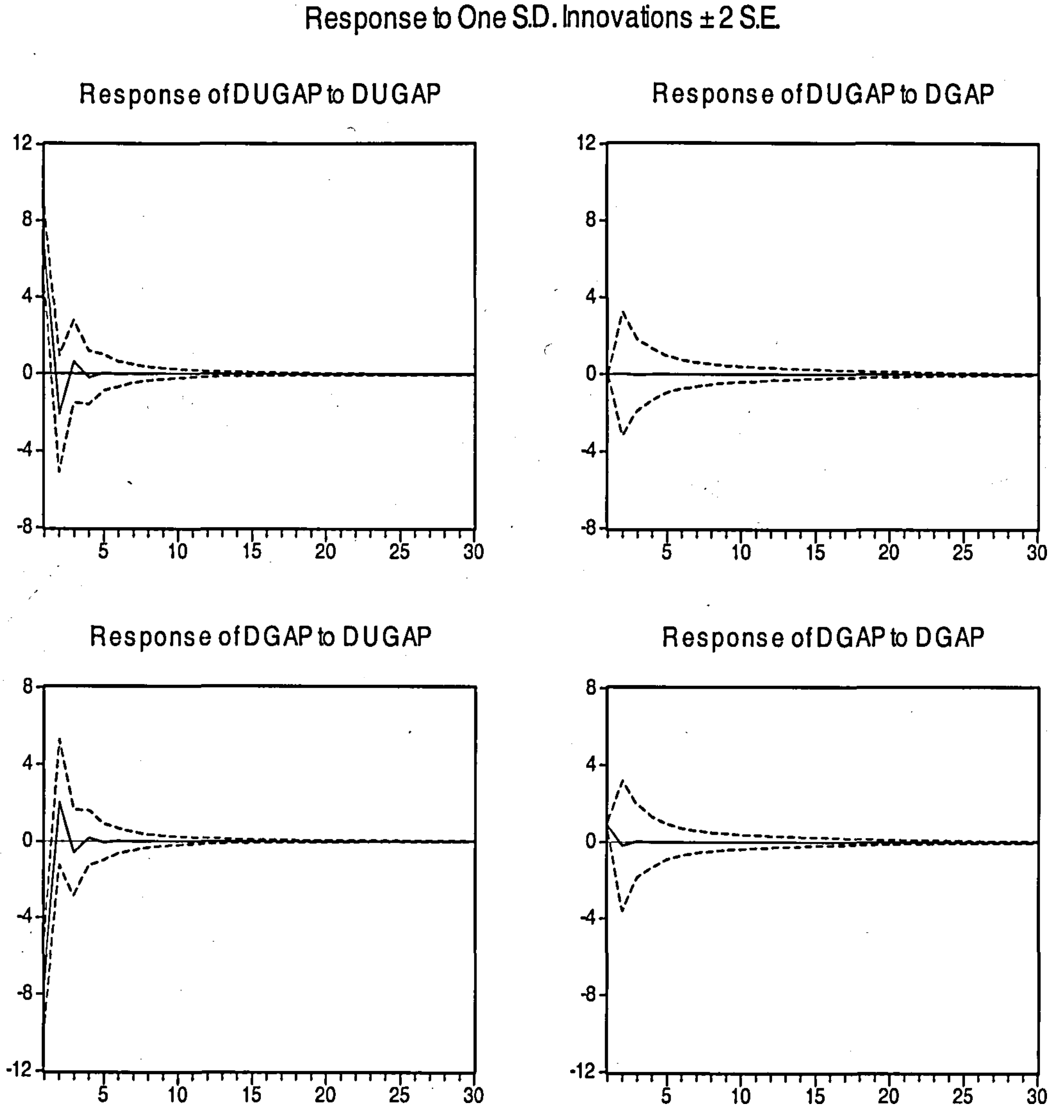
Sample: 1972 2001

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
DGAP does not Granger Cause DUGAP	25	0.00125	0.97213
DUGAP does not Granger Cause DGAP		0.00069	0.97927

A2.6.2 IMPULSE RESPONSE FUNCTIONS

Fig. A2.6 Impulse Response Functions



A2.6.3 VARIANCE DECOMPOSITION

Table A2.2: Variance Decomposition

DUGAP:

Period	S.E.	DUGAP	DGAP
1	6.672139	100.0000	0.000000
2	6.989257	99.99504	0.004956
3	7.018123	99.99396	0.006043
4	7.020747	99.99381	0.006190
5	7.020982	99.99379	0.006206
6	7.021003	99.99379	0.006207
7	7.021005	99.99379	0.006207
8	7.021005	99.99379	0.006207
9	7.021005	99.99379	0.006207
10	7.021005	99.99379	0.006207

DGAP:

Period	S.E.	DUGAP	DGAP
1	7.298454	98.72757	1.272429
2	7.579454	98.75659	1.243411
3	7.601944	98.76012	1.239881
4	7.603827	98.76048	1.239523
5	7.603987	98.76051	1.239489
6	7.604001	98.76051	1.239486
7	7.604002	98.76051	1.239486
8	7.604002	98.76051	1.239486
9	7.604002	98.76051	1.239486
10	7.604002	98.76051	1.239486

Ordering: DUGAP

DGAP

APPENDIX 3: ALTERNATIVE RESULTS

Phillips equation

SSpace: NAIRU

Estimation Method: Maximum Likelihood

Model: Time-Varying Coefficient Model

Sample: 1972 2001

Included Observations: 27

Variance of observation equations: Diagonal

Variance of state equations: Diagonal

Convergence achieved after 63 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.743955	0.135962	5.471798	0.0000
C(2)	-0.377612	0.588122	-0.642064	0.5275
OBVAR(1,1)	10.04299	3.445465	2.914843	0.0080
SSVAR(1,1)	8.085414	5.217792	1.549585	0.1355
Final SV1	11.75643	3.730845	3.151144	0.0046
Log Likelihood		-81.03135		

IN = C(1)*EIN +C(2)*AUR +SV1

SV1 = SV1(-1)

R-squared	0.923577	Mean dependent var	13.96667
Adjusted R-squared	0.920520	S.D. dependent var	8.925676
S.E. of regression	2.516349	Sum squared resid	158.3003
Durbin-Watson stat	2.358017		

Cobb-Douglas production function

Dependent Variable: LY

Method: Least Squares

Sample: 1972 2001

Included observations: 30

Convergence achieved after 7 iterations

LY=C(1)+C(2)*LK+(1-C(2))*LATE+(1-C(2))*C(3)*YEAR

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	2.402977	2.313082	1.038864	0.3081
C(2)	0.129645	0.048244	2.687271	0.0122
C(3)	0.003326	0.001274	2.609577	0.0146

R-squared	0.989561	Mean dependent var	11.13743
Adjusted R-squared	0.988787	S.D. dependent var	0.327707
S.E. of regression	0.034701	Akaike info criterion	-3.789454
Sum squared resid	0.032512	Schwarz criterion	-3.649334
Log likelihood	59.84181	F-statistic	1279.667
Durbin-Watson stat	0.297278	Prob(F-statistic)	0.000000

APPENDIX 4: DATA

Table A4.1: DATA USED IN THE ESTIMATION

Year	LF	TE	UR	IN	EIN	K	Y
1972	5.79	3.08	5.15	3.70	6.73	62061.67	38055.60
1973	6.02	3.24	4.61	9.20	6.22	68559.18	39582.80
1974	6.25	3.45	2.80	17.00	17.49	66598.48	40793.60
1975	6.50	3.55	4.17	19.10	15.74	63113.30	41971.40
1976	6.76	3.73	3.76	9.90	12.59	59046.27	43818.20
1977	7.02	3.92	3.64	12.90	11.35	62386.20	47380.80
1978	7.30	4.08	4.44	12.20	17.04	68708.71	51009.20
1979	7.59	4.32	4.21	8.60	8.93	71921.91	53520.20
1980	7.89	4.53	5.01	12.90	11.96	79315.13	55656.80
1981	8.21	4.78	5.59	12.50	11.90	84528.41	58980.60
1982	8.53	5.03	6.64	22.20	20.44	83560.60	60985.00
1983	8.87	5.37	6.80	14.40	14.49	73709.09	62837.40
1984	9.22	5.62	8.68	9.10	10.16	73749.16	63057.20
1985	9.58	5.93	9.58	10.80	12.24	79083.26	66289.60
1986	9.96	6.22	10.73	10.50	7.04	73109.12	69963.80
1987	10.06	6.38	11.19	8.70	7.89	79251.32	73368.80
1988	10.38	6.59	12.39	12.30	11.06	84379.26	77139.40
1989	10.69	6.71	14.43	13.50	13.79	88167.63	81062.00
1990	10.99	6.85	16.40	15.80	14.22	84560.43	84472.60
1991	11.31	6.95	18.61	19.60	20.08	86673.53	86230.00
1992	11.62	7.02	20.97	27.30	23.47	90199.29	86644.20
1993	11.94	7.90	14.37	46.00	39.53	79659.67	86855.60
1994	12.25	8.21	14.15	28.80	42.63	80273.45	89491.40
1995	12.58	8.67	12.61	1.60	2.87	84904.55	93802.80
1996	13.13	9.17	12.22	9.00	7.53	96625.65	98151.80

Year	LF	TE	UR	IN	EIN	K	Y
1997	13.65	9.52	12.27	11.20	11.90	108352.70	100472.90
1998	14.18	10.06	13.45	6.60	8.01	118719.30	102252.70
1999	15.03	10.43	13.07	5.80	2.37	127041.40	103701.50
2000	15.62	10.82	12.54	10.00	6.39	132349.50	103455.90
2001	16.24	11.23	11.67	5.8	6.33	137907.80	104731.20

LF is the labour force in millions (obtained from KTMM)

TE is total employment in millions (see section 3.5 for explanations of its derivation)

UR is the unemployment rate as a percentage of labour force

IN is inflation rate

EIN is the expected inflation rate

K is capital stock in million Kshs at constant 1982 prices

Y is Gross Domestic Product in million Kshs at constant 1982 prices