ESTIMATING POTENTIAL OUTPUT PER CAPITA FOR ZIMBABWE.

A DESERTATION SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN ECONOMICS

OF

THE UNIVERSITY OF NAMIBIA

BY

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MAY 2015

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ABSTRACT

The thrust of this study was to estimate the potential output per capita of Zimbabwe using Structural Vector Autoregressive method (SVAR). The study used quarterly data for the period 1990 to 2012 on the following variables: Gross Domestic Product per Capita (GDPC), Consumer Price Index and unemployment rate presented as y_t, p_t and u_t respectively. The long-run SVAR model estimation was done to show the permanent effect of unemployment, consumer price index and gross domestic product per capita on potential output of the economy. The SVAR model appropriately captured the recessions of 2000, 2002 and that of 2006-2008. The estimated potential output shows that it does not deviate significantly from the actual output. In addition the potential output per capita for Zimbabwe declined or in other words shifted inwards for the period 2000 to 2010 but it has been increasing since 2011. The reasons for the decline had been suggested to be migration of skilled labour force, capital outflow, and the fast track land reform programme initiated by government at the turn of the millennium. The researcher recommends that the extensions of this investigation could incorporate estimating the natural rate of unemployment (NAIRU), and formulate policies of reducing it. The NAIRU is another variable which is also important in macroeconomics because when the economy is operating efficiently and producing at its potential; unemployment has to be at its NAIRU level.

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ACKNOWLEDGEMENTS

I would like to thank my supervisor, Prof. E. Ziramba for his guidance during the preparation of this thesis. I appreciate his constructive criticism because without his critical contributions, this thesis would not be in this form. I would also like to extend my gratitude to my husband Tafie for his support during the course of preparing this thesis.

DEDICATION

I wish to dedicate this thesis to my husband Tafie and sons Isheanesu and Anotida.

DECLARATION

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Blessing Musariri

CHAPTER 1

1.0 Introduction

Potential output is defined as an estimate of “full –employment” gross domestic product or the level of GDP attainable when the economy is operating at a high rate of resource use (Robert, 2004). It can also be defined as the level of output consistent with a stable inflation rate and low unemployment rate. When the economy is operating at its potential output, unemployment is at its lowest level called the natural rate of unemployment commonly known as NAIRU. NAIRU means the non-accelerating inflation rate of unemployment. The difference between actual GDP and potential output is called the output gap. Output gap serves as an important indicator for the state of the economy. Although potential output measures the productive capacity of the economy, it is not a technical ceiling on output that cannot be exceeded. Rather, it is a measure of sustainable output, at which the intensity of resource use is neither adding to nor subtracting from inflationary pressure. If actual output exceeds its potential level, then constraints on capacity begin to bind, restraining further growth and contributing to inflationary pressure. If output falls below potential, then resources are lying idle and inflation tends to fall.

The pervasive usage of potential output in the policy arena as pointed out by many economists is hardly surprising since potential output constitutes the best composite indicator of the aggregate supply side capacity of an economy and of its scope for sustainable, non-inflationary, growth (Chagny, Lemoine, & Pelgrin, 2004.) The concept not only provides a summary indication of the underlying health or relative performance of an economy at a given point in time but can also be used for policy assessments over longer periods, by, for example, providing a reference value for judging the effectiveness of specific or general, economy-wide, microeconomic reform initiatives. Therefore estimating potential output is essential for the conduct of monetary and fiscal policy. This is because, to know whether the macroeconomic policy will achieve stable prices and the lowest possible unemployment rate it is equally important to know the output level compatible with these macroeconomic objectives.

Since 1962 when Okun explicitly stated the relationship between unemployment and potential output (a result known in literature as Okun’s law) the topic of estimating potential output became more interesting among researchers and academics. For the last decade, this topic has dominated the research area. Quite a number of researchers such as Chagny, Lemoine and Perlgrin (2004), Filho (2004), Arnold (2009), Benes et al., (2010), Serju (2006), Baghli et al., (2006) just to mention a few were interested in this area . Benes et al., (2010) noted that questions about the level and growth of potential output have re-surfaced in recent years as a crucial issue for monetary and fiscal policy.

Since potential output is not observable, a variety of techniques have been proposed by economists to estimate potential output. Some of these methods include the labour productivity growth accounting, statistical filtering techniques (centered moving averages, bandpass filters, Hodrick- Prescot filters, Baxter and King filter), simultaneous econometric models and the multivariate time series models for example Structural Vector Autoregressive methodologies which were considered to be more superior to their counterparts univariate methods (Chagny, Lemoine & Perlgrin, 2004).

1.1 Background of the Study

The economic history of Zimbabwe from 1980 to 2011 can be divided into four periods. The first decade from 1980 to 1990 is termed the post-independent era; from 1990 to 1995 is a period of economic liberalisation and implementation of Economic Structural Reform (ESR) and the period 2000 to 2008 is infamously known as an economic crisis period and lastly the transitional period (2009 to 2010), (Muzulu & Mashonganyika, 2011).

During the post-independence era real Gross Domestic Product (GDP) growth rate averaged 3 to 4% per annum and reached a peak of 7% in 1990. Between 1991 and 1995 ESR was implemented in response to poor macroeconomic performance. One of the key elements of ESR was an emphasis on monetary policy reform, in the form of liberalised interest rate and exchange rate policies. Other key ESR targets include, growth rate of GDP by 5% annually (1990-1995), a slowdown in inflation from 17, 7% in 1990 to 10% and reduction of budget deficit to 5% of GDP by 1995, (Human Development Report, 1998).

During the period of ESR unemployment continued to rise, manufacturing output declined in 1995, consumption levels declined, there was a massive redistribution of income from urban wage earners to rural population and household welfare declined due to a decline in public spending on social services.

In the late 1990s the government sanctioned the land reform programme. During the land reform programme, agricultural output declined. This decline in output coupled with a growing budget deficit, severe foreign currency shortages contributed to a continuous decline in the growth of real GDP from 0% in 1998 to -7.4% in 2000, and subsequently -10.3% in 2003. Between 2000 and 2007 real GDP declined by approximately 40%, (Millennium Development Goals (MDGs) Status Report Zimbabwe, (2010) .

Since the mid-1990s Zimbabwe experienced a sharp decline in real (GDP). The decline in output is attributed to various factors (Benes et al., 2010). Some of the factors include decline in the labour force participation rate, decline in the investment rate, the decline in international trade (which can be used as a proxy for technological change), as Zimbabwe’s traditional trade partners were not willing to trade with the country, and closure of some vital businesses and mines. For example, the continued deterioration of the economy forced Falcon Gold to shut down operations at Venice mine in 2006. As actual GDP declined over time, this causes “GDP *hysteresis*”, which means that the decline in actual GDP pulls down the potential output of the country. Figure 1 below shows the trend of Zimbabwe’s real GDP since 1980. Between 1998 and 2008 Zimbabwe experienced a sharp decline in real GDP.

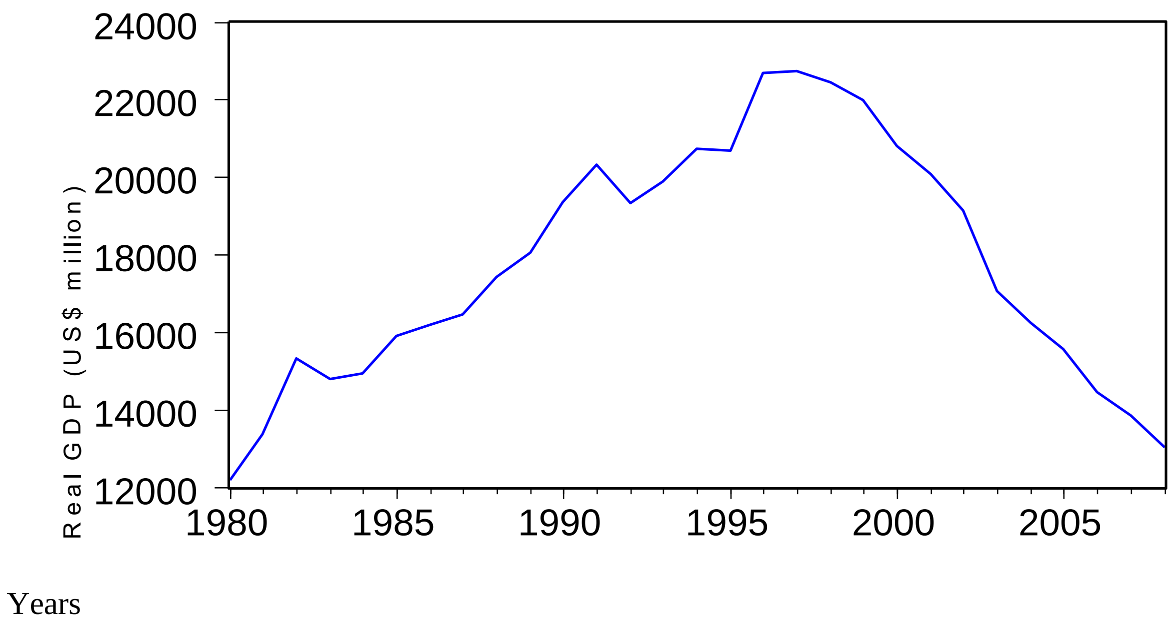


Figure 1: Real GDP of Zimbabwe from 1980 to 2008

Source: World Bank, (1980 – 2008)

Since 2000 Zimbabwe suffered the problem of brain drain, as qualified and experienced workers left the country in search of high paying jobs in other countries like South Africa, Botswana, United States of America and United Kingdom.

The volume of export and import trade of Zimbabwe with European countries declined sharply, (MDGs Status Report, 2010). Moreover, the land reform’s impact was seen in the reduction of agricultural output and hence a continued decline in real GDP. The decline of output in the agricultural sector affected other sectors like manufacturing and mining. This saw the closure of some mines for example Sabi Gold Mine in Zvishavane in 2004, and other mines like Shabani Mine were operating below capacity.

All these problems, according to basic economic theory pushed the potential output of Zimbabwe inside, and likely raised the natural rate of unemployment upwards and worsened the conditions of most poor people who were already struggling to come out of poverty.
Benes et al., (2010) cited factors that reduce potential output. These include low investments because of unusual uncertainty, tightness of credit, low labour force participation and erosion of skills; all these are synonymous to Zimbabwe. They also pointed out that evidence from the October 2009 *World Economic Outlook* shows that when there is an economic shock that reduces actual output, output would not go back to its old trend but will permanently remain below it.

The World Bank group (2013, p.13) reports that

> Since 2009, Zimbabwe’s economy has started to recover from the 1999-2008 crisis that saw economic output cumulatively declining by more than 45%. Supported by a strong recovery of domestic demand and government consumption, real gross domestic product (GDP) grew by 20.1% between2009-2011. GDP growth was led by strong growth in mining (107%), agriculture (35%) and services (51%) while recovery in manufacturing sector (22%) has been less vigorous. Despite the strong 2009-2011 economic rebound, GDP growth in 2012 has moderated to an estimated

5%, largely supported by mining. The agricultural sector went down by 3.5% as the production of maize declined due to adverse weather conditions, lower hectarage and subdued yields**.**

Uncertainty about the implementation of the indigenization program negatively affected overall growth in the mining sector, beyond the growth in diamonds and gold.

According to (ZIMSTAT, 1985-2003) unemployment rate in Zimbabwe was rising since 1995. For example in 1995 the unemployment rate was 6.1% but in 2008 the official rate was 23.6%. Also for the period 1998 to 2003 real GDP per capita declined from $2 161 in 1998 to $1 611 in 2003, which denotes a decline of almost 25% of GDP per capita, (ZIMSTAT 1985-2003). Figure 2 below, shows the trend of unemployment in Zimbabwe since 1985. Zimbabwe first experienced high unemployment rate in 1992 which was around 22%. Following a fall in real GDP, unemployment rose from 11% to 21.8% in 1992.

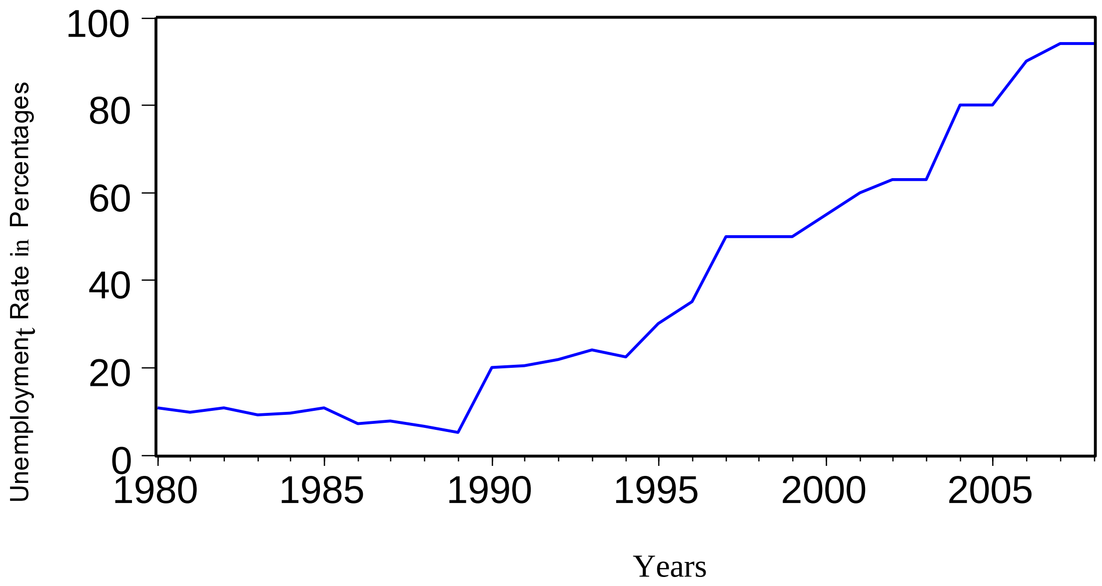


Figure 2: Unemployment Trend in Zimbabwe Since 1980

Source: ZimStat, (1980- 2008)

Inflation, which denotes a general increase in the price level, become the “country’s economic enemy number one” in the 2000s. The economic impact of inflation was that it reduced the purchasing power of money, stifled economic growth, and resulted in low worker morale which reduced productivity, eroded the competitiveness of the country in international trade and reduced savings (Reserve Bank of Zimbabwe, 2007). During periods of volatile inflation, prices grow faster than wage rates. This can have a negative impact in the labour participation rate. In high inflationary environments, workers know that this will reduce their real wage rate and they will be discouraged to work. The impact of their action can be seen in reduced output. Inflation is notoriously known for redistributive effect of income from lenders to borrowers, especially when it is unanticipated.

Figure 3 below shows the inflation trend of Zimbabwe since 1980. Before 1998 the inflation rate in Zimbabwe was moderate. After 1998 the inflation rate continuously increased. The main cause of inflation was an explosive growth in monetary aggregates. For example, in 2006 money supply (M3) growth was 590.6% and in 2007 the growth in M3 was 2083.2% (Reserve Bank of Zimbabwe, 2007), for the same period in 2006 inflation rate was 1016.7% and increased to 6723.7% in 2007, (ZIMSTAT, 2008). Other major drivers of inflation were stated as food, rent and rates, education and energy, (Reserve Bank of Zimbabwe, 2005).

The diagram below shows that inflation went so high since 2005. It is important to note that when inflation is rising, and if that increase cannot be attributed to any shock such as the oil price or money supply growth, then the rise is due to excess demand, that is, actual output will be above potential output (Butler, 1996).

Efforts to reduce inflation were directed in reducing money supply growth during the crisis period. In the economic history of Zimbabwe, there is evidence that the monetary authorities focused solely on reducing inflation and maintain stable prices, but without knowing the output level that is compatible with stable prices.

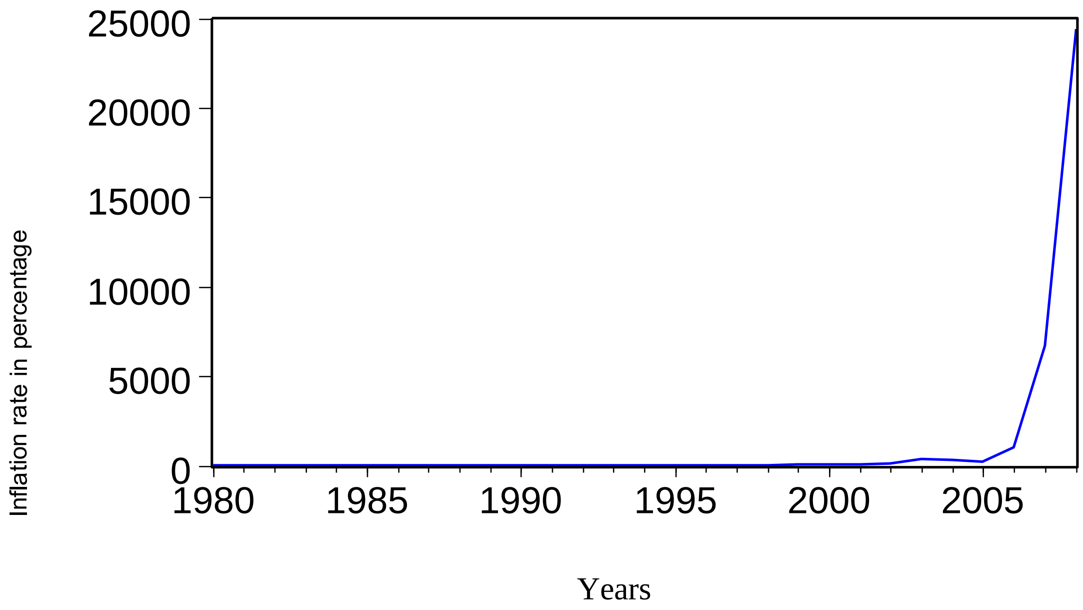


Figure 3: Inflation Trend in Zimbabwe Since 1980

Source: World Bank, (1980 – 2000)

1.2 Statement of the Problem

Mc Morrow and Roeger (2001) commented that 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. One of the major aims of macroeconomic policy for most central banks is stable inflation rate with high employment rate. In order to achieve this it is important to know the economic output level which is compatible with stable inflation and the lowest possible unemployment rate. The output level that is consistent with this goal is the potential output level. The series of economic events that took place in Zimbabwe over the period under study, the economic crisis associated with high levels of unemployment and inflation leading to most productive sectors shutting down and people migrating to other countries would raise an interest into researching the potential economic output of Zimbabwe. Again those who deal with fiscal issues are more interested to know the economic output level that is prone to structural rather than cyclical factors. This again requires an estimation of potential output that links to a sustainable fiscal policy.

1.3 Objective of the study

The objective of this study is:

- To estimate potential output per capita of Zimbabwe’s economy. This enables one to find out whether the potential output per capita of Zimbabwe has shifted inwards or outwards during the sample period, 1990 to 2012.

1.4 Significance of the Research

Despite the fact that the topic has been dominating the research arena, no research for estimating potential output per capita of Zimbabwe has been conducted before using the structural vector auto-regressive (SVAR) methodology. It is the aim of this paper to estimate the potential output per capita of Zimbabwe using the SVAR method. It is the purpose of this study to fill such a gap.

1.5 Limitations of the study

This study aims at empirically investigating the potential economic output for Zimbabwe. This requires a wide range of variables to be studied. However, this study has only considered output per capita, inflation and unemployment due to unavailability of data on other variables which could help to clearly reveal the potential economic output.

1.6 Organisation of the study

This chapter gave a brief overview and background of the area of the study in the context of the Zimbabwean economy. The remainder of this study is as follows: Chapter 2 discusses the existing theoretical and empirical literature on the subject of the study. Chapter 3 documents the methodology and empirical motivation as well as the variables used, while Chapter 4 presents the results and their interpretations. Chapter 5 summarises the findings of the study, their policy implications and also gives recommendations.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The motivation of this chapter is to explore the theoretical and empirical explanations of potential output. The first section uncovers the theory of potential output. The empirical literature section explores studies, methodologies, applications and observations that have been made by different authors and researchers in different countries and regions on the subject.

2.1 Theoretical Literature Review

Laxton and Tetlow (1992), commented that it appears from the literature that the concept of potential output has evolved from one that is focused on the maximum possible output to the current preferred one as defined by Chagny, Lemoine and Pelgrin (2004) which defines it as that level of output consistent with stable inflation rate and the lowest possible unemployment rate,. It can be regarded as trend-output concept. The basic assumption is that the economy fluctuates around this trend at business cycle frequencies.

Benk, Jakab and Vadas (2005), noted that the other definition of potential output is based on the traditions of dynamic macroeconomic theory, where the optimal or equilibrium output is defined as the level of output prevailing under perfect price flexibility. This concept is often distinguished from potential output and sometimes is called natural output. Natural output depends on several key structural factors, such as labour, capital, the terms of trade and foreign output. According to this view, natural output fulfills profit and utility maximisation conditions, all budgets and transversality conditions hold and the economy is in equilibrium.

Broadly speaking the literature distinguishes definitions of potential output into two broad categories, the Keynesian and the Neo-classical tradition. The Keynesian view is discussed first.

The Keynesian tradition- The business cycle results primarily from movements in aggregate demand in relation to a slow moving level of aggregate supply. In business cycle downswings, there exist factors of production that are not fully employed. In the Keynesian framework, a modern economy can be trapped in underemployment equilibrium - an equilibrium that occurs below the full employment level. If there is an economic shock that emanates from the demand side and push the aggregate demand out, output and price will increase. Shocks that emanate from the supply side and reduce the aggregate supply will reduce output and increase the price level. It can be seen clearly that in this model when aggregate demand increase and aggregate supply decreases simultaneously, price increases, a phenomenon known as stagflation. In terms of the Phillips curve relationship, the short-run Phillips curve will shift upwards. The economy can produce its natural rate of output when unemployment is at its natural rate. Any change in the economy that alters the natural rate shifts the long run aggregate supply curve.

The neoclassical tradition - potential output is driven by exogenous productivity shocks to aggregate supply that determine both the long run growth trend and, to a large extent, short term fluctuations in output over the business cycle. In the classical model, output depends on labour, capital, natural resources, and technological changes. Any positive changes to these variables shift the potential output to the right. It is also informative to know that labour supply is affected by labour force participation rate, among other variables (Samuelson & Nordhous, 1991). When the economy experiences an extended period of high unemployment rate, it is likely that the natural rate of unemployment will also increase (Snowdon & Vane, 2005). This phenomenon is known in theoretical literature as unemployment *hysteresis*. According to Dornbusch and Fischer (1992) the reason is that the unemployed become accustomed to not working and enjoying odd jobs, for example selling pencils, vegetables and tomatoes in the streets, or they can become discouraged from applying for jobs. In addition to this, potential employers reinforce the problem, they believe that if someone spent a long time without working, the person cannot have the experience required for the job and as a result firms will not employ that person. Thus, a person becomes increasingly unemployable with time. Amornthum (2002) argued that a long period of unemployment tends to reduce the productivity of workers, which inevitably hurts the potential growth of a country.

Unlike the Keynesian framework where the economy might reach its potential only after an extended period, potential output in the neoclassical framework is synonymous with the trend growth rate of actual output. The key measurement problem is to distinguish between permanent and transitory movements in and around potential output.

Aggregate demand and Aggregate supply framework- In the aggregate demand and aggregate supply framework it is assumed that long-run aggregate supply (LRAS) shocks have permanent effects on the level of output while temporary aggregate demand shocks and short-run aggregate supply shocks have temporary effects on the price level and output. A positive supply shock shifts the LRAS out, resulting in permanent increase in output and permanent fall in prices. A positive aggregate demand shock shifts the aggregate demand , which increases output (temporarily) and prices (Morling, 2002).

Central banks are more interested in the level of potential output for it provides them with a basis to use monetary policy to guide the economy towards the desired level, (Mc Morrow & Roeger, 2001). Output gap, which is the difference between the actual and potential, is used by central banks as an indicator of inflationary pressures. It is also necessary for measuring fiscal deficit (Serju, 2006).

Given the key measurement problem of distinguishing between permanent movements in potential output and transitory movements around potential output and its nature that it is not observable, the main challenge is finding the correct estimation of the potential output. Potential output can only be derived from either a purely statistical approach (which may suffice for short run purposes) or from a full econometric analysis (more appropriate for medium and long run studies). The difference is when one use a deterministic set of mathematical equations and/or uses either econometrics or statistics to obtain results i.e one is based on deterministic equations and the other is based on statistics or econometrics. An alternative in literature is to follow statistical trends, then incorporate economic fundamentals in econometric forecasts. It is clear, however, that conducting such an analysis requires a number of arbitrary choices, either at the level of parameters (in statistical methods) or in the theoretical approach and choice of specifications, data and techniques of estimation (in econometric work), (Mc Morrow & Roeger, 2001).

Given the methodological choices outlined in the previous paragraph, the essential question to be addressed in terms of calculating potential output is whether an econometric, as opposed to a statistically based, approach provides the best way to proceed. Clearly, for the purposes of any continuous monitoring exercise, statistical trend estimation methods have a number of important advantages, including conceptual simplicity, ease of construction, relatively timely in terms of availability and finally a minimum of value judgments to be used. However, as against these latter gains one perhaps loses the possibility of examining the underlying economic factors which are driving any observed changes in the potential output indicator or indeed the opportunity of establishing any meaningful link between policy reform measures with actual outcomes. In the same way, whilst economic estimation would appear to overcome, at least partially, the latter concerns in terms of appraising policy effectiveness, on the negative side difficulties clearly emerge in terms of achieving a consensus amongst policy makers on the modeling and estimation methods to be employed. Policy makers need to be made fully aware of these latter trades-offs which make any decision making process, involving a choice between the statistical and economic approaches to calculating potential or trend output, a difficult one to undertake in practice.

Methodologically, no consensus on estimation methods has been reached. Therefore a variety of techniques have been proposed by economists to estimate potential output. According to the Congressional Budget Office of the United States (2004), some of these methods include:

- The labour productivity growth accounting: this approach models potential output as a function of labour and labour productivity. It is considered in the sense that it avoids the need to estimate and project the capital input. The two inputs it uses can be cyclically adjusted by using Okun’s law or other detrending methods.

  The labour productivity growth accounting looks explicitly at the supply side of the economy. Potential output is taken to measure the productive capacity; as such any estimate of potential output is likely to benefit from explicit dependency on factors of production. For example if labour increases, then this method will show acceleration in potential output, ceteris paribus. This method also permits a transparent accounting of all the sources of growth that is it allows analysts to divide the growth of actual or potential GDP into contributions made by each of the factor inputs.

  This method however, is based on an estimate of the amount of slack in the labour market which in turn requires an estimate of the Natural rate of unemployment. Such estimates are highly uncertain. Few economists would claim that they can confidently identify the current NAIRU to within a percentage point. Secondly, this approach is not very sensitive to possible errors incurred in the average level of the estimated NAIRU.

- Statistical filtering techniques: these include methods such as centered moving averages, band pass filters, Hodrick- Prescott filters, Baxter and King Filter. These methods are often used to extract the trend from GDP directly.

The advantages of these methods are that they are more flexible in how they estimate the trends in the data series and the values of parameters. For example, statistical filtering technics do not generally use Okun’s law and do not require judgments about trend breaks during the sample. They follow the data more closely; as such they tend to identify changes in trends more quickly. The statistical approaches also allow the values of estimated parameters to change as the economy changes.

The statistical filtering techniques have some disadvantages that many of the filters do level their trends to any external measure of capacity. Therefore their results can be interpreted as trend GDP but not as potential GDP. In other words they do not yield an estimate of the level of output that is consistent with stable inflation. Filters do not produce cyclically adjusted estimates of GDP meaning that they do not attempt to remove the effects of business cycle fluctuations from the variable being filtered. They require analysts to make assumptions about how the filters are structured, including the values of one or more parameters without providing guidance about satisfactory values. Statistical methods average the past and future values to calculate the trend. This leads to problems identifying the trend at the end of the sample because fewer future values are available to come up with the average.

- Simultaneous econometric models: some researchers have defined full simultaneous systems of equations that describe the behavior of the variables such as output, employment, productivity and inflation. The parameters of these equations can be estimated using statistical techniques and under certain assumptions, the equations can be used to calculate potential output.

- Multivariate time series models: These include econometric methods of estimation known as Vector Auto regressions (VARs) and Structural VARs. These models estimate the parameters of econometric equations using statistical techniques. They impose far fewer restrictions on the structure of and the relationships between equations in the system. SVARs were considered to be more superior to the other univariate methods (Chagny, Lemoine & Perlgrin, 2004).

Econometrics and time series models have similar advantages over statistical approaches in that they are more flexible in how they estimate the trends in the data series and the values of parameters. For example, they do not require judgments about trend breaks during the sample because they follow the data more closely and tend to identify changes in trends more quickly. The econometric model and time series model approaches allow the data to determine the strength of the relationships amongst variables and equations within the model. Their main disadvantage is that they are highly aggregated and can obscure some underlying relationships in the economy for instance they may indicate that there has been growth in potential output but they do not give an insight into the sources of growth.

This study is going to use one of the multivariate time series models; the Structural VAR approach. This approach to estimating potential output is based on simple theoretical aggregate supply - aggregate demand models. The idea is to estimate such a model in a vector auto-regression form, to use theoretical restrictions to identify the major shocks to the system and to decompose movements in output into permanent and transitory components. The shocks can then be used to construct the measures of the output gap. Several techniques exist for recovering the shocks affecting the variables in VAR. The reduced-form errors of a reduced form VAR can be used to recover the structural shocks. However, the recovery of the structural shocks from the reduced-form errors requires the identification of the elements of the matrix of contemporaneous coefficients that relates the structural shocks to the reduced form errors.

2.2 Empirical Literature

Due to uncertainties around the estimation of potential output, most researchers when estimating potential output of respective countries use a variety of techniques. Most researchers came up with almost similar conclusions that the SVAR methodology adequately explain changes in inflation rate as compared to other estimation methods, (Serju, 2006 and Chagny, Lemoine & Perlgrin, 2004).

Teixeira (2001) noted that since potential output is unobservable its estimates involve a high degree of uncertainty, as can be seen by the existence of several methods to estimate it. He used the production function to estimate the potential output for Brazil for the period 1980 to 2000. The results show that for the sample period, the Brazilian economy operated below its potential output. The estimated production function shows that the economy experienced a boom for the years1980, 1986 and 1987. The most negative output gap occurred in 1983 and 1992, two years after the deep recessions of 1981 and 1990.

Morling (2002) estimated potential output of developing countries from Asian economies, Latin America, Middle East and Africa using annual data covering the period 1980 to 1998. The included variables were real GDP and GDP deflator, which he considered to be the most comprehensive measure of a country’s price level. The results obtained suggest that the decomposition of output into permanent and transitory shocks is not sufficient to properly identify demand and supply shocks for many developing countries. In addition, he found that, measures of the output gap constructed for developing countries are likely to capture a mixture of supply and demand induced deviations in actual output from potential output. The dominant shock may or may not be demand shocks. Hence the output gap measures are a less useful guide for assessing inflationary pressures and for conducting monetary policy in developing countries.

Chagny, Lemoine and Pelgrin (2004) estimated the potential output for the Euro-Area for the period 1970 to 2002. The research was carried out to test the statistical reliability of different methods used to compute output gap. The methods tested include, the multivariate HP filter, the multivariate unobserved component and the SVAR model. The variables used include GDP, inflation rate, unemployment rate, capacity utilization and relative import price. They also found that interpretation may differ across different specifications used. It was found that multivariate detrending models are less reliable than a SVAR in terms of inflation forecast. The multivariate unobserved component models perform better than HP multivariate models in relative terms, for estimating potential output and the output gap.

Njuguna (2005) estimated the potential output for Kenya from 1972 to 2001 using HP filter and the unobserved components methods, linear methods, SVAR and the production function. He used the following variables; GDP, private consumption, time trend, labour employed and capital stock. The results show that potential output and its growth, and output gap changes depending with the method used. However, the results from most methods showed some consistence with one another and this implies that a consensus can be obtained on the performance of the economy.

Serju (2006) estimated the potential output for Jamaica using the linear trend, HP filter, the Band-Pass (BP) filter, Kalman filter and the SVAR methods using quarterly data from 1983 to 2004. According to the linear trend method, Jamaica experienced a long period of excess supply from September 1983 to March 1989, but on average SVAR depicted shorter periods of excess supply. HP and BP filters show almost similar periods of excess supply. The conclusion was that the linear trend exaggerates the performance of the economy, hence, the robustness of the method appear questionable. Since liberalisation, SVAR was found to be consistent with periods of high inflation. Serju argued that when prices are controlled, excess demand cannot explain movement in prices adequately. He also found that the coefficient of the GDP gap derived from linear trend and the SVAR were positive and significant in explaining inflation. The HP and BP filters contained insufficient information to explain inflation. SVAR and linear trend estimates have greatest predictive power for output sample forecast.

Cesaroni (2007) estimated the potential output for the Italian economy for the period 1985 to 2005 using quarterly data. The variables used were real GDP and capital utilisation. He used the SVAR methodology, HP-filter and Baxter and King-filter. He used a number of methods in order to show the superiority of the SVAR methodology over other conventional methods used. The results of potential estimates from the HP and Baxter and King-filters were similar, but they were different from the estimates using SVAR. For example, for the period 2001 to 2005 the two methods show a negative gap, but the SVAR shows a positive gap, which seems to be the experience of the economy during that period. The results confirm the strength of the SVAR model.

Konuki (2008) estimated the potential output and the output gap for Slovakia. He used HP filter, the production function and the MV Kalman filter approaches, for the period 2001 to 2010 using quarterly data. The findings point out that the MV Kalman filter produces estimates of excess demand that characterises much more realistically situation in Slovakia and provides a better base for conducting macroeconomic policy than the HP filter and production functions. Gagales (2006) point that the problem with the MV filter is that estimated parameters may not be accurate and results are sensitive to the choice of starting values.

Lemoine et al., (2008) estimated the potential output for the euro area using the production function, HP filter and the multivariate unobserved components (MUC), and SVAR model for the sample period 1972 to 2006. The different models were compared according to their ability to forecast inflation. The naive model, specified as a random walk, was used as a benchmark. The MUC was better than the naive model for short run horizon, but it was not found to be statistically significant. The SVAR was again better than the random walk model for medium run horizon and still this was not statistically significant. The production function performs worse than the naive model. They concluded that the different estimation methods had some advantages and drawbacks, and the choice of the estimation strategy depends on the specific needs of the final user of output gap estimates.

Osman (2008) estimated potential output and output gap for four east African countries; Kenya, Ethiopia, Tanzania, and Uganda using the linear trend method, HP filter, the frequency domain filter, and the unobserved component model. The results indicate that the estimates obtained were comparable to each other for different estimation methods used and also the results confirm that these countries have almost the same business cycle.

Epstein and Macchiarelli (2009) estimated potential output of Poland for the period 1995 to 2007 using quarterly data. They developed a methodology based on the production function approach to estimate potential output of the Polish economy. They also estimated the potential output using the same data over the same period using the HP filter. They argued that pure statistical methods like HP filter can be particularly problematic in estimating potential output growth in emerging market economies. In their results the production function was more effective as compared to HP filter, and the production function also helps to identify the turning points of the business cycle. The production function was able to capture the period of boom before Poland experienced a crisis.

Adamu, Iyoha, and Kouassi, (2010), estimated the potential output for Nigeria using quarterly data covering the period 1980 to 2008. The variables used include domestic output, employment (proxied by labour force), and capital utilisation. The methodologies used were linear trend, HP filter, and the SVAR techniques. They found that the linear trend method produces good results, for example it clearly shows the country’s recession of 1990’s and boom during the first decade of the 21st century. The results from the HP filter were not consistent with the country’s experiences, for example it failed to capture the recession of the 1990’s and the boom of the first decade of the 21st century. Adamu, Iyoha, and Kouassi, (2010) repeated the test using annual data to estimate potential output; they found that results obtained from both methods were not appealing as those of quarterly data. They reported that the linear trend obtained using annual data failed or erroneously show a deep recession in the 1980’s instead of a minor one. They also found that the SVAR estimate of potential output using annual data does not properly capture recession of the 1990’s, but it correctly captures the boom of the new millennium. They argued that the use of quarterly data was likely to improve performance of the SVAR but they noted that the major constraint was unavailability of quarterly data (which is a problem of most developing countries, and this hinders fruitful researches). As an alternative in most developing countries annual data is used to estimate potential output. The linear trend appeared to be superior over other alternative estimations.

Saulo,Vasconcelos and Leão (2010) estimated the potential output for Brazil using the HP filter, the production function, Band-Pass filter, linear trend, moving average, univariate unobserved components (UCC), Beveridge-Nelson decomposition and SVAR. The study used quarterly data for the period 1995 to 2006. The variable used include real GDP, employment and inflation rate. To test the performance of alternative methods used they construct the Taylor rule, using the output gap obtained from alternative methods. The results show that only the UCC method fitted in the Taylor rule. The Phillips curve was also used to test the usefulness of the output gap obtained from different techniques. The variables used in the simple Phillips equation include domestic inflation and the output gap. The root mean-squared forecast error (RMSFE) was used to compare forecast quality. A comparison of the RMSE of alternative methods with the AR indicates that all eight alternative methods have upper RMSE errors, meaning that there is no additional information in putting output gap as an explanatory variable in the Phillips curve. The results demonstrate that at all holdback periods only Beveridge-Nelson is significantly better than the error forecast at 10 percent level. Hence, the Beveridge-Nelson decomposition helps to improve the prediction of inflation and assessing the actual economic situation.

Benes et al., (2010) estimated potential output of twelve industrial nations which are U.S.A, Germany, U.K, France, Italy, Canada, Euro Area, Australia, Norway, New Zealand, Spain, and China using the Multivariate (MV) filter technique for the period 2000 to 2008 using quarterly data. The results confirm that in forecasting the MV filter was better. Using the MV filter, estimates shows that growth rate of potential output varies over time, and changes in growth rate were related to the business cycle. The estimated output gap correctly explains the movements in inflation.

2.3 Conclusion

In the chapter it has been found that different researchers used different estimation techniques to estimate potential output of different countries. Different methods yield different results. But the SVAR methodology was found to be most superior when it was compared with other methods for example HP filter, linear trend, production function, Kalman filter and Baxter and King filter. It has also been found that the output gap is a determinant of inflation, when it is positive inflation rate rises and when it is negative inflation rate decreases.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter presents the methodology to be used in carrying out this research. It also focuses on the justification of the variables used in the study. An explanation of the type and sources of the data will be provided.

3.1 Methodology

The thrust of this study is to estimate the potential output per capita for Zimbabwe using Structural Vector Autoregressive method. Potential output is estimated from a structural vector auto-regression (SVAR) method. The SVAR model combines economic theory with statistical techniques to differentiate between permanent and temporary movements in output. This method stems from the Keynesian and neo-classical models which identify potential output with the aggregate supply capacity of the economy and cyclical fluctuations with changes in aggregate demand. Based on vector auto-regressive (VAR), Blanchard and Quay (1989) identify structural supply and demand disturbances by assuming that the former have a permanent impact on output while the later have temporary effect.

The variables to be used are Gross Domestic Product per Capita (GDPC), the Consumer Price Index and the unemployment rate. All variables are measured in natural logs and will be presented as y_t, p_t, and u_t , respectively. The variables are expressed in logarithm form to reduce the problem of skewed data to normal form as some inferences depend on the assumption of normal distribution.

According to Enders (2010), the simple covariance stationary multivariate dynamic simultaneous equations model is represented as follows:

$$\Delta \gamma_t = -\alpha_{11}\Delta P_t - \alpha_{12}\Delta U_t + \gamma_{11}\Delta\gamma_{t-1} + \gamma_{12}\Delta P_{t-1} + \gamma_{13}\Delta U_{t-1} + \varepsilon_{1t}$$

$$\Delta P_t = -\alpha_{21}\Delta\gamma_t - \alpha_{22}\Delta U_t + \gamma_{21}\Delta\gamma_{t-1} + \gamma_{22}\Delta P_{t-1} + \gamma_{23}\Delta U_{t-1} + \varepsilon_{2t} \qquad (1)$$

$$\Delta U_t = -\alpha_{31}\Delta\gamma_t - \alpha_{32}\Delta P_t + \gamma_{31}\Delta\gamma_{t-1} + \gamma_{32}\Delta P_{t-1} + \gamma_{33}\Delta U_{t-1} + \varepsilon_{3t}$$

Equation (1) is called the structural VAR since it is assumed to be derived by some underlying economic theory. The exogenous error terms are assumed to be independent and are interpreted as structural innovations. In matrix form, after re-arranging, (1) can be written as;

$$\begin{bmatrix} 1 & \alpha_{11} & \alpha_{12} \\ \alpha_{21} & 1 & \alpha_{22} \\ \alpha_{31} & \alpha_{32} & 1 \end{bmatrix} \begin{bmatrix} \Delta y_t \\ \Delta p_t \\ \Delta u_t \end{bmatrix} = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} \Delta y_{t-1} \\ p_{t-1} \\ u_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \qquad (2)$$

This can be written compactly in vector form as

$$\alpha\chi_t = \gamma\chi_{t-1} + \varepsilon_t \quad (3)$$

The reduced form of the SVAR, a standard VAR model is found by multiplying (3) by$\boldsymbol{\alpha^{-1}}$, assuming it exist and solving for $\boldsymbol{\chi_t}$ in terms of $\boldsymbol{\chi_{t-1}}$ and $\boldsymbol{\varepsilon_t}$**:**

$$\chi_t = \alpha^{-1}\gamma\chi_{t-1} + \alpha^{-1}\varepsilon_t \quad (4)$$

$$= A_1\chi_{t-1} + \mu_t$$

Where; $A_1 = \alpha^{-1}\gamma$**,** and $\mu_t = \alpha^{-1}\varepsilon_t$

Using lag operator (4) can be represented as;

$$A(L)\chi_t = \mu_t \qquad (4a)$$

Where; $A(L) = I - A_1 L$

As μ_t are the error terms of the reduced form they are cross related and therefore have no direct economic interpretation. Therefore, the shocks will be investigated with respect to the innovations $\boldsymbol{\varepsilon_t}$ (Kirchigässner & Wolters, 2007). Equation (4) shows that the innovations are linearly related to the error terms of the reduced form equation (4):

$$\mu_t = \alpha^{-1}\varepsilon_t.$$

The first task is to estimate an unrestricted VAR, which is equation (4). The moving average(MA) or Wold representation of the estimated reduced form VAR is found by multiplying both sides of (4a) by $A(L)^{-1}$ to give,

$$\chi_t = A(L)^{-1}\mu_t \quad (5)$$

$$= A(L)^{-1}\alpha^{-1}\varepsilon_t$$

In matrix form (5) can be represented as,

$$\begin{bmatrix}\Delta y_t\\ \Delta p_t\\ \Delta u_t\end{bmatrix} = \begin{bmatrix}\theta_{11}^{(0)} & \theta_{12}^{(0)} & \theta_{13}^{(0)}\\ \theta_{21}^{(0)} & \theta_{22}^{(0)} & \theta_{23}^{(0)}\\ \theta_{31}^{(0)} & \theta_{32}^{(0)} & \theta_{33}^{(0)}\end{bmatrix}\begin{bmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\\ \varepsilon_{3t}\end{bmatrix} + \begin{bmatrix}\theta_{11}^{(1)} & \theta_{12}^{(1)} & \theta_{13}^{(1)}\\ \theta_{21}^{(1)} & \theta_{22}^{(1)} & \theta_{23}^{(1)}\\ \theta_{31}^{(1)} & \theta_{32}^{(1)} & \theta_{33}^{(1)}\end{bmatrix}\begin{bmatrix}\varepsilon_{1t-1}\\ \varepsilon_{2t-1}\\ \varepsilon_{3t-1}\end{bmatrix} + \cdots + \begin{bmatrix}\theta_{11}^{(s)} & \theta_{12}^{(s)} & \theta_{13}^{(s)}\\ \theta_{21}^{(s)} & \theta_{22}^{(s)} & \theta_{23}^{(s)}\\ \theta_{31}^{(s)} & \theta_{32}^{(s)} & \theta_{33}^{(s)}\end{bmatrix}\begin{bmatrix}\varepsilon_{1t-s}\\ \varepsilon_{2t-s}\\ \varepsilon_{3t-s}\end{bmatrix} + \cdots (6)$$

The elements of the matrices, $\theta_{ij}^{(k)}$ give the dynamic multipliers or impulse response of ΔY_t, ΔP_t and ΔU_t to changes in ε_{1t} , ε_{2t} , and ε_{3t} .

Without some restrictions, the parameters in the SVAR are not identified. That is, given values of the reduced form parameters it is not possible to uniquely solve for the structural parameters. Some restrictions on the parameters of SVAR are required in order to identify all of the structural parameters. The assumptions used for identification are not rich enough to suggest proper identification restrictions on the SVAR.

Following Blanchard and Quay (1989) it is assumed that demand shocks have no long run effect on output while supply-side productivity shocks are assumed to have a permanent effect. This implies that potential output is related to productivity shocks. Thus, the accumulated effects of ε_{2t} and ε_{3t} on Δy_t are equal to zero. That is

$$\sum_{\mathrm{k}=0} \theta_{12}\,(\mathrm{k})\varepsilon_{2\mathrm{t}-\mathrm{k}} + \sum_{\mathrm{k}=0} \theta_{13}\,(\mathrm{k})\varepsilon_{3\mathrm{t}-\mathrm{k}} = 0$$

Thus, change in output per capita attributed to potential output per capita is given by:

$$\Delta y_t^p = \theta_{11}(L)\varepsilon_{1t} = \sum_{k=0} \theta_{11}\,(k)\varepsilon_{1t-k}$$

The cyclical portion of output per capita that depends on demand side shocks is given by the output gap, which is given as follows:

$$gap_t = \theta_{12}(L)\varepsilon_{2t} + \theta_{13}(L)\varepsilon_{3t}$$

Potential output per capita can be easily estimated by the following definition

Output per capita gap = potential output per capita – GDPC

Potential output = GDPC + Output per capita gap

Villaverde and Ramirez (nd) document the advantages and limitations of SVAR methodology. The model has been commended for its stronger reliance on theory but it allows the data to determine the short-run dynamics. SVAR, have also contributed to the understanding of aggregate fluctuations, and have clarified the importance of different economic shocks. Lastly, SVAR models promise to give interesting patterns from the data that will prevail across a set of incompletely specified dynamic economic models with a minimum of identifying assumptions.

Villaverde and Ramirez (nd) also identify the following problems of SVAR: First, economic shocks recovered from a SVAR do not resemble the shocks measured by other mechanisms. Secondly, the shocks recovered from any SVAR may reflect variables omitted from the model. If these omitted variables correlate with the included variables, the estimated shocks will be biased. Another fundamental weakness of the VAR approach to modeling is that the large number of parameters involved makes the estimated models difficult to interpret. In particular some lagged variables may have coefficients which change sign across the lags which makes it difficult to see what effect a change in variable would have upon the future values of the variables in the system, so to solve this problem economists construct block significance test, impulse response functions, and variance decompositions, (Brooks, 2008). Finally, results of many SVAR are sensitive to the identification restrictions, Cerra and Saxena (2000) identified the problems of this method. They argued that the approach is limited by its ability to identify at most only as many types of shocks as there are variables.

3.2 Justification of Variables

When estimating VAR all variables are treated as endogenous variables.

GDP per Capita

Gross Domestic Product, (GDP) is the market value of goods and service produced by an economy in a given year at constant price. Benes *et al*, (2010) point out that when GDP declines for a long period of time actual output will not go back to its old trend, and this has the effect of pooling down potential output. Actual output can be regarded as a pre-requisite for the growth in potential output. When actual output is greater than the potential output, then this will give pressure to inflation to rise (Serju, 2006). However, this research uses GDP per capita instead of real GDP figures. The reason behind this choice is that Zimbabwe has experienced a lot of brain drain as people left the country in search of better living conditions. This factor also contributed to loss of potential in the economy. Therefore GDP in relation to the population may be a good reflector of the performance in terms of potential output. The major advantage of GDP per capita as an indicator is that it is measured frequently, widely, and consistently.

Consumer price index

Consumer Price Index, (CPI) is one of the indexes of calculating inflation. Inflation rate denotes the growth of the price level of an economy over a period of time. If the inflation rate is low and stable, businesses are able to plan and increase production. In an unstable economy where inflation rate increases rapidly, this can have negative impact on the economy. This is because high rates of inflation increase the costs of production, and hence reduce the aggregate supply and price level start to increase. A period of stagflation will ensue. On the other hand, negative inflation rates affect production in that firms will produce only when there is an order otherwise they will not. This is because firms which produce and stock their output will incur losses as prices decline below the cost of production.

Unemployment

In economic terms, unemployment occurs if there are qualified workers who would be willing to work at prevailing wages but cannot find jobs. Amornthum (2002) argues that a long period of unemployment tends to reduce the productivity of workers, which inevitably hurts the potential growth of a country. If unemployment is above the NAIRU, then the economy is not operating on its potential output and the price level will not be stable.

3.3 Diagnostic tests

Unit Root Test

The unit root test is used to test for stationarity. In this study we will use the

Augmented Dickey-Fuller (ADF) test. The actual procedure is to compute the tau statistics, τ. If the absolute value of the computed tau statistic is greater than the ADF critical values, we reject the hypothesis that there is a unit root, and conclude that the time series is stationary.

Impulse Response Function

Impulse response function is constructed to solve the problems resulting from some lagged variables having coefficients, which change sign across the lags making it difficult to see what effect a change in variable would have upon the future values of the variables in the system.

When using VAR system of equations the significance of all the lags of each of the individual variables is tested jointly using an F-test. Since several lags of the variables are included, the coefficients on individual lags may not appear significant and others may alternate signs. However, the F-test correctly establishes whether all of the lags of a particular variable are jointly significant.

Impulse response measures the effect impulse, that is, a shock with the size of one standard deviation of the error term μ_t of the variable i at time t_0 on the variable j in later periods. So for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the system are noted. Thus, if there are n variables in a system, a total of n^2 impulse responses could be generated. If the system is stable the shock will eventually die out (Brooks, 2008).

Variance Decomposition

Variance decomposition measures the proportion of the movements in the dependent variables that are due to their own shocks, versus shocks to other variables. A shock to the i^{th} variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decompositions determine how much of the s-step ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for $s = 1, 2, \ldots$. In practice, it is usually observed that own series shocks explain most of the error variance of the series in a VAR.

The Residual Tests

The purpose of residual test is to detect whether autocorrelation and heteroscedasticity are a serious problem in the model. In this study we will test autocorrelation using Lagrange Multiplier (LM) test, and heteroscedasticity using White’s Heteroscedasticity test to be explained below.

Autocorrelation: The Lagrange Multiplier (LM) Test

Autocorrelation occurs when the residuals are correlated across time. The main problem of autocorrelation is that the t-test and F-test of significance will not be valid, and if they are used they provide misleading results about statistical significance of estimated regression coefficient.

In this study, the method used to test for autocorrelation is the autocorrelation LM test. The method reports the multivariate LM test statistics for residual serial correlation up to the specified lag order h. The LM test statistic is calculated by estimating an auxiliary regression of the error terms u_t on the original right- hand regressors and the lagged residualu_{t-h}, where the missing first h values of u_{t-h} are equated to zero. The LM test statistics is distributed as

Chi-square χ^2 with k^2 degrees of freedom, where k is the number of endogenous variables. The null hypothesis is that there is no serial autocorrelation.

White’s Heteroscedasticity Test

Heteroscedasticity occurs when the variance of the error terms are not constant over time. Estimation in the presence of Heteroscedasticity results in wider confidence intervals, so that the t-test and F-test are more likely to give inaccurate results, that we end up accepting insignificant coefficients. The test is conducted as follows: We first estimate the VAR equations, and estimating an auxiliary regression, that is the squared residuals from the original regression are regressed on the original regressors, their squared values and the cross products of the regressors. The system LM statistic is distributed as the χ^2 distribution with degrees of freedom equal to mn where m is the number of cross products of the residuals in the system and n is the number of common set of the right-hand side variables in the test regression. The null hypothesis is that there is no Heteroscedasticity.

Lag Length Selection Criteria

Brooks (2008) pointed out that for annual data using many lags will consume more degrees of freedom if the sample size is small. He proposed to use a maximum lag length of 1. For small samples using more lags will make it difficult to conduct cointegration test using the Johansen (1988) approach since there will be insufficient information.

Economic theory does not provide us with information about the appropriate number of lags to be included, so some criteria can be used to determine the appropriate lag structure. One of the methods used to determine the optimal lag length is the Akaike’s Information Criteria (AIC). The second method to be used is the Bayesian Information Criterion (BIC) proposed by Schwarz (1978). Other methods to be considered include the likelihood ratio test (LR) and

Hannan-Quinn Information Criterion (HQ). Usually the model with the smallest AIC, HQ or BIC is preferred.

3.4 Sources of data

The research makes use of quarterly data on total labour force; labour force participation rate; and total population statistics for the period 1990 to 2012 sourced from the World Bank to calculate unemployment rates in Zimbabwe. The study will also use statistics on GDP per capita from World Bank. The Consumer Price Index data is obtained from the Reserve Bank of Zimbabwe.

3.5 Conclusion

The chapter discusses the methodology to be used which is the SVAR method. It also explains the econometrics tests to be carried out, which are unit root test, autocorrelation, heteroscedasticity and the Chow test - to test for structural stability. Some coefficients estimated using VAR approach is difficult to interpret, therefore the impulse response and variance decomposition will be used to solve the problem. These techniques have been explained in regards to how they facilitate interpretation of the results.

CHAPTER 4

PRESENTATION OF RESULTS

4.0 Introduction

This chapter presents results of some important econometric tests. The tests conducted include unit root tests, residual tests which include autocorrelation and heteroscedasticity, and stability tests. The lag selection criterion will be used and VAR estimates obtained. Then the potential output per capita will finally be estimated. We will also present the results obtained of the potential output and the output gap. The chapter ends with the interpretation of the results.

4.1 Unit Root Test

Unit root tests were used to test for stationarity of the data used for SVAR analysis. Prior to conducting the unit root test, graphical inspection was done on each series. This was done to provide prior knowledge of the series stationarity in order to complement results from the unit root tests. Preliminary graphical analysis indicated that all the series were explosive.

Graphical presentation of stationarity tests results.

Fig 4.1.1 below presents stationarity tests for LNGDPC. The graphs show that LNGDPC followed a trend in levels and only became stationary after first differencing.

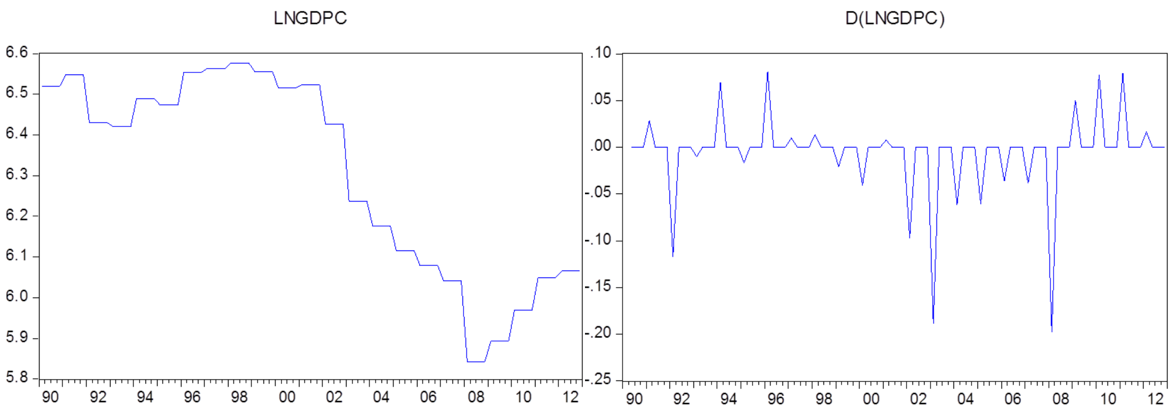


Figure 4.1.2: Stationarity tests for LNUEM

Fig 4.1.2 below presents stationarity tests for LNUEM. The graphs show that in levels LNUEM was not stationery and only became stationery after first differencing.

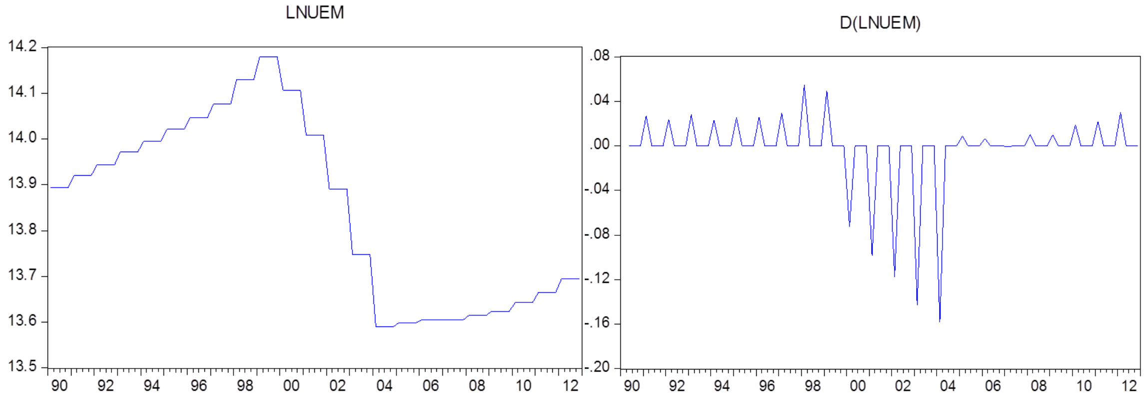


Fig 4.1.3 below presents stationarity tests for LNCPI. The graphs show that in levels CPI was not stationery and only became stationery after first differencing.

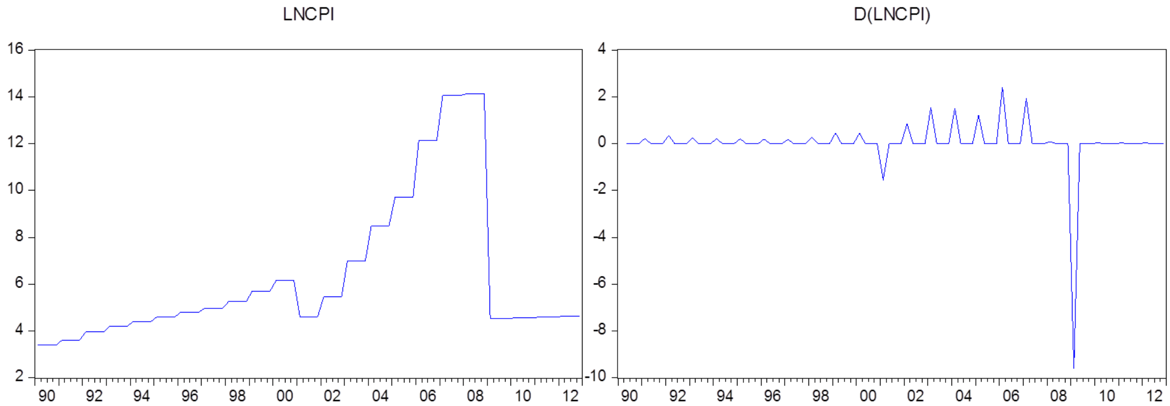


Figure 4.1.3: Stationarity tests for LNCPI

The Augmented Dickey-Fuller (ADF) test was used to test for stationarity and the results are presented in table 4.1 below. The test uses a null hypothesis that the data is stationary against the alternative that they are not. Gross domestic product per capita was not stationary at level as was expected, it was found to be stationary after first differencing. That is, it is integrated of order 1, which is I (1). The same applies to unemployment and consumer price index which only became stationary after first differencing, so they are integrated of order 1, that is I(1). In each case presented in table 4.1, the null hypothesis is that there is unit root that is the time series is non-stationary. In each case, the ADF test statistics in absolute terms is greater than the critical values at 1%, hence we reject the null hypothesis of unit root, and thus all-time series are stationary. The conclusion is that all the series are stationary at first difference.

Table 4.1 Unit Root Test

Variable	**ADF Test Statistics**	**Critical Value at 1%**	**Order of Integration**
GDPC	-9.487693	-4.063233	I(1)
CPI	-9.390903	-4.063233	I(1)
UEM	-21.10696	-4.066981	I(1)

4.2.0 Residual Test

4.2.1 Autocorrelation: The Lagrange Multiplier (LM) Test

The model was tested for serial auto correlation using the LM test. The Lagrange multiplier tests in the VAR and SVAR specifications are undertaken. This is done to test for the absence of serially correlated disturbances. The null hypothesis is that there is no autocorrelation. The probabilities presented below from lag 1 to 5 are greater than 10% except for lag 4 only, going by the majority, we do not reject the null hypothesis of no autocorrelation. If the LM test statistic calculated is greater than the critical ${\chi^2}_{5\%;9}$ from tables of Chi-squared distribution we reject the null hypothesis of no autocorrelation, otherwise we do not reject. The critical ${\chi^2}_{5\%;9}$ is approximately 19.0. Since the LM test statistics from lag 1 to 5 are less than 19.0 except for

4 only, going by the majority, we do not reject the null hypothesis of no autocorrelation. The χ^2 with 9 degrees of freedom show no auto correlation at 5% level. Table 4.2.1 summarises the results and shows that the null hypothesis of no serial correlation cannot be rejected.

Table 4.2.1 VAR Residual Serial Correlation LM Test

Lags	LM Statistics	Probability
1	2.094369	0.9899
2	2.885043	0.9687
3	5.013978	0.8331
4	26.95290	0.0014
5	0.933178	0.9996

Probs from chi-square with 9 df.

4.2.2 White's Heteroscedasticity Test

Test for heteroscedasticity was performed at 5% level. The null hypothesis is that there is no heteroscedasticity. The test regression is run by regressing each cross product of the residuals on the cross products of the regressors and testing the joint significance of the regression. Under the null hypothesis of no heteroscedasticity, the non-constant regressors should not be jointly significant. The first line of table 4.2.2.1 has (res1*res1) which are cross products, and the calculated F-statistic is 8.016380. If the calculated F-statistics is greater than the critical F-statistic from the tables of F-distribution we reject the null hypothesis of no heteroscedasticity. The critical F-statistics with 30 degrees of freedom for numerator and 56 degrees of freedom for denominator is greater than 8.016380. Since the critical value of F-statistics is greater than calculated F-statistics we do not reject the null hypothesis of no heteroscedasticity. Table 4.2.2.1 shows a summary of the test both individually and jointly.

Table 4.2.2.1 White Heteroscedasticity Test – Individual components.

Dependent	**R-Squared**	**F(30,56)**	**Probability**	**Chi-squared(30)**	**Probability**
res1*res1	0.811124	8.016380	0.0000	70.56782	0.0000
res2*res2	0.309516	0.836751	0.6971	26.92790	0.6271
res3*res3	0.668173	3.758757	0.0000	58.13106	0.0015
res2*res1	0.453709	1.550314	0.0778	39.47267	0.1155
res3*res1	0.560670	2.382229	0.0025	48.77830	0.0166
res3*res2	0.304817	0.818478	0.7201	26.51909	0.6484

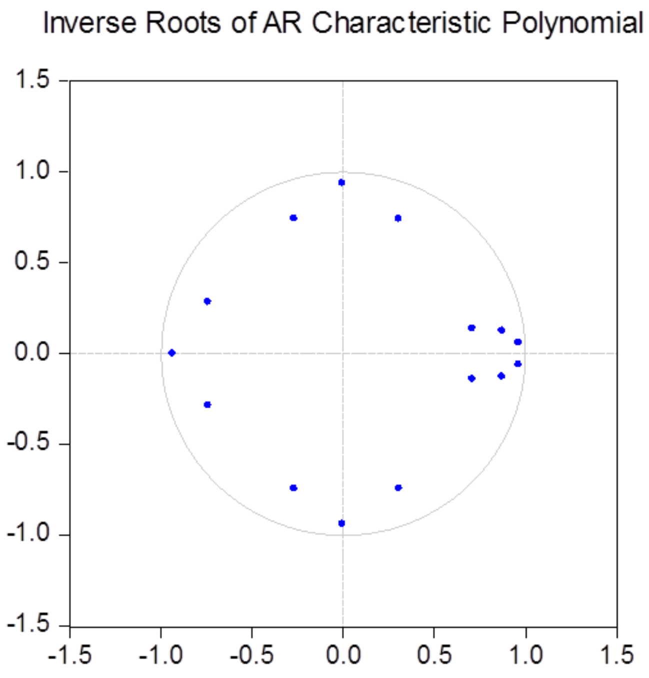
Table 4.2.2.2 show the joint test for White's heteroscedasticity test. The null hypothesis is that there is no heteroscedasticity. We use the χ^2 test at 5% significant level with 180 degrees of freedom (df). If the calculated Chi-squared of 208.1493 is greater than the critical χ^2 test at 5% with 180 df we reject the null hypothesis. The critical value of χ^2 at 5% with 180 df is found to be less. So we do not reject the null hypothesis of no heteroscedasticity.

Table 4.2.2.2 Joint Test for White's Heteroscedasticity Test

Chi-Squared	**Degrees of freedom**	**probability**
208.1493	180	0.0739

4.2.3 Stability tests

To determine whether the VAR model was suitable for analysis, a VAR stability test were conducted. The results of the stability test are shown below:



For the VAR model to satisfy the stability conditions, all roots should lie inside the circle and the modulus has to be less than one. At the chosen lag length, the results showed that all the modulus were less than one. The figure above shows that no root lies outside the unit circle hence the VAR satisfies the stability condition. The results suggest that the model satisfies the stability condition because no root lies outside the unit circle.

4.3 Lag Length Selection Criteria

In estimating a reduced-form VAR, special attention needs to be put on ensuring an appropriate specification of the lag length so as to ensure no serial correlation from the residuals. Table 4.3 provides the lag length selection criteria. Based on the sequential modified LR (Likelihood ratio) test statistic (each test at 5% level), Final Prediction Error (FPE), Akaike Information Criterion (AIC) and Hannan-Quinn (HQ) criterion, the table suggests an appropriate lag length of five and six. Following the LR AND FPE selection criteria, the lag length of five is used.

Table 4.3 Lag Length Selection Criteria

Lag	**Logl**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-97.90351	NA	0.002218	2.402464	2.489279	2.437363
1	217.8830	601.4981	1.49e-06	-4.901976	-	-4.762381
2	219.7442	3.412138	1.77e-06	-4.732004	4.554717*	-4.487712
3	222.3043	4.510725	2.07e-06	-4.578674	-4.124300	-4.229685
4	226.0913	6.401820	2.35e-06	-4.454555	-3.710525	-4.000870
5	276.2339	81.18322*	8.89e-07*	-	-3.325961	-
6	278.5411	3.570650	1.05e-06	5.434140*	-4.045102	4.875758*
7	281. 838	5.082142	1.22e-06	-5.274787	-3.625304	-4.611709
8	287.7840	8.147917	1.34e-06	-5.142472	-3.232544	-4.374697
				-5.066286	-2.895914	-4.193815

* indicates lag order selected by the criterion

Following the lag selection above, thus the results of the estimated reduced-form VAR with the appropriate five lags are provided in Table 4.3.

4.4 Presentation of Results

Without imposing any restrictions, the SVAR cannot be identified both in the short run and the long run. Thus, to identify the underlying structural model, restrictions are made based on economic theory. Table 4.4.1 shows the identifying restrictions of the short-run model.

4.4.1 Contemporaneous restrictions

Restriction Type: short-run pattern matrix

Matrix A =

1	0	0
C(1)	1	0
C(2)	C(3)	1

Matrix B =

C(4)	0	0
0	C(5)	0
0	0	C(6)

Table 4.4.2 provides the results of the contemporaneous model identified by applying some economic theory–based restrictions. These restrictions will enable the SVAR to be identified both in the short run and the long run. Note that the likelihood ratio (261.2163) test statistic for null hypothesis of over-identifying restrictions does not reject the restrictions implying that they are statistically valid. The coefficients of the variables cpi and gdpc are expected to have a positive effect on potential output level in the short run, whereas the variable unemployment is expected to have negligible impact on potential output. Looking at the probability of the majority of variables, the restrictions are statistically valid.

Table 4.4.2: Estimated coefficients of contemporaneous variables.

	Coefficient	Std error	z-Statistic	Prob
C(1) C(2)	13.31608 0.033316	3.111394 0.072786	4.279780 0.457724	0.0000 0.6472

C(3)	0.001138	0.002248	0.506440	0.6125
C(4)	0.004356	0.000325	13.41641	0.0000
C(5)	0.128569	0.009583	13.41641	0.0000
C(6)	0.002742	0.000204	13.41641	0.0000

Estimated A and B matrix.

Matrix B was used to estimate the structural error terms and innovations.

Estimated A matrix:

1.000000	0.000000	0.000000
13.31608	1.000000	0.000000
0.033316	0.001138	1.000000

Estimated B matrix:

0.004356	0.000000	0.000000
0.000000	0.128569	0.000000
0.000000	0.000000	0.002742

Table 4.4.3 presents the estimated results using VAR approach. Values in parentheses are t-statistics and in the brackets are standard errors. The evaluation of the significance of variables in the context of a VAR almost invariably occurs on the basis of joint tests (*F* test) on all of the lags of a particular variable in an equation, rather than by examination of individual coefficient estimates. Since several lags of the variables are included in each of the equations in the system, the coefficients on individual lags may not appear significant for all lags, and may

have signs and degrees of significance that vary with the lag length. However, *F*-tests will be able to establish whether all of the lags of a particular variable are jointly significant, (Brooks, 2008).

Table 4.4.3 Reduced-Form Vector Autoregression Results

	LNGDPC	LNCPI	LNUEM
LNGDPC(-1)	1.378608	3.964030	0.054179
	(0.11664)	(3.48004)	(0.07716)
	[11.8191]	[1.13908]	[0.70217]
LNGDPC(-2)	-0.246483	-2.131077	-0.048195
	(0.20635)	(6.15633)	(0.13650)
	[-1.19451]	[-0.34616]	[-0.35308]
LNGDPC(-3)	-0.076137	-2.436630	-0.027244
	(0.20878)	(6.22896)	(0.13811)
	[-0.36467]	[-0.39118]	[-0.19727]
LNGDPC(-4)	-0.604151	13.37075	0.119695
	(0.20585)	(6.14152)	(0.13617)
	[-2.93491]	[2.17711]	[0.87902]
LNGDPC(-5)	0.442189	-8.356257	-0.124505
	(0.11559)	(3.44875)	(0.07647)

	[3.82537]	[-2.42298]	[-1.62825]
LNCPI(-1)	0.002556	1.308653	0.001312
	(0.00362)	(0.10813)	(0.00240)
	[0.70530]	[12.1020]	[0.54728]
LNCPI(-2)	-0.001558	-0.206959	-0.000537
	(0.00614)	(0.18333)	(0.00406)
	[-0.25348]	[-1.12887]	[-0.13201]
LNCPI(-3)	-7.69E-05	-0.085648	-7.64E-05
	(0.00620)	(0.18505)	(0.00410)
	[-0.01240]	[-0.46283]	[-0.01863]
LNCPI(-4)	-0.005081	-0.378524	0.001297
	(0.00613)	(0.18279)	(0.00405)
	[-0.82927]	[-2.07079]	[0.32011]
LNCPI(-5)	0.002525	0.344568	-0.001207
	(0.00348)	(0.10370)	(0.00230)
	[0.72640]	[3.32284]	[-0.52492]
LNUEM(-1)	0.156542	-1.953621	1.652502
	(0.16944)	(5.05523)	(0.11208)
	[0.92388]	[-0.38646]	[14.7434]

LNUEM(-2)	-0.061854	-0.563230	-0.398039
	(0.33018)	(9.85106)	(0.21842)
	[-0.18733]	[-0.05717]	[-1.82238]
LNUEM(-3)	-0.005488	-0.819446	-0.144061
	(0.33721)	(10.0607)	(0.22307)
	[-0.01627]	[-0.08145]	[-0.64582]
LNUEM(-4)	-0.201954	9.016559	-0.401717
	(0.33271)	(9.92627)	(0.22008)
	[-0.60700]	[0.90835]	[-1.82528]
LNUEM(-5)	0.180154	-8.760764	0.308703
	(0.18230)	(5.43905)	(0.12059)
	[0.98821]	[-1.61072]	[2.55985]
C	0.119552	-4.649309	0.026689
	(0.03754)	(1.12003)	(0.02483)
	[3.18456]	[-4.15104]	[1.07474]

R squared	0.996264	0.980146	0.999162
Adjusted R squared	0.995475	0.975951	0.998986
F-Statistics	1262.189	233.6729	5646.768

The high values of R^2 which are 0.996264 and of adjusted R^2 of 0.995475 implies that growth rate in output can be explained or is greatly influenced by consumer price index and unemployment. The remaining percentage can be explained by other factors.

4.5 Long-run Structural Model

The long-run SVAR model estimation shows the permanent effect of unemployment, consumer price index and gross domestic product per capita to potential output of the economy. The results of the long-run structural model are provided in Table 4.5.1 below. All parameters in the GDPC equation are statistically significant and bear the expected signs. Unemployment and consumer price index have a negative permanent effect on the output level.

Restriction Type: long-run pattern matrix

Long-run response pattern:

Matrix C =

C(1)	C(2)	C(4)
0	C(3)	C(5)
0	0	C(6)

Table 4.5.1: Estimated coefficients of contemporaneous variables.

	Coefficient	Std error	z-Statistic	Prob
C(1)	0.038393	0.002862	13.41641	0.0000
C(2)	0.003520	0.004055	0.868026	0.3854

C(3)	1.675501	0.124884	13.41641	0.0000
C(4)	0.490126	0.036757	13.33415	0.0000
C(5)	-2.893559	0.278760	-10.38011	0.0000
C(6)	0.733162	0.054647	13.41641	0.0000

Estimated A matrix:

1.000000	1.000000	1.000000
0.000000	0.000000	0.000000
0.000000	0.000000	0.000000

Estimated B matrix:

0.003704	0.003704	0.003704
-0.116951	-0.116951	-0.116951
5.88E-05	5.88E-05	5.88E-05

Table 4.5.1 all the variables are not expected to have significant impact on output growth in the long run and thus their impact is very small. Looking at the probability of the majority of variables, the restrictions are statistically valid.

4.5.2 Impulse Response Analysis

The impulse response analysis describes how innovations (shocks) to one variable affect another variable after a given period. The estimated orthogonolised and structural responses from both the short-and long-run models are presented in Figure 4.5.2 below. The graphs reveal results which are very similar to the models analysed so far. In the first 8 periods, the impact of gdpc shocks to gdpc are statistically significant, and during these periods both longrun and shortrun effect on gdpc of a shock to gdpc is positive implying that the shock leads to an increase in gdpc. The effect increases in the first three periods and from the fourth period onwards it reduces. Thereafter the impact of gdpc on itself is not statistically significant. A shock to gdpc has statistically insignificant effects on cpi except in the first 3 periods where the impact is negative. A shock to unemployment has statistically insignificant effects on cpi and significant impact on gdpc from period 9 onwards. Shocks to cpi have positive but decreasing effects to cpi up to period 8 and become insignificant thereafter. Shocks to cpi have insignificant impact on both gdpc and unemployment.

Fig 4.5.2: Short run impulse response analysis.

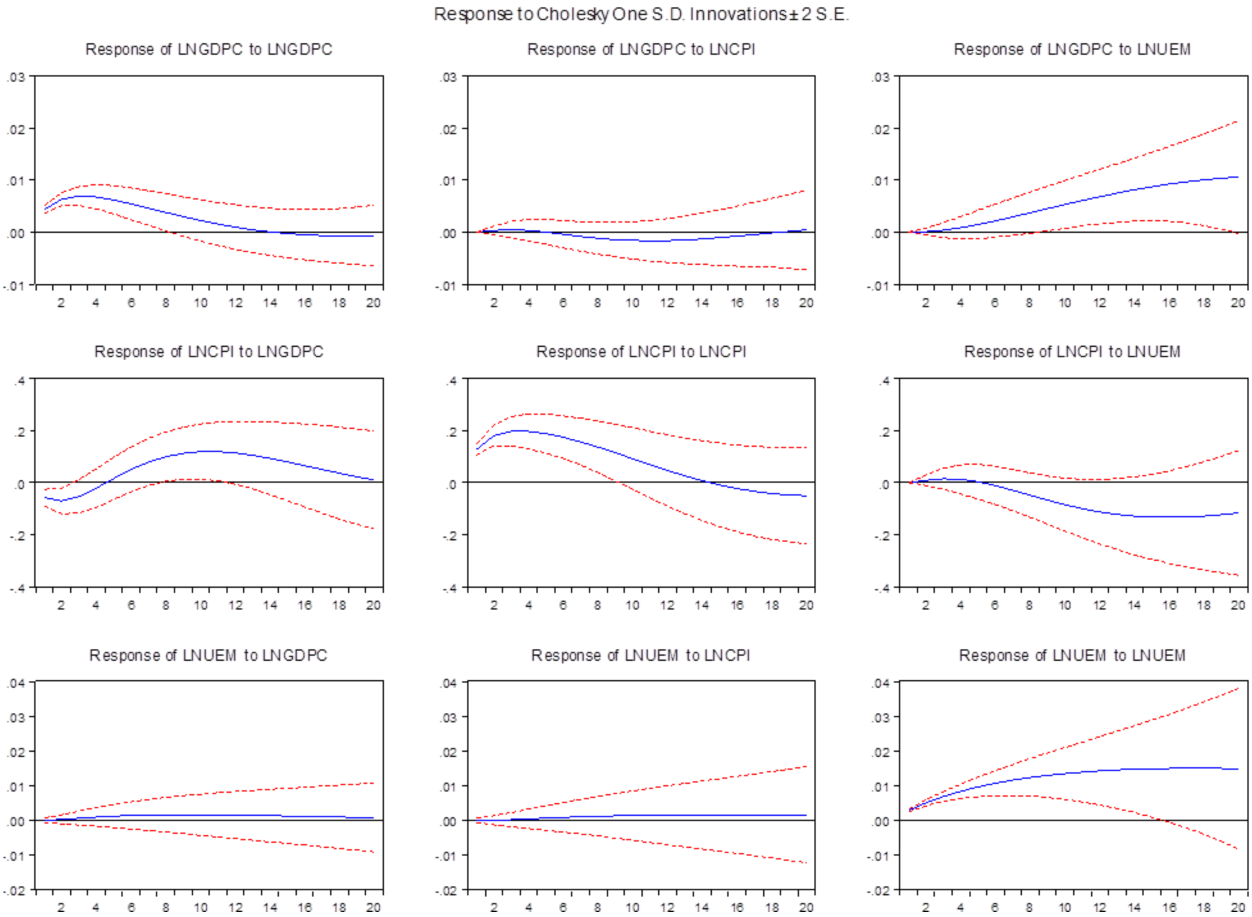
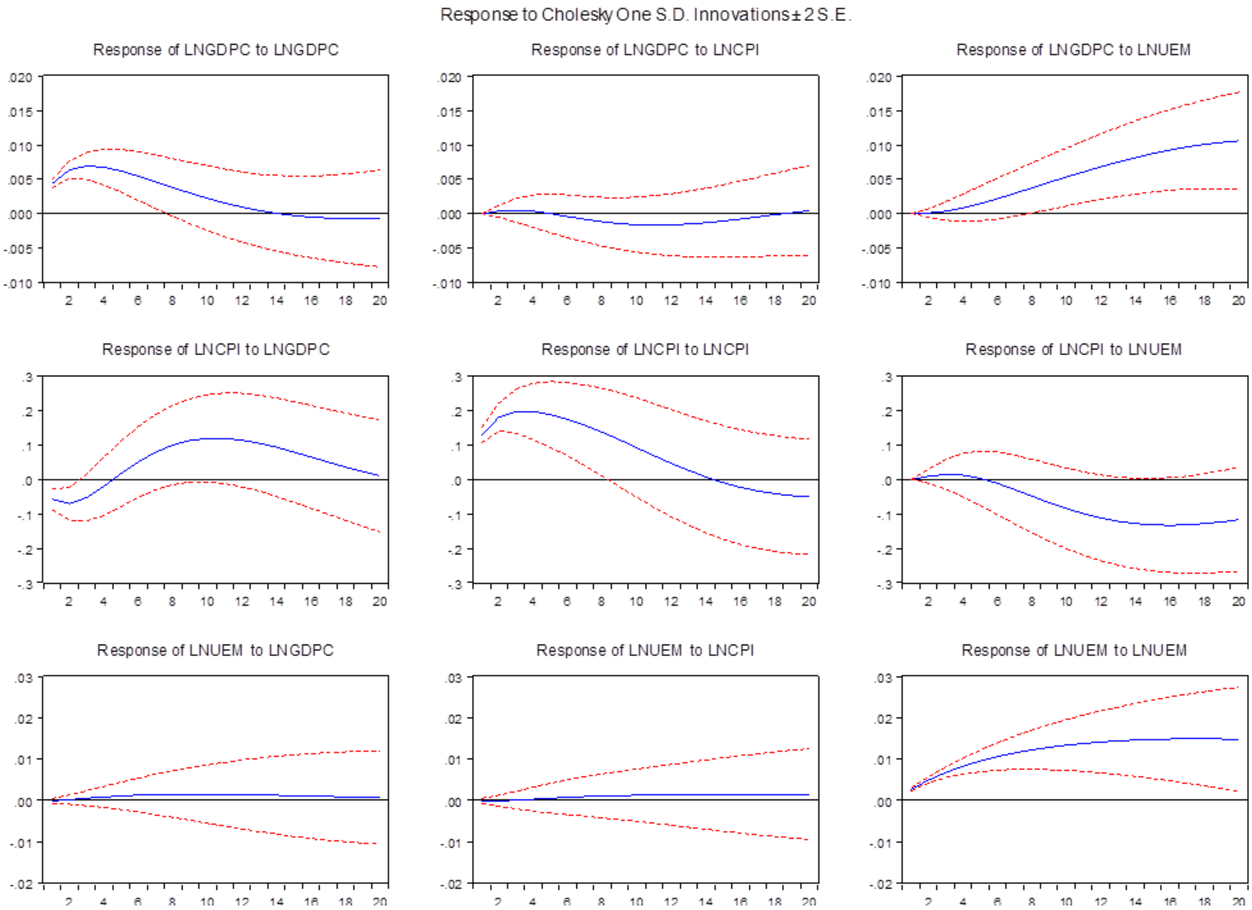


Figure 4.5.2: Long run impulse response analysis.



4.5.3 Long Run Forecast Error Variance Decomposition

The forecast error variance decomposition provides information about the dynamic relationships among jointly analysed VAR and SVAR system variables. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. They measure the relative importance of shocks arising from one variable in explaining another variable. Table 4.5.3 provides the Cholesky forecast error variance decomposition results. The first part reports the variance decomposition of lngdpc.the following parts represent variance decomposition of lncpi and lnuem.

As expected, the largest importance is placed on each variable in explaining itself. In the GDPC model other than the importance of the, variable itself, unemployment influences gdpc strongly than cpi and these shocks impact significantly after the 4th period. In the unemployment model, apart from the unemployment itself, gdpc explains unemployment more strongly; however the impact reduces as the period increases. Gdpc strongly explains the variations in cpi compared to unemployment. However the influence reduces as the number of period increases. Unemployment increasingly influences cpi and significant impact has been noted from the 18th period.

Table 4.5.3: Forecast Error Variance Decomposition.

Variance decomposition of LNGDPC:

PERIODS	S.E	LNGDPC	LNCPI	LNUEM
1	0.004356	100.0000	0.000000	0.000000
2	0.007698	99.81747	0.173613	0.008916
3	0.010371	99.59018	0.288098	0.121722
4	0.012405	99.19603	0.268031	0.535936
5	0.013934	98.27223	0.212483	1.515290
6	0.015113	96.39201	0.260549	3.347442
7	0.016088	93.21157	0.506293	6.282135
8	0.016979	88.58613	0.957939	10.45593
9	0.017878	82.62957	1.540756	15.82968
10	0.018851	75.69257	2.134323	22.17311
11	0.019936	68.26393	2.622672	29.11340
12	0.021152	60.83934	2.932485	36.22818
13	0.022497	53.81512	3.045484	43.13940
14	0.023961	47.44050	2.987920	49.57158
15	0.025523	41.82460	2.809856	55.36555

16	0.027160	36.97318	2.565944	60.46087
17	0.028845	32.83072	2.303173	64.86610
18	0.030557	29.31405	2.055702	68.63025
19	0.032273	26.33407	1.844535	71.82139
20	0.033973	23.80742	1.679659	74.51292

Variance decomposition of LNCPI:

PERIODS	S.E	LNGDPC	LNCPI	LNUEM
1	0.141047	16.91018	83.08982	0.000000
2	0.240580	14.36394	85.48312	0.152939
3	0.316416	11.06945	88.61847	0.312075
4	0.373791	8.212920	91.44620	0.340881
5	0.419016	6.703350	93.01907	0.277582
6	0.456961	6.907896	92.79559	0.296513
7	0.490599	8.637461	90.74589	0.616653
8	0.521417	11.36183	87.22638	1.411787
9	0.550016	14.47549	82.75947	2.765049
10	0.576590	17.47508	77.85699	4.667937
11	0.601213	20.02578	72.93219	7.042035
12	0.623954	21.95666	68.27787	9.765472
13	0.644911	23.22684	64.07665	12.69651
14	0.664199	23.88580	60.42159	15.69260
15	0.681928	24.03731	57.33778	18.62491

16	0.698189	23.80969	54.80210	21.38821
17	0.713049	23.33327	52.76057	23.90616
18	0.726553	22.72492	51.14285	26.13223
19	0.738730	22.07911	49.87366	28.04723
20	0.749607	21.46455	48.88095	29.65450

Variance decomposition of LNUEM:

PERIODS	S.E	LNGDPC	LNCPI	LNUEM
1	0.002747	0.082916	0.283934	99.63315
2	0.005681	0.116060	0.095235	99.78870
3	0.008873	0.395960	0.047865	99.55618
4	0.012188	0.696539	0.094444	99.20902
5	0.015547	0.942112	0.188560	98.86933
6	0.018897	1.116996	0.296835	98.58617
7	0.022202	1.227625	0.399939	98.37244
8	0.025439	1.286562	0.489039	98.22440
9	0.028591	1.306383	0.561757	98.13186
10	0.031648	1.297777	0.619100	98.08312
11	0.034602	1.269277	0.663517	98.06721
12	0.037449	1.227507	0.697815	98.07468
13	0.040189	1.177533	0.724631	98.09784
14	0.042820	1.123180	0.746221	98.13060
15	0.045343	1.067285	0.764410	98.16831
16	0.047759	1.011900	0.780617	98.20748

17	0.050071	0.958451	0.795913	98.24564
18	0.052280	0.907874	0.811080	98.28105
19	0.054388	0.860724	0.826663	98.31261
20	0.056398	0.817270	0.843017	98.33971

4.6 Estimates of potential output per capita and the output gap

The table below presents the estimated potential output per capita in each quarter of the years from 1990 to 2012. The estimated values are then compared to the actual figures in their respective quarters .The difference is known as the output gap.

PERIOD	LNGDPC	PGDPC	OUTPUT GAP		PERIOD	LNGDPC	PGDPC	OUTPUT G
1990 q1	1.628382	1.619381	-0.009		1997 q1	1.63666	1.639883	0.003223
q2	1.627408	1.62797	0.000563		q2	1.63775	1.640548	0.002798
q3	1.626427	1.634285	0.007858		q3	1.638646	1.641268	0.002622
q4	1.625436	1.638325	0.012889		q4	1.639325	1.642044	0.002719
1991 q1	1.624434	1.64009	0.015657		1998 q1	1.639763	1.644349	0.004586
q2	1.623428	1.639581	0.016153		q2	1.639939	1.644647	0.004708
q3	1.622436	1.636796	0.014361		q3	1.639834	1.644412	0.004578
q4	1.621485	1.631737	0.010252		q4	1.639433	1.643644	0.004211
1992 q1	1.620612	1.614532	-0.00608		1999 q1	1.638723	1.641783	0.003059
q2	1.619861	1.608871	-0.01099		q2	1.637695	1.640172	0.002477
q3	1.619269	1.604885	-0.01438		q3	1.636339	1.638251	0.001913
q4	1.61887	1.602572	-0.0163		q4	1.634649	1.636022	0.001372
1993 q1	1.618687	1.603019	-0.01567		2000 q1	1.63262	1.630822	-0.0018
q2	1.618732	1.603619	-0.01511		q2	1.630248	1.629038	-0.00121
q3	1.61901	1.605458	-0.01355		q3	1.627526	1.628008	0.000482
q4	1.619514	1.608537	-0.01098		q4	1.624449	1.627733	0.003284
1994 q1	1.620229	1.619304	-0.00093		2001 Q1	1.62101	1.634204	0.013195
q2	1.621134	1.622281	0.001147		Q2	1.617205	1.633041	0.015837
q3	1.622207	1.623919	0.001712		Q3	1.613038	1.630236	0.017198
q4	1.623427	1.624216	0.000789		Q4	1.608523	1.625788	0.017265
1995 q1	1.624773	1.616007	-0.00877		2002 Q1	1.603685	1.619162	0.015476
q2	1.626226	1.61649	-0.00974		Q2	1.59856	1.611644	0.013083
q3	1.62776	1.618499	-0.00926		Q3	1.593194	1.602698	0.009505
q4	1.629344	1.622034	-0.00731		Q4	1.587638	1.592325	0.004687
1996 q1	1.630941	1.633693	0.002752		2003 Q1	1.581954	1.571978	-0.00998
q2	1.63251	1.637641	0.005131		Q2	1.576203	1.562168	-0.01403
q3	1.634009	1.640476	0.006466		Q3	1.570441	1.554349	-0.01609
q4	1.635404	1.642197	0.006794		Q4	1.564715	1.548521	-0.01619

2004 Q1	1.559064	1.549613	-0.00945		2009 Q1	1.486231	1.467433	-0.0188	
Q2	1.553514	1.545794	-0.00772		Q2	1.486212	1.470984	-0.01523	
Q3	1.548086	1.541994	-0.00609		Q3	1.48665	1.474962	-0.01169	
Q4	1.542796	1.538213	-0.00458		Q4	1.487507	1.479369	-0.00814	
2005 Q1	1.537658	1.533566	-0.00409		2010 Q1	1.488739	1.485212	-0.00353	
Q2	1.532681	1.530178	-0.0025		Q2	1.490296	1.490073	-0.00022	
Q3	1.527872	1.527162	-0.00071		Q3	1.492126	1.494959	0.002833	
Q4	1.523238	1.52452	0.001282		Q4	1.494178	1.499871	0.005693	
2006 Q1	1.518782	1.523268	0.004486		2011 Q1	1.496401	1.507321	0.010921	
Q2	1.514511	1.520965	0.006454		Q2	1.498748	1.511279	0.01253	
Q3	1.510434	1.518628	0.008195		Q3	1.501181	1.514256	0.013076	
Q4	1.506563	1.516258	0.009695		Q4	1.503666	1.516254	0.012588	
2007 Q1	1.502918	1.519997	0.017079		2012 Q1	1.50618	1.517272	0.011092	
Q2	1.49952	1.515102	0.015582		Q2	1.508707	1.51731	0.008603	
Q3	1.496406	1.507717	0.011311		Q3	1.511238	1.516368	0.005129	
Q4	1.49362	1.497841	0.004222		Q4	1.51377	1.514446	0.000676	
2008 Q1	1.491212	1.469568	-0.02164						
Q2	1.489238	1.461074	-0.02816						
Q3	1.487738	1.456452	-0.03129						
Q4	1.486735	1.455702	-0.03103						
2009 Q1	1.486231	1.467433	-0.0188						

4.8 Interpretation of Results

Potential output presented in the table above has been estimated using the SVAR methodology. The SVAR model appropriately captures the recession of 2000 which was partly caused by political instability in the country and the land reform programme. The results show that the rate of decline of potential GDP was faster than the rate of decline of actual output after the year 2000.

The SVAR captured the recession of 2002 and that of 2006-2008 also. These results are different to those found by Adamu et al., (nd) for the economy of Nigeria and Serju (2006) for the economy of Jamaica. According to Serju (2006, p.16) “Although not [SVAR] depicting consistent periods of excess demand or supply, they show on average shorter periods relative to the result from the trend model and BP filter.” This implies that sometimes SVAR shows erroneously periods of excess demand instead of excess supply or vice-versa. Adamu et al., (nd) noted that that the SVAR estimates of potential output using annual data does not properly capture the performance of the economy. They recommended the use of quarterly data. This is usually a problematic for developing countries, since the official quarterly data are not published. The use of quarterly statistics in this research has, however, managed to prove the reliability of quarterly data in making SVAR estimates correct.

It is evident that the potential output of Zimbabwe shifted inwards for almost a decade. For example in 2000 potential GDPC was 6.5156 but in 2010 it had declined to 5.970 which is a decrease of almost 8.3 % for that period alone. The reasons why potential output declined are as follows:

During the period 2000 to 2010 there was a massive exodus of skilled work force from Zimbabwe to other countries in seeking for high paying jobs and better living conditions. This follows after the domestic currency lost its value due to inflation. Capital outflows were a serious problem in Zimbabwe during the economic crisis era. Investors disinvested in the country as they were seeking safe destination with high returns and low risk. Increased outflow of funds on investment account raise local unemployment and negatively affect economic growth of the economy.

Another possible reason is the decline of the agriculture sector which was disturbed by the fast track land reform programme. Output in the agriculture sector declined as commercial farmers were replaced by peasant farmers who lacked experience and knowledge of farming. Agriculture exports declined as a result. Employment in that sector also declined massively.

The results are also similar to those of Gounder and Morling (2000) for the economy of Fiji and Adnan *et al,* (2008) for the economy of Pakistan. They obtained negative coefficient for the output gap. Fiji and Pakistan are developing countries which poses similar characteristics with Zimbabwe. According to Gounder and Morling (2000) the economy was more prone to supply side shocks such as coups, political instability, and natural disasters. Adnan *et al*, (2008) found negative coefficients of output gap for periods 1961-1970 and 1981-1990 for the economy of Pakistan. During these periods the economy of Pakistan experienced supply side shocks. The economy was more vulnerable to political instability during these periods. The results contrast well those obtained by other researchers especially for developed countries. For example Serju (2006), obtained a positive coefficient for output gap. The main reason for this difference is that Jamaica is an advanced economy as compared to Zimbabwe.

For a fruitful interpretation of the results the variance decomposition and impulse response to Cholesky were constructed (see Appendix 4). The reason for constructing variance decomposition and impulse response to Cholesky is that some lagged variables in the SVAR system of equations may have coefficients which changes sign across the lags which makes it difficult to see what effect a change in variable would have upon the future values of the variables in the system. So to solve this problem, it is important to construct impulse response functions, and variance decompositions (Brooks, 2008). In the variance decomposition table (Appendix 4) for example shocks to GDPC growth account for more than 64% variation in GDPC growth. Another important feature is that a shock to output growth rate has more influence on unemployment than inflation as shown by unemployment impact being above 9% whereas it accounts for more than 6% variation in consumer price indices.

Construction of impulse response to Cholesky shows that the response of growth in GDPC is always negative for a shock in consumer price indices LNCPI. Innovations to consumer price indices always have a negative impact on unemployment (LNUEM) since the impulse response is always negative and the effect of the shock does not die out.

4.9 Conclusion

In this chapter econometric tests were carried out. There was no problem of autocorrelation and heteroscedasticity. The estimated potential output shows that it does not deviate significantly from the actual output. In addition the potential output of Zimbabwe declined or in other words shifted inwards for the period 2000 to 2010 but however the potential has been increasing since 2011. In the next chapter we will offer conclusion and policy recommendations to interested parties especially the monetary and fiscal authorities.

CHAPTER 5

POLICY RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

This chapter offers a summary of the research and some policy recommendations which are suitable for the prosperity of the economy. The policies are based on the findings of the research.

5.1 Summary of the Study

Potential output and the output gap are important in macroeconomic modelling and policy formulation. This research was focusing on the estimation of potential output and the output gap using a structural technique – the SVAR. In the research it was found that potential output of Zimbabwe decreased between 2000 and 2009. The reason for this decline can be attributed to fast track land reform, migration of skilled labour force from Zimbabwe to other countries, decline in worker’s productivity due to a prolonged period of unemployment and natural disasters such as droughts.

5.2 Recommendations

The thrust of the study was to estimate potential output of Zimbabwe using the SVAR methodology. Economic growth is the expansion of the potential output, and this is possible when there are technological changes. Considering participation in international trade as a proxy to technological change (see Benes *et al*, 2010), there is need for Zimbabwe to be more open and trade with as many countries as it can. The economy should trade with advanced economies like USA, United Kingdom (UK), Japan, and China among other advanced nations. Trading with advanced nations enables the country to imitate their technology and we can expect the potential output to shift outwards over time. Thus government should make sure that the economy is more open and solve their international disputes for the economy to realise full recovery.

Output gap is a significant determinant of inflation. If the monetary authorities are more concerned with stable prices and high employment level there is need to formulate their policies based on the state of the economy. That is if the economy is above its potential output the monetary authorities must use contractionary policies. So there is need to know the potential output of the economy if the authorities are to come up with credible monetary policy.

It is unfortunate that the central bank operated for years without any effort to estimate the potential output of Zimbabwe. We have seen that after 2000 the potential output was less than actual GDP but the monetary authorities fearing recessions tried to print more money and pump it into the economy. The result was high inflation rates.

The other policy implication from this research is the relative importance of the output gap or capacity constraint to inflation in Zimbabwe. Monetary policy cannot affect long run growth, however, it is capable of affecting short run demand and hence the output gap.

The results also show that output level does not deviate a lot from potential output. In that regard, there is a constraint on how much faster the economy will be able to grow. The inability of potential output to grow or accelerate faster since the 2000’s may reflect the level of disinvestment in manufacturing, the reduction in acreages in agriculture due to land invasions. The financial sector crisis of the mid 2000’s could have also contributed to the slow growth of the economy.

We propose that the monetary authorities should estimate potential output regularly for it to know the appropriate monetary policy stance to be adopted.

This study has shown that Zimbabwe is more vulnerable to supply side shocks. In Zimbabwe the economic policy had become too oriented toward the management of aggregate demand. In this study we propose that policy makers should adopt supply side policies. These put more emphasis on incentives for people to work and to save and large tax cuts to reverse slow economic growth and slumping productivity growth. Incentives denote adequate returns to working, saving and entrepreneurship. Lowering tax rates would raise the post-tax return to capital and labour; higher post-tax returns would induce greater labour and capital supply, along with higher rate of innovation and productivity growth; and the increase of inputs will increase the growth of potential output and thereby shift the aggregate supply to the right.

Another implication of this study to fiscal authorities is that government can be able to calculate its actual budget, structural budget (this calculates what government revenues, expenditures and deficits would be if the economy were operating at potential output) and cyclical budget – which calculates the effects of business cycle on the budget; it is the difference between actual budget and structural budget. A higher cyclical deficit coming from the operation of the automatic stabilisers would indicate that the economy is in economic down turn. It is possible that the part of budget deficit experienced by the government during the economic crisis was partly due to economic downturn. By not focusing on the demand management (for example using government spending to stabilise the economy) government can adopt the supply side policies (explained above) to direct the economy towards full employment at low cost without putting pressure on inflation to increase.

The estimates of output gap obtained in this study suggest that there is no room for the fiscal authorities to run a budget deficit without creating inflationary pressures. The fiscal expansionary policy must bear in mind the declining potential output growth that the economy has been experiencing between 1998 and 2008 implying that there is a much lower limit to the extent to which the budget deficit can grow. And because of the declining potential growth the economy experienced, it would be more appropriate if the fiscal expansion were aimed at those expenditures that would lead to an increase in the economy’s long-term growth in potential output.

In conclusion, considering the uncertainty that surrounds the estimation of potential output, more researches are required in order to improve its estimates and that of the output gap. Therefore, caution must be exercised about taking on board the implication of current estimates of the output gap. The implication of these uncertainties is that policymakers should not rely on a single measure of estimating potential output.

5.3 Recommendation for Future Study

Potential output is important because it enables monetary and fiscal authorities to formulate appropriate policy. Another variable which is also important in macroeconomics is the natural rate of unemployment (NAIRU). The economy is operating efficiently if it is producing its potential and unemployment is at its NAIRU. Thus, it is important to estimate the NAIRU, and formulate policies of reducing it at low cost so as to make as many people working as possible.

5.4 Conclusion

The main thrust of the study was to estimate potential output of Zimbabwe using SVAR method. The results show that actual output of Zimbabwe does not deviate significantly from potential output, and also that potential output have declined sharply between 1998 and 2008. The study was successfully carried.

APPENDICES

Appendix 1: Unit Root Test

Augmented-Dickey-Fuller Unit Root Test on GDPC

Null Hypothesis: D(LNGDPC) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.487693	0.0000
Test critical values:	1% level	-4.063233	
	5% level	-3.460516	
	10% level	-3.156439	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNGDPC,2)

Method: Least Squares

Date: 01/27/14   Time: 08:47

Sample (adjusted): 1990Q3 2012Q4

Included observations: 90 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDPC(-1))	-1.017114	0.107203	-9.487693	0.0000
C	-0.004266	0.008549	-0.499046	0.6190
@TREND(1990Q1)	-1.87E-05	0.000160	-0.116811	0.9073

R-squared	0.508526	Mean dependent var	0.000000
Adjusted R-squared	0.497228	S.D. dependent var	0.055721
S.E. of regression	0.039510	Akaike info criterion	-3.591764
Sum squared resid	0.135810	Schwarz criterion	-3.508437
Log likelihood	164.6294	Hannan-Quinn criter.	-3.558162
F-statistic	45.00925	Durbin-Watson stat	2.000471
Prob(F-statistic)	0.000000		

Augmented-Dickey-Fuller Unit Root Test on UEM

Null Hypothesis: D(LNUEM,2) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-21.10696	0.0000
Test critical values:	1% level	-4.066981	
	5% level	-3.462292	

	10% level	-3.157475

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNUEM,3)

Method: Least Squares

Date: 01/27/14 Time: 08:41

Sample (adjusted): 1991Q2 2012Q4

Included observations: 87 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNUEM(-1),2)	-3.602727	0.170689	-21.10696	0.0000
D(LNUEM(-1),3)	1.668856	0.126667	13.17517	0.0000
D(LNUEM(-2),3)	0.801239	0.066213	12.10092	0.0000
C	-0.002612	0.005173	-0.504852	0.6150
@TREND(1990Q1)	5.37E-05	9.55E-05	0.562040	0.5756

R-squared	0.920654	Mean dependent var	-0.000308
Adjusted R-squared	0.916783	S.D. dependent var	0.077532
S.E. of regression	0.022366	Akaike info criterion	-4.706793
Sum squared resid	0.041020	Schwarz criterion	-4.565074
Log likelihood	209.7455	Hannan-Quinn criter.	-4.649727
F-statistic	237.8608	Durbin-Watson stat	2.065926
Prob(F-statistic)	0.000000		

Augmented-Dickey-Fuller Unit Root Test on CPI

Null Hypothesis: D(LNCPI) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.390903	0.0000
Test critical values:	1% level	-4.063233	
	5% level	-3.460516	
	10% level	-3.156439	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNCPI,2)

Method: Least Squares

Date: 01/27/14   Time: 08:44

Sample (adjusted): 1990Q3 2012Q4

Included observations: 90 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCPI(-1))	-1.006749	0.107205	-9.390903	0.0000
C	0.176873	0.244896	0.722235	0.4721

@TREND(1990Q1)	-0.003506	0.004599	-0.762393	0.4479

R-squared	0.503394	Mean dependent var	1.66E-17
Adjusted R-squared	0.491977	S.D. dependent var	1.585148
S.E. of regression	1.129826	Akaike info criterion	3.114769
Sum squared resid	111.0560	Schwarz criterion	3.198096
Log likelihood	-137.1646	Hannan-Quinn criter.	3.148371
F-statistic	44.09454	Durbin-Watson stat	2.000180
Prob(F-statistic)	0.000000		

Appendix 2: Residual Test

VAR Residual Serial Correlation Test

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 01/25/14 Time: 12:42

Sample: 1990Q1 2012Q4

Included observations: 87

Lags	LM-Stat	Prob
1	2.094369	0.9899
2	2.885043	0.9687
3	5.013978	0.8331
4	26.95290	0.0014
5	0.933178	0.9996
6	0.995126	0.9994
7	1.116577	0.9991
8	15.34423	0.0819
9	0.632398	0.9999
10	0.618554	0.9999
11	0.633639	0.9999
12	12.69359	0.1770

Probs from chi-square with 9 df.

VAR Residual HeteroscedasticityTes

t

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Date: 01/25/14 Time: 12:43

Sample: 1990Q1 2012Q4

Included observations: 87

Component	Skewness	Chi-sq	Df	Prob.
1	-1.925899	53.78176	1	0.0000
2	-2.365037	81.10430	1	0.0000
3	0.936692	12.72217	1	0.0004
Joint		147.6082	3	0.0000

Component	Kurtosis	Chi-sq	Df	Prob.
1	19.04311	933.0080	1	0.0000
2	13.27296	382.5596	1	0.0000
3	14.35099	467.0628	1	0.0000
Joint		1782.630	3	0.0000

Component	Jarque-Bera	df	Prob.

1	986.7898	2	0.0000
2	463.6639	2	0.0000
3	479.7850	2	0.0000
Joint	1930.239	6	0.0000

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Date: 01/25/14 Time: 12:43

Sample: 1990Q1 2012Q4

Included observations: 87

Joint test:

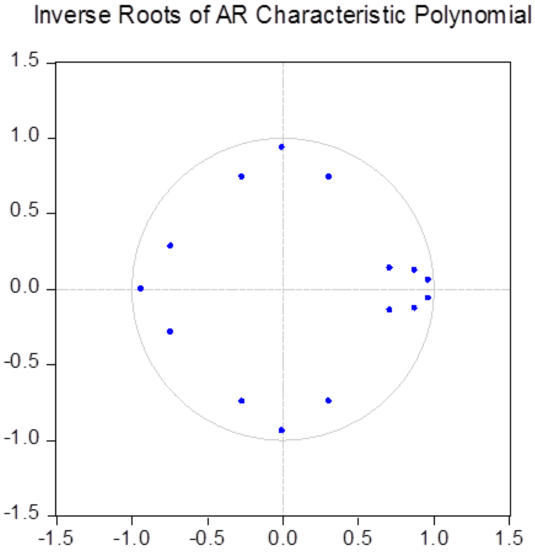
Chi-sq	df	Prob.
208.1493	180	0.0739

Individual components:

Dependent	R-squared	F(30,56)	Prob.	Chi-sq(30)	Prob.
res1*res1	0.811124	8.016380	0.0000	70.56782	0.0000
res2*res2	0.309516	0.836751	0.6971	26.92790	0.6271
res3*res3	0.668173	3.758757	0.0000	58.13106	0.0015
res2*res1	0.453709	1.550314	0.0778	39.47267	0.1155

res3*res1	0.560670	2.382229	0.0025	48.77830	0.0166
res3*res2	0.304817	0.818478	0.7201	26.51909	0.6484

Stability



Appendix 3: VAR Lag length Selection Criteria

VAR Lag Order Selection Criteria

Endogenous variables: LNCPI LNGDPC LNUEM

Exogenous variables: C

Date: 01/25/14 Time: 11:40

Sample: 1990Q1 2012Q4

Included observations: 84

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-97.90351	NA	0.002218	2.402464	2.489279	2.437363
1	217.8830	601.4981	1.49e-06	-4.901976	-4.554717*	-4.762381
2	219.7442	3.412138	1.77e-06	-4.732004	-4.124300	-4.487712
3	222.3043	4.510725	2.07e-06	-4.578674	-3.710525	-4.229685
4	226.0913	6.401820	2.35e-06	-4.454555	-3.325961	-4.000870
5	276.2339	81.18322*	8.89e-07*	-5.434140*	-4.045102	-4.875758*
6	278.5411	3.570650	1.05e-06	-5.274787	-3.625304	-4.611709
7	281.9838	5.082142	1.22e-06	-5.142472	-3.232544	-4.374697
8	287.7840	8.147917	1.34e-06	-5.066286	-2.895914	-4.193815

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendix 4: Estimated Results

Vector Autoregression Estimates

Date: 01/25/14 Time: 12:20

Sample (adjusted): 1991Q2 2012Q4

Included observations: 87 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	LNCPI	LNGDPC	LNUEM
LNCPI(-1)	0.898851	0.000272	-0.000556
	(0.10949)	(0.00376)	(0.00240)
	[8.20925]	[0.07242]	[-0.23165]
LNCPI(-2)	4.04E-12	-1.37E-14	-6.54E-14
	(0.14243)	(0.00489)	(0.00312)
	[2.8e-11]	[-2.8e-12]	[-2.1e-11]
LNCPI(-3)	-4.35E-12	-7.76E-14	-2.46E-13
	(0.14243)	(0.00489)	(0.00312)
	[-3.1e-11]	[-1.6e-11]	[-7.9e-11]
LNCPI(-4)	0.225923	-0.011067	0.000992
	(0.14244)	(0.00489)	(0.00312)
	[1.58608]	[-2.26131]	[0.31773]
LNCPI(-5)	-0.169483	0.007523	-0.000307

	(0.10963)	(0.00377)	(0.00240)
	[-1.54601]	[1.99739]	[-0.12761]
LNGDPC(-1)	1.434133	0.857944	0.040292
	(3.60616)	(0.12390)	(0.07905)
	[0.39769]	[6.92436]	[0.50969]
LNGDPC(-2)	7.25E-10	-1.38E-12	-3.80E-11
	(4.58273)	(0.15746)	(0.10046)
	[1.6e-10]	[-8.8e-12]	[-3.8e-10]
LNGDPC(-3)	-1.04E-09	3.12E-13	-2.97E-11
	(4.58273)	(0.15746)	(0.10046)
	[-2.3e-10]	[2.0e-12]	[-3.0e-10]
LNGDPC(-4)	16.94464	0.000650	0.140850
	(4.58273)	(0.15746)	(0.10046)
	[3.69750]	[0.00413]	[1.40204]
LNGDPC(-5)	-14.74016	0.018433	-0.134862
	(3.44546)	(0.11838)	(0.07553)
	[-4.27814]	[0.15571]	[-1.78553]
LNUEM(-1)	-1.129022	0.049780	0.968601
	(3.99385)	(0.13722)	(0.08755)

	[-0.28269]	[0.36277]	[11.0632]
LNUEM(-2)	-9.80E-10	-2.34E-12	9.26E-11
	(5.55738)	(0.19094)	(0.12183)
	[-1.8e-10]	[-1.2e-11]	[7.6e-10]
LNUEM(-3)	1.86E-09	-1.97E-11	3.38E-11
	(5.55738)	(0.19094)	(0.12183)
	[3.4e-10]	[-1.0e-10]	[2.8e-10]
LNUEM(-4)	-15.41056	0.532232	0.652762
	(5.56966)	(0.19137)	(0.12210)
	[-2.76687]	[2.78123]	[5.34629]
LNUEM(-5)	12.25904	-0.473878	-0.696000
	(4.13735)	(0.14215)	(0.09070)
	[2.96302]	[-3.33358]	[-7.67388]
C	36.69940	-0.707013	0.741564
	(16.6320)	(0.57145)	(0.36460)
	[2.20655]	[-1.23722]	[2.03391]
R-squared	0.915386	0.983567	0.990491
Adj. R-squared	0.897510	0.980096	0.988482
Sum sq. resids	72.55638	0.085653	0.034868
S.E. equation	1.010901	0.034733	0.022161

F-statistic	51.20709	283.3129	493.0413
Log likelihood	-115.5505	177.7183	216.8140
Akaike AIC	3.024149	-3.717662	-4.616413
Schwarz SC	3.477649	-3.264162	-4.162913
Mean dependent	6.463432	6.294672	13.84816
S.D. dependent	3.157679	0.246190	0.206488

Determinant resid covariance (dof adj.)	4.95E-07
Determinant resid covariance	2.69E-07
Log likelihood	287.7376
Akaike information criterion	-5.511209
Schwarz criterion	-4.150708

Structural VAR Estimates

Date: 01/25/14 Time: 12:37

Sample (adjusted): 1991Q2 2012Q4

Included observations: 87 after adjustments

Estimation method: method of scoring (analytic derivatives)

Convergence achieved after 8 iterations

Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

Restriction Type: short-run pattern matrix

A =

1	0	0
C(1)	1	0
C(2)	C(3)	1

B =

C(4)	0	0
0	C(5)	0
0	0	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.009716	0.003533	2.749718	0.0060
C(2)	0.002879	0.002310	1.246208	0.2127
C(3)	-0.173366	0.067230	-2.578699	0.0099
C(4)	1.010901	0.076636	13.19091	0.0000
C(5)	0.033316	0.002526	13.19091	0.0000
C(6)	0.020892	0.001584	13.19091	0.0000
Log likelihood	261.2163			

Estimated A matrix:

1.000000	0.000000	0.000000
0.009716	1.000000	0.000000
0.002879	-0.173366	1.000000

Estimated B matrix:

1.010901	0.000000	0.000000
0.000000	0.033316	0.000000
0.000000	0.000000	0.020892

Structural VAR Estimates

Date: 01/25/14 Time: 12:37

Sample (adjusted): 1991Q2 2012Q4

Included observations: 87 after adjustments

Estimation method: method of scoring (analytic derivatives)

Convergence achieved after 9 iterations

Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

Restriction Type: long-run pattern matrix

Long-run response pattern:

C(1)	C(2)	C(4)
0	C(3)	C(5)
0	0	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	8.146931	0.617617	13.19091	0.0000
C(2)	-2.838557	0.899560	-3.155494	0.0016
C(3)	0.182042	0.013801	13.19091	0.0000
C(4)	-8.039928	1.107706	-7.258178	0.0000
C(5)	1.299568	0.100435	12.93945	0.0000
C(6)	1.068107	0.080973	13.19091	0.0000
Log likelihood	261.2163			

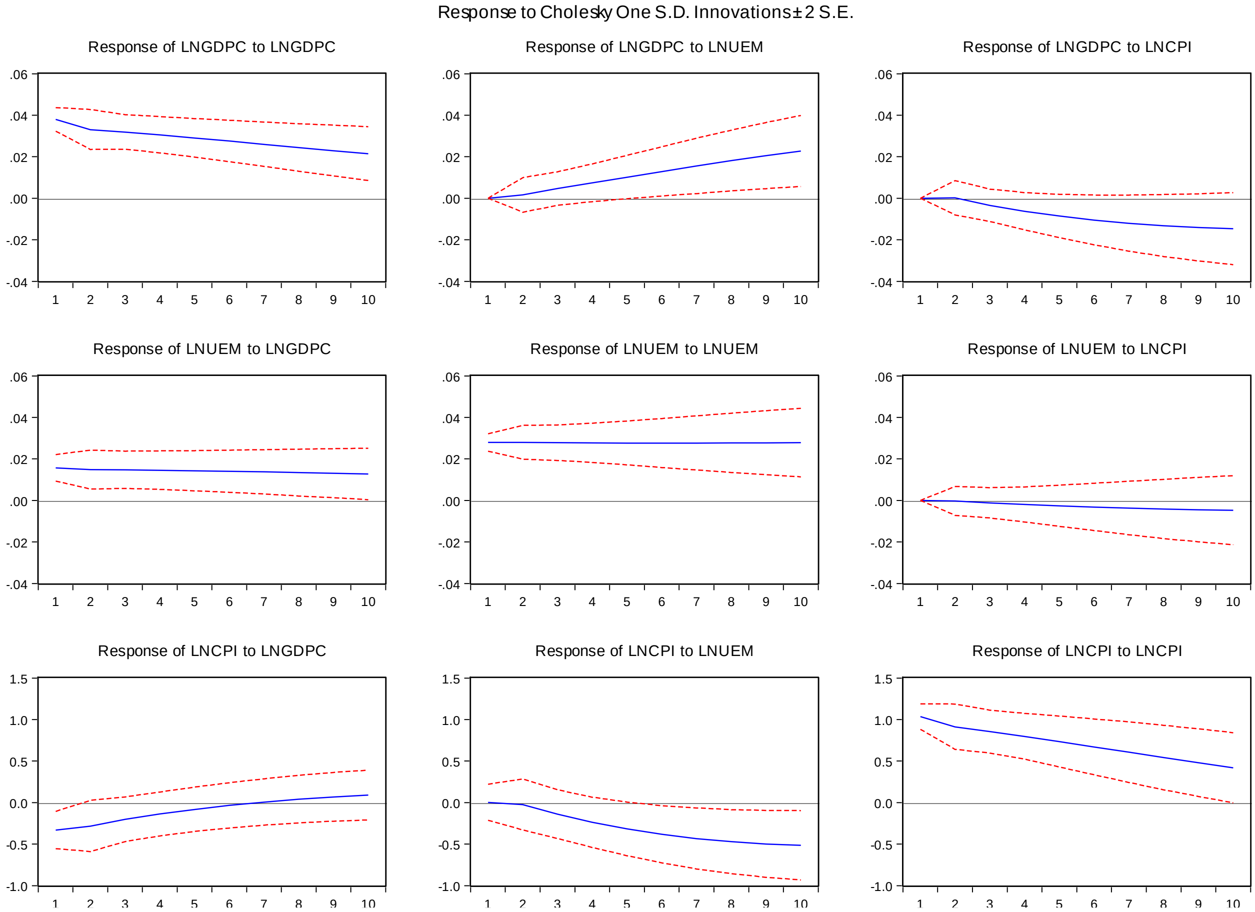
Estimated A matrix:

1.000000	0.000000	0.000000
0.000000	1.000000	0.000000
0.000000	0.000000	1.000000

Estimated B matrix:

0.364242	-0.789289	-0.516016
0.026651	0.013101	0.018014
-0.001055	-0.008058	0.020617

Graphical presentation of the impulse response results



Varia

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DPC:

Perio S.E. LNGDPC LNUEM LNCPI

d

1	0.038009	100.0000	0.000000	0.000000
2	0.050398	99.90109	0.097207	0.001700
3	0.059913	98.98665	0.671423	0.341923
4	0.067936	97.18368	1.700337	1.115979
5	0.075077	94.55973	3.218833	2.221434
6	0.081677	91.26091	5.210293	3.528792
7	0.087937	87.46084	7.624428	4.914730
8	0.093980	83.33355	10.38872	6.277738
9	0.099879	79.03859	13.41878	7.542623
10	0.105674	74.71198	16.62785	8.660172

Variance Decomposition of LNUEM:

Period	S.E.	LNGDPC	LNUEM	LNCPI
1	0.032014	23.97327	76.02673	0.000000
2	0.044983	22.94756	77.04766	0.004781
3	0.054898	22.57432	77.37144	0.054245
4	0.063197	22.31145	77.55005	0.138498

5	0.070478	22.04834	77.70103	0.250633
6	0.077045	21.76071	77.85626	0.383031
7	0.083076	21.44421	78.02728	0.528517
8	0.088684	21.10153	78.21766	0.680813
9	0.093948	20.73789	78.42748	0.834628
10	0.098921	20.35920	78.65513	0.985670

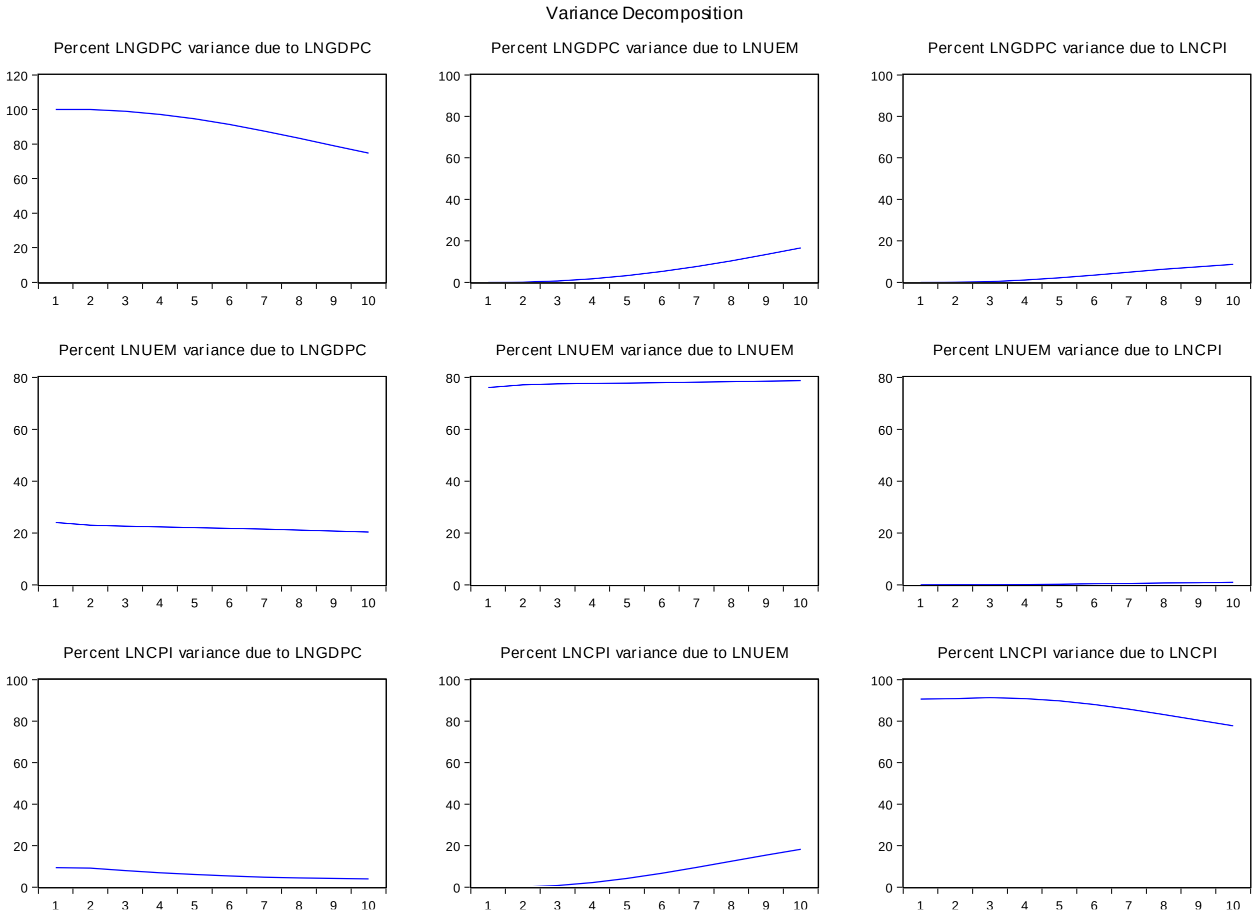
Variance Decomposition of LNCPI:

Period	S.E.	LNGDPC	LNUEM	LNCPI
1	1.087435	9.341592	0.001045	90.65736
2	1.447806	9.097286	0.030453	90.87226
3	1.698636	8.007246	0.711670	91.28108
4	1.896067	6.955507	2.146947	90.89755
5	2.059546	6.054929	4.200120	89.74495
6	2.199625	5.332705	6.705890	87.96141
7	2.322293	4.784959	9.497908	85.71713
8	2.431158	4.393422	12.42853	83.17805
9	2.528489	4.133749	15.37636	80.48989

10	2.615782	3.980170	18.24785	77.77197

Cholesky Ordering: LNGDPC LNUEM LNCPI

Graphical presentation of the variance decomposition results



Appendix 5: Estimated Potential Output results

PERIOD	GDPC	PGDPC	OUTPUT GAP	YGDPC	PGDPC	OUTPUT GAP
1990 Q1	6.519962	6.514703	-0.00526	6.519962	6.50838	-0.01158
Q2	6.519962	6.510484	-0.00948			
Q3	6.519962	6.506268	-0.01369			
Q4	6.519962	6.502064	-0.0179			
1991 Q1	6.548205	6.497891	-0.05031	6.548205	6.491863	-0.05634
Q2	6.548205	6.493777	-0.05443			
Q3	6.548205	6.489782	-0.05842			
Q4	6.548205	6.486002	-0.0622			
1992 Q1	6.43086	6.482567	0.051707	6.43086	6.43086	0.048005
Q2	6.43086	6.479646	0.048786			
Q3	6.43086	6.477378	0.046518			
Q4	6.43086	6.475868	0.045009			
1993 Q1	6.420633	6.475197	0.054564	6.420633	6.420633	0.055785
Q2	6.420633	6.475412	0.054779			
Q3	6.420633	6.47653	0.055897			
Q4	6.420633	6.478532	0.057899			
1994 Q1	6.48972	6.481364	-0.00836	6.48972	6.48972	-0.00236
Q2	6.48972	6.484938	-0.00478			
Q3	6.48972	6.489168	-0.00055			
Q4	6.48972	6.493974	0.004254			
1995 Q1	6.47303	6.499273	0.026243	6.47303	6.47303	0.035088

Q2	6.47303	6.504983	0.031953			
Q3	6.47303	6.511003	0.037973			
Q4	6.47303	6.517212	0.044182			
1996 Q1	6.554007	6.523468	-0.03054	6.554007	6.554007	-0.02166
Q2	6.554007	6.529598	-0.02441			
Q3	6.554007	6.535451	-0.01856			
Q4	6.554007	6.540889	-0.01312			
1997 Q1	6.563742	6.545786	-0.01796	6.563742	6.563742	-0.01239
Q2	6.563742	6.550025	-0.01372			
Q3	6.563742	6.5535	-0.01024			
Q4	6.563742	6.556114	-0.00763			
1998 Q1	6.577052	6.557775	-0.01928	6.577052	6.577052	-0.01947
Q2	6.577052	6.558397	-0.01865			
Q3	6.577052	6.557906	-0.01915			
Q4	6.577052	6.556239	-0.02081			
1999 Q1	6.556227	6.553345	-0.00288	6.556227	6.556227	-0.01043
Q2	6.556227	6.549186	-0.00704			
Q3	6.556227	6.543727	-0.0125			
Q4	6.556227	6.536936	-0.01929			
2000 Q1	6.515601	6.52879	0.013189	6.515601	6.515601	-0.00247
Q2	6.515601	6.519276	0.003675			
Q3	6.515601	6.508376	-0.00723			
Q4	6.515601	6.496066	-0.01954			
2001 Q1	6.52327	6.482329	-0.04094	6.52327	6.52327	-0.06509
Q2	6.52327	6.46716	-0.05611			

Q3	6.52327	6.450579	-0.07269			
Q4	6.52327	6.432641	-0.09063			
2002 Q1	6.425829	6.413446	-0.01238	6.425829	6.425829	-0.04371
Q2	6.425829	6.393153	-0.03268			
Q3	6.425829	6.371925	-0.0539			
Q4	6.425829	6.349949	-0.07588			
2003 Q1	6.237016	6.327444	0.090427	6.237016	6.237016	0.056264
Q2	6.237016	6.304675	0.067659			
Q3	6.237016	6.281854	0.044838			
Q4	6.237016	6.259148	0.022132			
2004 Q1	6.175614	6.236697	0.061083	6.175614	6.175614	0.028461
Q2	6.175614	6.214626	0.039012			
Q3	6.175614	6.193024	0.01741			
Q4	6.175614	6.171953	-0.00366			
2005 Q1	6.115426	6.151466	0.03604	6.115426	6.115426	0.006945
Q2	6.115426	6.131618	0.016192			
Q3	6.115426	6.112442	-0.00298			
Q4	6.115426	6.093959	-0.02147			
2006 Q1	6.079119	6.076192	-0.00293	6.079119	6.079119	-0.02764
Q2	6.079119	6.059181	-0.01994			
Q3	6.079119	6.042963	-0.03616			
Q4	6.079119	6.027591	-0.05153			
2007 Q1	6.040657	6.013139	-0.02752	6.040657	6.040657	-0.04647
Q2	6.040657	5.999713	-0.04094			
Q3	6.040657	5.987437	-0.05322			

Q4	6.040657	5.97646	-0.0642			
2008 Q1	5.842797	5.966964	0.124168	5.842797	5.842797	0.114349
Q2	5.842797	5.959174	0.116377			
Q3	5.842797	5.953233	0.110436			
Q4	5.842797	5.949213	0.106416			
2009 Q1	5.892748	5.947119	0.054371	5.892748	5.892748	0.055754
Q2	5.892748	5.946886	0.054138			
Q3	5.892748	5.948419	0.055671			
Q4	5.892748	5.951585	0.058837			
2010 Q1	5.970114	5.956218	-0.0139	5.970114	5.970114	-0.00402
Q2	5.970114	5.962117	-0.008			
Q3	5.970114	5.969088	-0.00103			
Q4	5.970114	5.97694	0.006826			
2011 Q1	6.04911	5.985487	-0.06362	6.04911	6.04911	-0.04973
Q2	6.04911	5.994536	-0.05457			
Q3	6.04911	6.003933	-0.04518			
Q4	6.04911	6.01356	-0.03555			
2012 Q1	6.065395	6.023328	-0.04207	6.065395	6.065395	-0.02729
Q2	6.065395	6.033166	-0.03223			
Q3	6.065395	6.043034	-0.02236			
Q4	6.065395	6.05291	-0.01248			

REFERENCES

Adamu, P., Iyoha M. and Kouassi E. (undated) Estimating Potential output for Nigeria: A Structural VAR Approach.Research Department, CBN, Abuja, Nigeria.

Amornthum Somchai (2002) Japan’s Potential Growth: An HP Filter Approach. Economic Development of Japan Research Paper for Econ 614

Baxter, A. and King, R. (1995) Measuring business cycles approximate band-pass filters for economic time series NBER W.P. No. 5022.

Benk, S., Jakab, Z. & Vadas, G. (2005). *Potential Output Estimations for Hungary: A Survey of Different Approaches*. Magyar: Nemzeti Bank

Benes, J., Clinton, K., Garcia-Saltos, R., Johnson, M., Laxton, D., Manchev, P. & Matheson, T. (2010) Estimating Potential Output with a Multivariate Filter**.** *International Monetary Fund IMF Working Paper WP/10/285.*

Blanchard, O.J. & Quah, D. (1989). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review*, 79 (4), 655- 673.

Brooks, C. (2008).*Introductory Econometrics for Finance* (2nd ed.). Cambridge University Press.

Butler, L. (1996). A Semi-Structural Method to Estimate Potential Output: Combining Economic Theory with a Time-Series Filter. The Bank of Canada.

Cesaroni, T. (2007). Estimating Potential Output using Business Survey data in a SVAR Framework.*JEL Classification*: C32, E32

Chagny, O., Lemoine, M. and Pelgrin, F. (2004). *An assessment of multivariate output gap estimates in the Euro area. Eurostat report, Project “Short term indicators for the Euro zone”.* Luxemburg: European Commission.

Congressional Budget Office (2001). CBO’S Method for Estimating Potential Output: An update. The Congress of the United States.

Congressional Budget Office (2004). CBO’S Method for Estimating Potential Output: An update. The Congress of the United States.

Dornbusch, R. & Fischer, S. (1992). *Macroeconomics* (6th ed.), New York City: McGraw Hill

Epstein, N., & Macchiarelli, C. (2009). Estimating Poland’s Potential Output: A Production Function Approach. *International Monetary Fund (IMF) Working Paper WP/10/15*

Filho, N. (2004). Estimating potential output: a survey of the alternative methods and their applications to Brazil. Comisión Economicapara América Latina yel Caribe (CEPAL).

Gagales, A., (2006). Growth in Greece: Can Better Performance be Sustained? Selected Issues and Statistical Appendix, IMF Country Report No. 06/5 (Washington: International Monetary Fund).

Gordon, R. (1997). The Time-varying NAIRU and its Implications for Economic Policy, *Journal of Economic Perspectives*, 11(1), 11–32.

Hodrick, R. & Prescott, E. (1997). Post-War U.S. Business Cycles: An empirical Investigation.*Journal of Money Credit and Banking, 29*(1), 1-16.

Johansen, S. (1988). Cointegration in Partial Systems and the Efficiency of Single- Equation Analysis, *Journal of Econometrics,* 52, 398- 402.

Konuki, T. (2008). Estimating Potential Output and the Output Gap in Slovakia. *Internanional Monetary Fund.WP/08/275.*

Krugman, P. (2009). *Economics* (2nd ed.), New York City: McGraw Hill.

Lemoine, M., Reroni, G. L., & Reynes, P. M. (2008). Real Time Estimation of Potential output and output gap for the Euro-Area: Comparing Production Function with Unobserved Components and SVAR approaches.ObservatoireFrancais des ConjocturesEconomiques.

Laxton, D., & Robert, T. (1992). A Simple Multivariate Filter for the Measurement of Potential Output. Technical Report No. 59.Ottawa: Bank of Canada.

Mc Morrow, K., & Roeger, W. (2001). Potential Output: Measurement Methods, New Economy Influences and Scenarios for 2001-2010- A comparison of the EU15 and the US. European Commission Economic Papers, 330-411.

Morling, S. (2002). Output Adjustment in Developing Countries: A Structural VAR Approach. School of Economics, The University of Queensland.

Muzulu, J., & Mashonganyika, S. (2011). *Beyond the Enclave Chapter twelve: Finance for Inclusive Growth*, 473 - 509. Institute for Development Studies, Harare, Zimbabwe.

Osman, M. (2008). Estimating Potential Output and Output Gap for East African Countries: An electric Approach. *European Journal of Economics, Finance and Administrative Sciences, 23,* 163- 192.

Robert, A. (2009). *The Challenges of Estimating Potential Output in Real Time.* Federal Reserve Bank of St. Louis .

Reserve Bank of Zimbabwe, (2005). *The 2005 Post Elections and Drought Mitigation Monetary Policy Frame Work and Supplements.*

Reserve Bank of Zimbabwe, (2007). Monthly Economic Review, March2007

Samueson, P.A. & Nordhaus, W. (1991) Economics (14th ed.), New York City: McGraw Hill.

Snowdon, B., & Vane, H. (2005). Modern Macroeconomics: Its Origins, Development and Current State. Edward Elgar Publishing Limited

Saulo, H., Vasconcelos, J.,& Leão, J. (2010). Estimating Potential Output and the Output Gap

- An Application to Brazil. Universidade Federal Rural de Pernambuco - UFRPE, Recife, Brazil.

Scacciavillani, F. & Swagel, P. (1999). Measures of Potential Output: An Application to Israel. *IMF Working Paper No. 99/96*. Washington D.C.: IMF

Serju, P. (2006). Estimating Potential Output for Jamaica: A Structural VAR Approach. Research Services Department.Research and Economic Programming Division Bank of Jamaica.

Teixeira,T. (2001). Estimating Brazilian Potential Output: A Production Function Approach. Central Bank of Brazil Research Department Working Paper Series.