DOES BICAUSALITY BETWEEN HEALTH AND GROSS DOMESTIC SAVINGS RATES EXIST IN THE SADC?

Master of Arts (Economics) Thesis

By

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DECLARATION

I, the undersigned, declare that this is my own original work and has not been submitted to any other institution for similar purposes. Where other people's work has been used, acknowledgements have been made.

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Signature

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Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and has been submitted with our approval.

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DEDICATION

To my aunts.

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ABSTRACT

This study has examined the bicausal relationship between health and gross domestic savings rates in SADC countries. The study has drawn from the life cycle demography hypothesis for theoretical basis. The study period is for the years 1990-2009 and the data have been collected from the World Development Indicators and Human Development Index. In particular, a panel vector autoregression (PVAR) model has been used to gauge if shocks to life expectancy will lead to changes or variations in gross domestic savings rate. Monte Carlo analysis has been used to compute 5 percent error bands.

The results indicate that shocks to life expectancy do not lead to a change in gross domestic savings rate. Shocks to life expectancy will also account for less than 2% in variations in gross domestic savings rate in the next twenty years. However, shocks to gross domestic savings rates are expected to have an influence on life expectancy in future. This means that if gross domestic savings rates increase, there is a possibility that health status will improve in the region. Government programmes that rely on gross domestic savings to fund health care will have more funds available per given level of income. If governments use the increases in savings, health status in the SADC will rise. The results are robust to various lag lengths.

The study is limited in that it has only considered one aspect of savings rates; the gross domestic savings rates. The other limitations are that no optimal lag length could be chosen and has only considered innovation accounting to the exclusion of panel granger causality tests because of software unavailability.

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LIST OF ABBREVIATIONS AND ACRONYMNS

ACT	Artemisinin Combination Therapy
AIC	Akaike Information Criterion
AIDS	Acquired Immunodeficiency Syndrome
DOTS	Directly Observed Therapy, Short Course
GDP	Gross Domestic product
GDS	Gross Domestic Savings Rate
GMM	Generalised Method of Moments
GMM-AIC	Akaike Information Criterion for GMM
GMM-BIC	Bayesian Information Criterion for GMM
GMM-HQ	Hannan Quinn Information Criterion for GMM
HIV	Human Immunodeficiency Virus
HQ	Hannan Quinn Information Criterion
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Nets
MDR TB	Multi-Drug Resistant Tuberculosis
MEC	Macroeconomic Convergence Programme
MPL	Marginal Productivity of Labour
OLS	Ordinary Least Squares
PMTCT	Prevention of Mother To Child Transmission
PVAR	Panel Vector Autoregression
SADC	Southern African Development Community
SADCC	Southern African Development Coordination Conference
SBIC	Schwarz Bayesian Information Criterion
TB	Tuberculosis
TP	Total Productivity

UNAIDS	Joint United Nations Programme on HIV/AIDS
VAR	Vector Autoregression
WHO	World Health Organisation
XDR TB	Extensively Drug Resistant Tuberculosis

CHAPTER ONE

INTRODUCTION

1.1 General Background

Of late, there has been an increasing realisation in the policy and theoretical domains that health has the capacity to influence macroeconomic fundamentals. The major focus is on the two way relationship between health and productivity and consequently economic growth. There is also bicausality between poverty and health, savings and health, rates of savings and health and investments and health (Bloom and Canning, 2003; Zamora, 2000). All the above relationships are also in a cyclical relationship such that a significant change in one variable is likely to lead to a significant change in the other (Abegunde and Stanciole, 2006). This study will focus on the bicausal relationship between health and gross domestic savings rates in the Southern African Development Community (SADC).

According to Bloom and Canning (2001), health can be defined as a state of complete physical, mental and social wellbeing and not merely the absence of diseases and physical infirmities. Consequently, health is a multidimensional and multiattribute phenomenon which is not easily captured by one variable. Apart from good health being responsible for increases in productivity of human capital, reducing income inequalities amongst individuals and nations, improving school attendances and reducing poverty, good health is also an ultimate goal in itself (Commission for Macroeconomics and Health, 2001; World Bank, 1993).

There are several channels through which health can affect the savings of individual households and nations. Health will impact the savings of individuals in the sense that it can affect their productivity. Consider an individual who is paid wages W that is determined by the equation

$$W = MPL * P \tag{1.1}$$

where MPL is the marginal productivity of labour

P is the price level

W is the nominal wage rate.

Now consider the situation where due to poor health, total productivity (TP) of the individual is zero such that the contribution of the individual at the margin is also zero. Then the individual's wage rate will be zero. The individual will have to either borrow or to use his savings in order to finance his daily consumption. Moreover, there will be an increase in consumption arising from an individual seeking medical care which might lead to a fall in savings. In addition, sick individuals will often rely on a guardian to look after them such that the loss in productivity of the household is further increased.

At the aggregate level, if the health of the nation is poor, governments will spend a lot of financial resources to finance consumption of curative medical goods and services. This reduces the amount of savings that a nation can achieve. Good health of a nation offers the poor the chance to invest in themselves and consequently, this has the potential to reduce income inequalities and inequities in a country. This has two implications for savings in an economy. Firstly, the poor can lift themselves out of poverty and start making savings. Secondly, it affords the poor the chance to further invest in themselves using preventive health care and good nutrition which will improve their productivity and consequently might result into increases in savings. Lastly, health has the potential to affect the poverty levels of a country. According to Zamora (2000), lack of effective health care can lead a nation into a health based poverty trap. The implications of this for savings are that the savings fall and even if they rise, they will be insufficient to raise the country out of poverty. A vicious cycle between health and savings or health and economic growth ensues in such an economy such that only donor influence can lift the country out of poverty[1]. Therefore, the effects of health on savings are serious and consequently the relationship between health and savings deserves serious attention.

[1] See Sorenson and Whitta-Jacobsen (2005) for a discussion of poverty traps.

1.2 Statement of the Problem

Savings are crucial for economic growth and development. High ratio of savings to GDP[2] means that the potential for investment at a given level of GDP is higher than with a lower ratio. Investment in turn leads to high economic growth. As an example, the East Asian tigers registered high savings rates during their boom period which partly explains their amazing growth rates.[3] Savings rates also determine whether a country falls into poverty trap or not and also determine the balanced growth path of an economy. Although savings rate does not directly influence the long run economic growth (Romer, 2001), savings rates determine the amount of funding available to technological progress which is the main determinant of long run economic growth.

The SADC is mostly a poor region and one of the strategies to achieve high economic growth is to stimulate savings rates. The Macroeconomic Convergence Programme (MEC) of the SADC set the targets of gross domestic savings rates (GDS) to be achieved by individual member states. From 2002-2008, the MEC required that countries achieve gross domestic savings rates of 25%, 30% for the period 2009-2012 and 35% for the period 2013-2018.[4] If achieved, such high gross domestic savings rates would create investment opportunities and consequently economic growth capable of lifting the SADC out of poverty. Based on the final MEC review (2009) for the period 2002-2008, most of the countries did not achieve the planned gross domestic savings rates. To the contrary, savings rates have been largely stagnant and in some cases are falling.

Meanwhile, the health situation in the SADC has been deteriorating. According to the estimates in the SADC Strategic Framework for 2003-2007, life expectancy is as low as 33 years in some SADC countries. HIV/AIDS prevalence is high with some

[2]The ratio of savings to GDP is known as the savings rate

[3]The extent of the impact of high savings rate on growth in East Asia is however debatable. One school called the fundamentalists argues that all growth in the region can be traced to high savings rate. The other school of thought called the assimilationists argues that those high savings rates were coupled with technological effects to yield high growth rates.

[4] The MEC focuses on convergence in outcomes and not convergence in policies. It is up to individual countries to decide which policies will improve the gross domestic savings rates. While this has the advantage of recognising individual heterogeneities of member states, it makes monitoring and evaluation at regional level difficult.

countries experiencing prevalence rates of over 30 percent [5] (SADC, 2008). Tuberculosis incidence and malaria prevalence have also been on the rise. Economic theory suggests that in such cases, savings rates are going to be negatively affected. To my knowledge, there has not been any study in the SADC region to ascertain whether it really is the case that deteriorating indicators of health are responsible for stagnant or declining gross domestic savings rates in the region.

The problem is that if indeed poor health has a negative impact on savings rates in the region, there is a possibility of a vicious cycle between health and savings rates with a further possibility of health based poverty traps. Moreover, if the vicious cycle develops, it might affect economic growth rates which in turn will mean reduced resources for the health sector.

1.3 Research Objectives

The main objective is to investigate whether there is bicausality between health and gross domestic savings rates in the SADC. This particular study shall use life expectancy at birth as a proxy for health. Therefore, the specific objectives shall be formulated as follows;

i. To investigate whether a one standard deviation shock to life expectancy in current time will influence current gross domestic savings rates in the SADC.
ii. To investigate whether a one standard deviation shock to life expectancy in current time will influence gross domestic savings rates in future in the SADC.
iii. To investigate whether a one standard deviation shock to current gross domestic savings rates in current time will influence life expectancy in the SADC.
iv. To investigate whether a one standard deviation shock to gross domestic savings rates in current time will influence life expectancy in future in the SADC.

[5] These are Botswana, Lesotho, Swaziland and Zimbabwe.

1.4 Hypotheses

i. A one standard deviation shock to life expectancy in current time does not influence current gross domestic savings rates in the SADC.
ii. A one standard deviation shock to life expectancy in the current time does not influence future gross domestic savings rates in the SADC.
iii. A one standard deviation shock to gross domestic savings rates in current time does not influence current life expectancy in the SADC.
iv. A one standard deviation shock to gross domestic savings rates in current time does not influence future life expectancy in the SADC.

1.5 Significance of the Study

Although it is widely acknowledged that there exists a bicausal relationship between health and some macroeconomic variables, the emphasis is usually on the relationship between health and economic growth. Casale and Whiteside (2006) justify this by arguing that economic growth represents increases in amount of resources available which in turn can be used to address most of the economic and social inequality problems. However, in the SADC, this has led to ignoring other health-macroeconomics relationships. Bonnel (2000) studied the impact of HIV/AIDS on savings in the SADC. However, to my knowledge, no study has addressed the impact of health on savings rates in the SADC.[6] This study shall therefore fill the gap that exists on the true relationship between health and gross domestic savings rates in the region. The study shall employ life expectancy at birth as a proxy for health.

1.6 Organisation of the Study

The rest of the study is organised as follows: Chapter Two provides a brief overview of the SADC region. In chapter Three, literature review is discussed and Chapter Four contains methodology which is used to investigate the research problems. Chapter Five presents the results while limitations of the study and conclusion are presented in Chapter Six.

[6]HIV/AIDS is not used as a proxy for health and therefore, the study by Bonnel did not endeavor to establish any relationship between health and savings in the SADC

CHAPTER TWO

BRIEF OVERVIEW OF THE SADC

2.0 Introduction

This chapter presents a brief overview of the SADC region. The chapter has four sections. The first section introduces the chapter, section 2.1 contains a brief background to the SADC and section 2.2 focuses on health status in the SADC region. The chapter is concluded in section 2.3. In the next chapter, we discuss literature review.

2.1 Brief Background to the SADC

The Southern African Development Community (SADC) was founded on 1st April 1980 as the Southern African Development Coordination Conference (SADCC). Apart from focusing on development issues, the grouping was also heavily involved in the liberation struggle for Namibia in particular. In particular, the SADCC was founded to achieve four principal objectives namely; to coordinate development projects within the region in order to lessen economic dependence on Republic of South Africa which was under apartheid regime; to implement programmes with national and regional impact; to achieve self-reliance through collective mobilisation of resources and to secure international standing and support.

The region changed from SADCC to Southern African Development Community (SADC) on 17th August 1992. As of 2011, the region had a population of 257,726,000 and a combined GDP of US$471.1 billion. By 2011, the SADC had 15 member states namely Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Republic of South Africa, Seychelles,

Swaziland, United Republic of Tanzania, Zambia and Zimbabwe. The region is essentially concerned with development and economic issues. In 2002, the macroeconomic convergence (MEC) programme was signed with the primary aims of reducing inflation, reducing current account as a percentage of GDP, reducing fiscal debt and to stabilise public debt as a percentage of GDP. The MEC programme also aims at achieving an average of 7% economic growth, gross domestic savings rates of 25%-35% between 2002 and 2018 and gross domestic investment of 30% for the same period. Eventually, the region intends to establish a monetary union.

There are several challenges that the region faces. The first challenge is that though the economies are largely agrarian, they also depend on rain fed agriculture. This means that when drought strikes, the countries must rely on food handouts. The second challenge is that of differences in per capita income and levels of development. With South Africa accounting for most of the income, the poverty levels are quite high in the region. For instance countries like Malawi, Democratic republic of Congo and Zambia have got real per capita incomes measured in 2000 US$ of less than 350. This can be contrasted to Botswana, Mauritius and Seychelles with real per capita income of over US$ 4,000. The other problems in the region include trade issues, low economic growth since 2008 due to the global crisis, low levels of literacy, HIV/AIDS pandemic, heavy reliance on donors, high levels of corruption, and environmental degradation.

2.2 Health Status in the SADC Region

The SADC health protocol was signed in 1999. It has got nine objectives and these include to identify, promote, coordinate and support those activities that have the potential to improve the health of the population within the region; to coordinate regional efforts on epidemic preparedness, mapping, prevention, control and where possible to eliminate communicable and non communicable diseases; to develop common strategies which reduce vulnerability of women and children; to harmonise and standardise health care provision; establish mechanisms for the referral of patients for tertiary care and development and efficient utilisation of health personnel and facilities. The basis for the protocol was the awareness of the importance of a healthy population and the realisation that coordination in the areas of health can yield better results.

The SADC experiences various health problems, amongst them are lack of finance to fund health programmes, and high prevalence rates of communicable and non-communicable diseases. According to SADC poverty profile (2008), HIV/AIDS, malaria and tuberculosis account for 90 percent of all avoidable mortality across all ages and sexes. The Acquired Immunodeficiency Syndrome (AIDS) is a disease caused by Human Immunodeficiency Virus (HIV). The most common way through which it spreads are through unprotected sex and mother to child transmission[7]. According to UNAIDS (2010), 34 percent of all HIV/AIDS cases worldwide are in ten of the fifteen SADC countries. 31 percent of all new infections occurred in the same countries in 2009. AIDS is said to have negative effects on economic growth and savings among other things. According to SADC poverty profile (2008), Botswana, Lesotho, Swaziland and Zimbabwe have HIV/AIDS prevalence rates of over 30 percent each.

The SADC is also a heavily malarious region. The disease is largely caused by Plasmodium Falciparum parasite transmitted by mosquitoes of the Anopheles species. The region is malarious because the Malaria parasite usually requires minimum temperatures of about 18 degrees Celsius to thrive and temperatures are usually high in the region. Malaria in the region usually affects children under 5 years of age. Botswana, Namibia, South Africa, Swaziland and Zimbabwe are malaria epidemic countries while Angola, Democratic Republic of Congo, Malawi, Tanzania and Zambia are malaria endemic.

Efforts to curb malaria in the region include establishment of SADC malaria week and establishment of SADC malaria day to sensitize the population on malaria. However, countries also pursue country specific programmes to combat malaria. For instance, the Malawi Government distributes free insecticide treated nets (ITNs) to pregnant women and also gives pregnant women intermittent presumptive treatment (IPT) for malaria. Based on World Malaria Report (2009), the Zambian government distributed long lasting insecticidal nets to 76 percent[8] of the population by 2008, Namibia to 92 percent and Swaziland 47 percent. Owing to some resistance to sulfadoxine pyrimethamine and chloroquine malaria drugs, the Malawi government

[7]This however is on the decline because of the introduction of Prevention of Mother To Child Programme (PMTCT) in the region.

[8] The assumption made by WHO is that one net caters for two individuals.

officially recognised artemisinin combination therapy (ACT) in 2008 as the new treatment for malaria (Kalirani-Phiri, Lungu and Coghlan, 2011). South Africa adopted ACT in 2001, Zambia in 2004 and Zimbabwe in 2008 (WHO, 2009). Countries in the region have also adopted indoor residual spraying (IRS) in efforts to fight malaria. For example, from 2000 to 2008, the government of South Africa used IRS in homes of 80 percent of the population at risk. For the same period, IRS supply by governments was 100 percent in Swaziland, 91 percent in Botswana and 20 percent in Zimbabwe.

Lastly, tuberculosis (TB) is also another major health problem in the region. This is caused by Mycobacterium Tuberculosis. Before HIV/AIDS, the disease was on the decline in the SADC, but has now re-emerged. HIV/AIDS –TB coinfection in the SADC accounts for up to 49 percent of all cases in the world. According to WHO (2010), Apart from Democratic Republic of Congo, Madagascar and Mauritius, over 50% of all new TB cases were HIV/AIDS positive. HIV/AIDS is also partly blamed for the emergence of Multi-drug resistant Tuberculosis (MDR-TB) and extensively drug resistant Tuberculosis (XDR-TB) in the region. According to the World Development Indicators (2011 Online edition), in 2009, the highest incidence of Tuberculosis per 100,000 people in the world was Swaziland (1257), then South Africa (971), followed by Zimbabwe (742), Namibia (727) and Botswana (694). All the listed countries are SADC member states. Five of the twenty two high burden countries with respect to TB are member states of the SADC[9]. Also, South Africa is also one of four countries that had largest numbers of MDR-TB in the world in absolute terms in 2010 (WHO, 2010).

The disease in the region is largely treatable using Directly Observed Therapy, Short Course (DOTS). This is the procedure recommended by the STOP TB campaign of the WHO. However, some countries in the SADC have got relatively high default rates which compromise the effectiveness of drugs. For instance, Angola had 26 percent default rate in 2006 although it had dropped to 18 percent by 2008. Botswana and South Africa have had default rates of over 10 percent during the same period.

[9] Burden of diseases is not restricted to incidence rates (WHO, 2010). The five high burden countries are Democratic republic of Congo, Mozambique, Tanzania, South Africa and Zimbabwe.

2.3 Conclusion

This Chapter has given a brief overview of the SADC region. The SADC is a relatively poor region with South Africa accounting for over 60 percent of all income in the region. There is a very huge disparity in the per capita incomes of countries in the region. To improve economic performance of the SADC countries, the Macroeconomic Convergence Programme was initiated in 2002. This, however, focuses on convergence in outcomes and not convergence in policies.

Amongst the challenges faced in the SADC are health problems. HIV/AIDS, malaria and tuberculosis dominate the health agenda in the region. HIV/AIDS has led to the re-emergence of TB in the region and also led to other strains of TB that are not easily curable. Although largely curable, efforts to cure TB are hampered by high drug default rates in some countries.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

Literature review consists of theoretical review and empirical review. Under theoretical review, we discuss savings as presented in the life cycle hypothesis and savings as presented in the precautionary motive. Savings in general constitute consumption that has been postponed from being effected today so that it can be effected at a later date (Romer, 2001). Although there are many models of consumption and savings, we only focus on the two models of savings because they have been used in modelling the possible effects of health on savings and thus are competing models. In our discussion of the life cycle model, we specifically employ modified life cycle hypothesis that takes into account the effects of health on life cycle behaviour.

The thesis uses life cycle demography hypothesis with a health component for theoretical basis. We also discuss precautionary savings theory because it can also take into account the effects of health and we give reasons why it is not appropriate for this study. After discussing the models for savings, we talk about health and the measurement of health that is used in this thesis. The rest of the chapter is organised as follows; Section 3.1 focuses on theoretical review, section 3.2 discusses the empirical literature and section 3.3 concludes the chapter. The next chapter discusses the methodology used in the study.

3.1 Theoretical Review

3.1.1 Life Cycle Hypothesis

The hypothesis was developed by Modigliani and Brumberg (1954, 1980), Modigliani and Ando (1963) and Modigliani (1975). The hypothesis was modified by Bloom, Canning and Graham (2003) to take into account the possible effects of health. The argument in the life cycle hypothesis is that individuals intend to smooth consumption over their lifetime. The life cycle hypothesis starts from what Deaton (1986) calls the representative version of the life cycle hypothesis.

Several assumptions are made in order to come up with the life cycle hypothesis with a health component. The first assumption that is put forward is that individuals maximize utility from the consumption of goods and services, leisure and health status over their lifetimes. The implications of this assumption are that consumers are rational, have got perfect foresight and that consumption is a function of expected life time resources. The limitation of this assumption is that individuals may not be perfectly rational but can have bounded rationality. The second assumption employed in this model is that an individual does not desire to receive or leave any bequest. This assumption limits the individual to getting his resources from labour, accumulated assets and by participating in the financial market. The strength of this assumption is to allow the individual to plan using the resources that he has control over. The third assumption is that financial markets are perfectly flexible in terms of intertemporal allocation of resources. The implications of this include the absence of liquidity or credit constraints. This obviously does not always work as observed by the credit crunch of 2008-2010. The other implications are zero or constant interest rates and absence of formal institutions to regulate the financial market. In reality, there are formal institutions that facilitate lending and borrowing behaviour. In addition, longevity is assumed exogenous and labour markets are endogenous. The endogeneity of the labour market is important because with improvements in health status, an individual can choose to postpone his retirement and with a fall in health status, he can retire early.

Then if the above assumptions hold, the basic life cycle hypothesis that includes health is formulated from a representative individual perspective. The representative

individual is born at time t_o and is expected to live up to time T. This lifespan is assumed certain in the basic model for each and every individual. The individual starts working at time t_1. Between time t_1 and time t_2, the individual uses resources from his labour income and just breakeven.[10] Between time t_2 and time t_3, the individual starts to participate in the financial market as a net lender. Then in this period, his income includes labour income and rent from capital. At time t_3, the individual retires but the time of his retirement is not fixed by the laws. The decision to retire is done when the marginal disutility from work is greater than marginal utility of consumption times the wage rate. Marginal disutility is a function of health status, among other things. Between time period t_3 and time T, the individual dissaves by using the resources that he accumulated during his working years. The resources exactly come to an end at the time of his death such that there are no bequests.

Now, suppose there is an exogenous increase in health such that the health status of an individual improves. This increases the number of years that an individual is expected to live and the individual therefore increases his savings to cater for the future. Also, the improvement of health results into the individual postponing his current retirement so that his earning years are increased. This has got two implications on the savings behaviour: the first one is that the individual postpones the time that he was expected to start dissaving and also he continues to save. It can further be noted that since health status directly enters the consumption utility function of an individual, it has the potential to lead to increase working hours and earnings and consequently both consumption and savings. Therefore, exogenous improvements in health will lead to increases in savings and the savings rate, ceteris paribus.[11]

Aggregating the above behaviour across individuals in an economy generates the life cycle demography[12] hypothesis that includes health. There are a number of crucial findings in the life cycle demography hypothesis with a health component. Firstly, the savings rate of an economy will be a function of economic growth rates and not levels of income in an economy. Secondly, savings rates will depend on the number of

[10]This behavior differs from the standard life cycle hypothesis because during this phase, individuals borrow to finance consumption.

[11] In some instances, it is possible that increased longevity due to better health leads to less disutility from work and increased productivity. The implication of this on savings is that you can have increases in savings rates, no change or even decreases as individuals expect to work longer. But more generally, it is expected to lead to increases in savings rate.

[12] Refer to Kwack and Lee (2005)

people that are in the productive age while the elderly and those in pre-productive age will be responsible for dissavings. Lastly, health of individuals will positively impact the savings rate in the sense that people will continue to be productive for a long time and thus save. Improvements in the health status of a nation will lead to people postponing retirement and also expecting to live longer lives, both of which lead to increases in savings and the savings rate.

The life cycle hypothesis has been criticized for ignoring other motives of savings and restricting all savings to the retirement motive. Other motives would include precautionary, pride motive, tax exemptions and investments. Other researchers have also found other determinants of savings in an economy which are not captured by the life cycle hypothesis. These include level of income, degree of financial liberalization, foreign aid (having a negative effect on savings), fiscal policy and distribution of income and wealth both at the level of individual economic agents and when factors of production are considered.

The applicability of the life cycle demography hypothesis in poor nations has been questioned. To counter this argument, Modigliani and Cao (2004) argue that the life cycle hypothesis can be implemented where you have intergenerational transfers. Poor nations are characterised by intergenerational households and therefore it is possible to consider the savings behaviour using the life cycle hypothesis. Moreover, it must be remembered that savings rates are not a function of income but of growth rates in income and since poor nations also experience economic growth, it must be possible to model the savings rate behaviour using the life cycle hypothesis.

3.1.2 Precautionary Savings

Precautionary savings constitute additional wealth held at a particular point in time due to past precautionary behaviour (Carroll and Kimball, 2008). In response to the likelihood that the future may present its own risks, individuals make a rational choice to allocate current available resources between the present and the future. How much individuals choose to consume depends on how much they value the current state with respect to the unknown future. Thus whether an individual is risk averse or risk loving will determine how much an individual saves (Romer, 2001). Since precautionary savings arise from uncertainty, the greater the uncertainty, the more the precautionary wealth that will be accumulated, ceteris paribus (Kazarosian, 1997; Palumbo, 1998).

In modelling precautionary savings, health has been found to be one of the significant shocks that individuals will face in their lifetime. Health is uncertain and the health care market is particularly distinct from other markets on account of this. Smith (1999) argues that if people anticipate that they will move into poor health and will have to incur health care costs or will have lower incomes they save enough prior to the illness to take care of this contingency. This argument is further complemented by Bonnel (2000) who argues that in the case of AIDS, this might be particularly common and Palumbo (1998) who argues that the elderly in The United States of America do not to dissave in the fashion predicted by the life cycle hypothesis due to the inherent uncertainty in health but may in fact accumulate wealth if they anticipate poor health.

Another form of health uncertainty is the time of death. This makes the households save or in the case of the elderly not to dissave as the standard life cycle model would predict (Davies, 1981; Skinner, 1985). Also health uncertainty has been found to be more significant than other forms of uncertainty and thus leads to more precautionary wealth than other forms of uncertain situations (Ravi, 2006).

Several shortfalls are associated with precautionary savings theory. Precautionary savings are very difficult to trace at national level (Carol and Kimball, 2008) and attempts to find specific components that constitute precautionary savings in the aggregate national savings have yielded different results for a particular country. Apart from this, the results depend on what a particular author includes as part of precautionary savings. In addition, there is no consensus on how best to model precautionary savings (Carol and Samwick, 1995b). Finally, the use of precautionary savings to model health largely uses micro level data. For the above cited shortfalls, the precautionary motive for savings is not suitable for this study and therefore is not used in the study.

3.1.3 Health and its Measurement

Health is a multiattribute phenomenon and consequently not all of its attributes are easily determined or easily measured. Therefore, a good measure of health must also capture some of the multidimensionality that is present in health. Life expectancy at birth will be used in this study because, it is an objective measure, it is an aggregate measure and also makes comparison with other studies easier because it is a standard

measure of health. In addition, life expectancy measure captures the physical, sociological and psychological aspects of health.

Life expectancy at birth refers to the number of years a newly born is expected to live if the prevailing conditions that influence mortality continue. Because life expectancy is calculated from life tables, it reflects the levels of mortality in a given population. Mortality in turn is generally associated with diseases. Then life expectancy will generally reflect the prevalence of disease and thus herein will capture the physical aspect of health. Generally, society with high life expectancy is a healthy society. However, because life expectancy also depends on levels of income, one can have a situation whereby a population lives long not necessarily because it is in the best physical conditions but because it has resources to enable them live with infirmities. Thus life expectancy as a measure of physical health is limited in the sense that not all the years will reflect good physical health of a particular society but also income.

Life expectancy also captures the social dimension of health. Generally, people who indulge themselves in healthy habits will live longer, if all other things are held constant. In literature, healthy habits include non smoking behaviour, exercising and absence of obesity. Good healthy habits are part of social life of a community and since they affect life expectancy, then life expectancy can be said to capture the social dimension of health. There is also evidence that social support to patients that are physically ill will lead to prolonged life in people that are chronically ill or has potential to lead to quick recovery (Uchin, 2009). Social pluralism also accounts for longer lives. Holding all other things constant, more socially active societies are healthier societies and live longer.

Holding all determinants of mortality equal, then people with mental problems are likely to die earlier than members of their own cohort and the greater the mental problems, the greater the likelihood of an earlier death (Colton, 2006). Thus if society has a large number of people that have mental problems, then ceteris paribus, life expectancy will be lower in such a society. Mental status can also lead to suppression of immunity and thus lead to morbidity and earlier mortality if it persists. Poor mental status is a known factor that leads to non adherence to pharmacological and non pharmacological therapeutical regimes and is also a significant determinant in whether individuals will adopt healthy habits or not. Therefore, life expectancy

measure will also reflect the psychological aspect of a society. Then in general reported life expectancy will have physical, social and psychological aspects of health inherent in them. Thus life expectancy can be used as a proxy for health.

There are several channels through which life expectancy might affect savings in an economy. The first one is that if individuals expect to live longer, they will save so that they consume the same at a future date. Increases in life expectancy will also lead to economic growth which is also a source of savings in the life cycle model. Increases in life expectancy might also lead to precautionary savings if individuals expect compressed morbidity.

Life expectancy as a measure of health is limited in that it does not necessarily capture the incidence and duration of physical diseases but only when these lead to mortality. It will also capture the social and psychological dimensions if these are significant causes of mortality. Thus it does not capture every aspect of health.

3.2 Empirical Literature

The aim of this section is to document and possibly discuss the results of some studies that were done before this one on the relationship between health and savings. The focus is especially on those that use the life cycle hypothesis. Bloom, Canning and Graham (2003) examine the possible relationship between health and life cycle savings. The measure of health they use is life expectancy. Using unbalanced panel data from 68 countries, they find that life expectancy is statistically significant at 5 percent level in determining the savings rate. The authors also find that the young and the aged depress savings in an economy. When fixed effects are taken into account, a ten year increase in life expectancy leads to an average increase in the saving rate of 4.5 percentage points. This is a very powerful result because it entails that regardless of differences in culture, values and institutions across nations, health will still determine the savings rate of a nation. However, the study at this stage also finds that improvements in health that lead to life expectancy beyond 65 years of age will be negative although crucially this is insignificant. Robustness tests also show that life expectancy is still positive and significant although its importance is slightly reduced. Due to endogeneity problems, life expectancy is instrumented by geography and the results indicate that life expectancy is still a significant determinant of savings rates.

Lee, Mason and Miller (2000) conduct a study on the impact of declining mortality and rise in fertility in Taiwan. Both of these are measures of health. In this study, the combination of the two is termed as demographic change and the results show that demographic change leads to a greater wealth .The model used herein differs from the traditional life cycle model in that there is no perfect foresight in this model. When sensitivity analysis is conducted, the results continue to show that the declines in mortality and increases in fertility have led to increases in the Taiwanese saving rates.

Ram and Schultz (1979) in their paper on lifespan, health, savings and productivity argue that increases in life expectancy accounted for by decreases in mortality are a major source of productivity and consequently savings in rural India. The study is conducted over the period 1951-1971. The major shortfall in the Ram and Schultz paper is that they assume the reduction in mortality and morbidity is largely exogenous. Their argument for this is that the resources that led to the health improvements were part of public health measures.

The result that the impact of improvement in health will be limited as life expectancy is raised beyond a certain age is not limited to Bloom et al (2003). Mason, Ogawa and Fukui (2004) investigate changes in the some elements of health in Japan. They look at components of declining fertility in Japan and increasing life expectancy in Japan. Both of these are indicators of health in a country. The study is based on projections and was done in an environment where multigenerational households were expected to decline. The results showed that with increases in life expectancy in Japan and declining fertility, there will be a fall in the savings rate of the country. Thus if health improvements lead to increases in life expectancy, there will be more retirees in Japan and consequently lead to a decline in savings. Thus while health has a positive impact on the savings rate, this will be up to a certain point.

Kinugasa and Mason (2007) study the impact of health in an overlapping generations setting. This means that both level and rate of change in the life expectancy are important. The focus is on adult survival rates. Their interest is to see the effects of declining mortality on savings rate in seven countries. They estimate ordinary least squares and two stage ordinary least squares and find that old age survival rates are important as a determinant of national saving rates. However change in adult survival rates has a positive statistically significant effect in Asian countries and not in the

western countries. This means that the improvements in health that result in increases in adult survival rates are good for the saving rates of Asian countries.

Bloom, Canning, Mansfield and Moore (2006) investigate the impact of health on national savings rates in the context of differing social security systems and retirement systems. The finding is that the higher the life expectancy is associated with higher saving rates when there is universal coverage of the social security system and retirement incentives but this is limited when you have a pay as you go system retirement system.

Bloom, Canning and Moore (2010) investigate the relationship between savings and health. Mortality is used in this particular study and assumed to have one to one mapping with life expectancy. The study incorporates compressed morbidity and the effects of health are examined in the context of existence of social security systems. Health is assumed to change deterministically with age. Retirement in this model is due to the onset of ill health. The result in this model is that rational individuals may actually increase their consumption due to improvements in health that lead to increases in life expectancy. This behaviour might be attributed to the existence of the social security programmes.

The general conclusion that can be drawn from the above empirical arguments is that health will generally lead to increases in saving rates at national level. This observation is however limited in the case of life expectancy because as the life expectancy improves beyond a certain age, there will be a decline or levelling off of the national savings rates.

3.3 Conclusion

This chapter has reviewed the life cycle hypothesis and precautionary savings. Life cycle hypothesis is preferred in this model because it takes into account the possibility of better health leading to increases in the savings rate. This is usually the general trend at national or international level. In addition, modelling precautionary savings can be very subjective and thus usage of the life cycle hypothesis takes away author subjectivity. The measure of health to be employed in this study is life expectancy and is chosen because it is an aggregate measure; it is objective and is standard in literature.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This chapter deals with methodological approach used to determine the influence of health on gross domestic savings rates. In literature, it is widely recognised that there exists a two way causal relationship between health and savings rate and between health and economic growth. Vector autoregression (VAR) modelling is one of the solutions to dealing with endogeneity problem. VAR is an atheoretic approach to modelling and is largely used for forecasting purposes. Although the approach is atheoretic, Johansen (1988) calls for empirical models to be guided by theory even if they will be investigated in the framework of the VAR. This particular study shall draw from the life cycle demography hypothesis that includes health for theoretical basis. Specifically, panel vector autoregression (PVAR) shall be used.

The rest of the chapter is organised as follows; section 4.1 discusses PVAR modelling, section 4.2 presents the econometric model that is employed in this study. In section 4.3, we define the variables used for the study. In section 4.4, we discuss methodological issues in PVAR modelling, section 4.5 focuses on data and data sources and section 4.6 concludes the chapter. Chapter Five is used for empirical analysis.

4.1 Panel Vector Autoregression Model

PVAR is a combination of panel data techniques and traditional time series VAR that allows for endogeneity. Panel VARs differ from the traditional time series VARs in some important respects. For instance, it is possible to run a panel VAR even in the presence of unit and explosive roots (Holtz-Eakin, Newey and Rosen, 1988). Secondly, estimates derivable from the panel VAR estimated using difference generalised method of moments are useable and are interpreted as results in granger causality tests. Lastly, methods of estimating a panel VAR include generalised

method of moments (GMM), Bayesian inference and quasi-maximum likelihood. This study estimates the PVAR using style GMM.

The generalised method of moments uses instrumental variables for modelling. There are generally two sets of GMM namely difference GMM and style GMM [13]. Difference GMM transforms all the variables by differencing and uses lags as instruments whilst system GMM uses the combination of both the first difference estimator and the estimator in levels to form a system estimator. In system GMM, the instruments in the difference estimator are like those in the difference GMM while the levels estimator would be instrumented by appropriate lags of the predetermined or endogenous variables or in the case of strictly exogenous variables, you use the variables themselves. No variable is treated as strictly exogenous in this study.

Roodman (2009) documents several general assumptions applicable in the difference GMM and also applicable in style GMM. These include that the system is dynamic, existence of arbitrarily distributed fixed individual effects, existence of some endogenous variables is permissible and the idiosyncratic error terms may have individual specific patterns of heteroscedasticity and serial correlation. The idiosyncratic error terms may not be correlated across individuals. Therefore, most of the tests applicable in standard VAR modelling shall not apply.

4.2 Econometric Specification of the Model

This study follows Holtz-Eakin et al (1988) which is the standard way of implementing a PVAR. However, it differs from the above in that the method of estimation follows Love and Zicchino (2006) who use style GMM.[14]

Therefore, the model is specified as

$$Z_{it} = \alpha_{ot} + \sum_{q=1}^{p} \beta_q Z_{it-q} + \Psi f_i + d_{it} + \varepsilon_{it} \qquad (4.1)$$

Where subscript i denotes the cross section index and t denotes the time series index

q is the lag length and p is the largest lag length

[13] The style GMM has further been subdivided, usually with the aim of finding further moments.
[14] Style GMM is preferred to difference GMM because pvar.ado software uses Style GMM and since there is no publicly available software that estimates difference GMM, the reason is not theoretical.

Z_{it} is a vector of 5 endogenous variables

α_{ot} is a vector of intercept terms

β_q is a 5 by 5 vector of coefficients

Ψ represents the coefficient of the individual fixed effect

f_i are individual fixed effects

d_{it} are country time dummies

ε_{it} is a vector of innovations[15] distributed as $(0, \sigma_i^2)$ and $E(\varepsilon_{it}\varepsilon'_{is}) = 0, s < t$

The innovation is assumed heteroscedastic because this has the ability to improve the individual heterogeneity of panels (Holtz-Eakin et al, 1988). Also, the strict assumption of no autocorrelation has not been imposed[16] but instead we have opted for orthoganalisation. This allows us to separate innovations from each other and also allows for projections to be made.

The endogenous variables present in Z_{it} are {Gross domestic savings rate, Productive age, Health as proxied by life expectancy, Growth rate of gross domestic product, Real interest rate}

4.3 Variable Definition

4.3.1 GDS

This stands for gross domestic savings rates[17]. We follow Bloom et al (2003) to derive the savings rate. The starting point for defining savings rate is the following identity

$$Y = C + I + G + (X - M) \qquad (4.2)$$

Where Y is gross domestic product; C is private consumption;

[15] In VAR modelling, the error term is known as innovation or impulse or shock (Enders, 2004)
[16] Based on the assumptions of GMM, you can impose no autocorrelation condition on the error terms. See Arellano and Bond (1990) for a discussion of this.
[17] This thesis shall only use gross domestic savings rates because of missing data on gross national savings rate in some countries during the study period.

G is government consumption; I represents investment both private and public (X –M) represents net exports. If taxes are given by T, then (T – G) represents government savings, whilst private savings of individuals and corporations are represented by total income available to them (Y) less consumption, C and less taxes, T. Then total savings in an economy will be given by

$$(T-G)+(Y-C-T)=Y-C-G=I+(X-M) \quad (4.3)$$

Let Y_{it} be total income in a particular country *i* at any given time t.

Let C_{it} be total consumption (Government and private) in particular country *i* at any given time t such that henceforth

$$C_{it}=C+G \quad (4.5)$$

Where C,G are as defined in equation 4.2

Then Gross domestic savings in a country will be given by the equation

$$Y_{it}-C_{it}=S_{it} \quad (4.5)$$

Then the gross domestic savings rate will be given by

$$\frac{S_{it}}{Y_{it}}=\frac{Y_{it}-C_{it}}{Y_{it}} \quad (4.6)$$

4.3.2) PDCTAGE

This stands for productive age. The life cycle demography hypothesis predicts that people in the working age are the ones responsible for savings in an economy whilst the elderly and the young are responsible for dissaving in any given economy. Productive age shall refer to the people in age groups 14-64. This is chosen because of data issues as this is the only available set of data that defines the productive age in the World Development Indicators. This is also the age group that is widely used in literature as representing the productive age. If all other things are held equal, economic theory predicts that there is a positive relationship between this variable and the savings rate.

4.3.3 GROWTH

This represents economic growth of a particular country. The life cycle hypothesis predicts that it is growth in income other than actual disposable income that accounts for savings in an economy, holding other things equal. With economic growth, there will be an increase in savings and the savings rate in an economy, ceteris paribus.

4.3.4 LEXP

This stands for life expectancy. There are three possible channels through which life expectancy can influence savings in the model adopted. If people expect to live long, then they are inclined to provide for tomorrow. One of the ways in which individuals do this is to increase their savings. Secondly, since life expectancy represents improvements in health, the amount of resources spent on consumption of medical goods and services falls, holding everything constant. You can also have an indirect increase in savings if life expectancy leads to economic growth.

4.3.5 R INTR

This represents real interest rate. The representative version of the life cycle hypothesis predicts that at individual level, the effect of interest rates on consumption and savings is ambiguous. The effect of a change in interest rates depends on income and substitution effects; depends on the initial financial position of the individual and elasticity of intertemporal substitution in consumption of the individual. However, the life cycle demography version predicts that in aggregate, interest rates positively influence savings and savings rates. Therefore the expectation in this thesis is that real interest rates will have a positive influence on saving rates.

4.4 Methodological Issues

4.4.1 Forward Mean Differencing

The PVAR model to be estimated includes fixed individual effects and normally, the within group transformation is used to remove fixed effects. However, in a PVAR, this procedure yields inconsistent estimates because of the presence of lagged endogenous variables. This procedure can also create serial correlation between the regressors and the error terms, even if originally there was no serial correlation problem.

Arellano and Bover (1995) suggest using forward mean differencing to remove the individual effects. Also known as the helmert procedure, forward mean differencing removes the mean of all future observations available for each country-year. This procedure maintains orthogonality amongst the errors as well as orthogonality between the transformed error terms and the untransformed original variables which are used as instrumental variables.

4.4.2. Time Demeaning

The model that is estimated contains time dummies. In panel data econometrics, it is important to separate between aggregate effects (such as business cycles) and individual specific effects. Time dummies or time effects are included in such models in order to acknowledge the presence of aggregate effects. Since our interest is only in the individual specific effects, we remove the time dummies by time demeaning. The Helmert procedure shall be applied to time –demeaned data (Love and Zicchino, 2006).

4.4.3 Model Order

The standard information criteria[18] are inappropriate in GMM because they are not consistent and cannot choose the appropriateness of moments. Andrews (1999) modified some information criteria to have GMM-AIC, GMM-BIC and GMM-HQ. However, these are not available in Stata. Even if available, there use would be compromised by the need to take into account individual heterogeneity of panels.[19]Moreover, although it is desirable to use information criteria (Binder et al, 2005), the issue of lag selection is still treated differently in panel VAR modelling.

Holtz-Eakin et al (1988) argue that in setting a lag length, it is desirable to specify an arbitrarily long lag length in modelling panel VAR. They arbitrary choose a lag length of three. Love and Zicchino (2006) do not specify the procedure of arriving at their chosen lag length of 1. Aspachs, Goodhart, Tsomocos and Zicchino (2007) also arrive at lag length three arbitrarily. Hayakawa (2011) discusses at how he would arrive at an optimal lag length but does not choose his lag length in that fashion but rather opts

[18] These include Akaike Information criterion (AIC), Schwarz Bayesian Information Criterion (SBIC) and Hannan Quinn Criterion (HQ)

[19]Pvar.ado could not store estimates and since the criteria introduced by Andrews (1999) would have to be estimated after model estimation, it was never going to work.

for lag length one for simplicity. Therefore, we follow Love and Zicchino (2006) and Holtz-Eakin et al (1988) to choose an arbitrary lag length. However, we differ from them in that we will perform robustness tests at various lag lengths. We shall use lag length two for estimating the model and lag lengths one and three shall be used to perform robustness tests.

4.4.4 Orthoganalisation

In order to separate the effects of one shock to a variable in the system, it is important to orthogonalise the error terms. This is important if the estimated model is to be used for projections.

Consider equation (4.1) which is the econometric model to be used in this thesis and is replicated below for convenience

$$Z_{it} = \alpha_{ot} + \sum_{q=1}^{p} \beta_q Z_{it-q} + \Psi f_i + d_{it} + \varepsilon_{it} \qquad (4.1)$$

Then for orthoganalisation we follow Holtz-Eakin et al (1988). The error term ε_{it} must satisfy

$$E(Z_{is}\varepsilon_{it}) = E(f_i\varepsilon_{it}) = E(d_{it}\varepsilon_{it}) = 0, \quad (s < t) \qquad (4.7)$$

To have orthogonal error terms, we use the Cholesky decomposition of variance-covariance matrix. This is equivalent to transforming the system in a recursive VAR. Under orthoganalisation that employs Cholesky decomposition; suppose you have three variables A, B and C. Then if the variables are ordered in the sequence A $\rightarrow$B $\rightarrow$C, then A is said to affect B and C contemporaneously as well as with lags, while B affects C Contemporaneously as well as with lags and also affects A with lags only and C affects both A and B with lags only. In this thesis, variables follow the following sequence: Life expectancy $\rightarrow$productive age $\rightarrow$real interest rate $\rightarrow$growth $\rightarrow$ savings rate.

In ordering variables it is important that there should at least be some sense if analysis is to be performed using Cholesky decomposition. This must be done to avoid author biases. The ordering is justified as follows; Life expectancy affects all other variables

contemporaneously as well as with a lag. This is justified in the sense that percentage of people within the productive age will depend on how long people live in a given country. Evidence also suggests that economic growth heavily depends on health and although there is bicausality between the two, the growth to health school of thought is weaker. Life expectancy is also said to influence investments contemporaneously (and perhaps therefore interest rates) and studies have shown that life expectancy has a contemporaneous effect on savings rates. Therefore life expectancy takes precedence over all variables in terms of which variable would have a contemporaneous influence on the remaining variables.

Productive age is also likely to influence growth and savings rate contemporaneously. Therefore, productive age comes second in the ordering. Real interest rates will affect economic growth via investment; therefore, real interest rates come before economic growth. The rate of interest is also a determinant of savings in an economy. Therefore real rate of interest takes precedence over economic growth and gross domestic savings rate.

The savings rate comes last. There is possible bicausality between savings and economic growth in literature. However, because this study is on the basis of the modified life cycle demography hypothesis that includes health, economic growth comes before savings rate in the ordering because savings and the saving rate are said to be dependent on economic growth. Therefore, the gross domestic savings rate variable will come last in the ordering of the variables.

4.4.5 Stationarity

Although it is not a must to have stationarity in panel VAR, this condition is usually in cases where the cross section dimension (N) of the panel is large. Since both the cross section and time series dimensions (T) are small and given that T (time dimension) is greater than the N (cross section dimension), we conduct unit root testing. Standard unit root tests like augmented Dickey-Fuller and the Phillips-Perron test, although they have improved power in panel models have been shown to yield inconsistencies. For example, Barbieri (2005) notes that if you want to do standard unit root tests on panel data with

$$H_0 : p = 0, H_a : p < 1 \qquad (4.8)$$

And the autoregressive model taking the form

$$\Delta y_t = \Delta y_{t-1} + u_{it},\ i = 1, 2, ..., N\ t = 1, 2, ...T \qquad (4.9)$$

Then the standard unit root tests are applied only on the first time series. However in panel data, for the same hypothesis, the interest is not in equation (4.9) but in

$$\Delta y_t = \Delta y_{t-1} + u_{it}, \qquad i = 1, 2, ..., N \qquad (4.10)$$

For this reason, specific panel unit root tests have been developed. There are two generations of unit root tests in panel modelling. The first generation consists of unit root tests that assume independence of cross-sectional units in the panels. The second generation assumes away independence. Most of the first generation unit root tests test the null hypothesis that there is presence of unit root in the panels but the alternatives might vary. The Levin, Lin and Chu (2002), Breitung (2000) and the Harris Tzavalis (1999) assume that all the panels share the same autoregressive parameter such that $\rho_i = \rho$ for all *i*. The panel unit root tests are largely and mostly asymptotic tests developed using the sequential limit theory. Because most of these tests require that N and T be substantially large, we shall use the Harris Tzavalis test that allows for small sample adjustment.

The Harris Tzavalis test is based on the bias corrected least squares estimate of the autoregressive parameter and is applicable to balanced data only. The assumption in the development of the test is that the error terms are independently and normally distributed for both the time and cross-section dimensions with zero means and finite heterogeneous variance.

Harris and Tzavalis consider a regression model of the form

$$y_{it} = \rho y_{i,t-1} + z'_{it}\,\gamma_i + \varepsilon_{it} \qquad (4.11)$$

Where $z'_{it}\,\gamma_i$ is included to represent panel specific means and trends.

To correct for possible biases, we remove panel means in conducting the test. The null hypothesis that is tested is that of unit root in panels against an alternative of stationary panels.

4.4.6 Impulse Response Analysis

We follow Hayakawa (2011) in order to define impulse response functions. The standard impulse response function in panel setting can be defined as follows: Consider equation (4.1) which is the econometric model to be used in this thesis and replicated below for convenience

$$Z_{it} = \alpha_{ot} + \sum_{q=1}^{p} \beta_q Z_{it-q} + \Psi f_i + d_{it} + \varepsilon_{it} \tag{4.1}$$

Taking away the intercept coefficients and country time effects, the model that includes individual heterogeneity can be rewritten as

$$Z_{it} = \beta_1 Z_{it-1} + ...\beta_p Z_{it-p} + \Psi f_i + \varepsilon_{it} \tag{4.12}$$

To obtain the non-orthogonalised impulse response in panels, you drop the subscript i and the fixed effects since these have no impact on the impulse responses.

Then the impulse response at time $j = 0,1,2,3,4,5,6$ will be given by[20]

$$\phi_j = \frac{\partial Z_{t+j}}{\partial \varepsilon_t'} \tag{4.13}$$

This thesis however employs orthogonalised impulse responses. Then the orthogonalised impulse responses are defined in the following manner

Let P be the lower triangular matrix such that

$$PP' = \Sigma \tag{4.14}$$

P' is the usual transpose of P

Σ is the usual notation for a matrix

[20] We only consider periods $j = 0,1,2,3,4,5,6$ for impulse responses because this is all the pvar.ado can do. Similarly, the future error variance decomposition can only consider the time horizon at ten year intervals. We only consider periods 10 and 20.

Then the orthogonalised impulse response at time j, denoted as (Θ_j^o) is given by the product of the non-orthogonalised standard impulse response at time j (ϕ_j) and the lower triangular matrix P

$$\Theta_j^o = \phi_j P \tag{4.15}$$

$j = 0,1,2,...6$ and where j represents a year such that $j = 0$ is the current year.

In order to derive confidence intervals for the impulse responses, we use Monte Carlo simulations. We use 10000 Monte Carlo repetitions to generate 5 percent error bands on each side of the estimated coefficient. As in Love and Zicchino (2006), we randomly draw coefficients of model (4.1) and using the estimated coefficients and their variance-covariance matrix, we recalculate the impulse responses. We generate 5th and 95th percentiles of this distribution to have confidence intervals. Therefore, the significance level is at 10 percent (Koetter and Polath, 2007).[21]

4.4.7 Future Error Variance Decomposition

This is the proportion of the movements in a sequenced variable to its own shocks versus shocks to other variables. When the error term is decomposed and results show that large component of it is from its own shocks as opposed to those of other terms in the model, then the variable is considered as largely exogenous with respect to other variables in the model and thus the VAR framework cannot explain the variable.

4.5 Data and Data Sources

The data for this thesis have been sourced from the World Development Indicators (2011) online edition and from the Human Development index of the United Nations (2010). The data in the World Development Indicators is compiled by the World Bank from various sources and has been used for research by many other researchers. Similarly, the data in the Human Development Index is available for use in research but is compiled by the United Nations Development Programme. The data on gross domestic savings rates, economic growth, real interest rates and productive age are sourced from the world development indicators (2011) whilst data on life expectancy

[21] It is not usual in Economics to study a problem at 10% significance level. However in empirical pvar modelling, this is almost standard because of the popularity of pvar.ado by Inessa Love.

are sourced from both the world development indicators (2011) and human development index (2010). The data are secondary in nature and are made available for public use and thus there is no need to have ethical clearance.

The data are for the period 1990 to 2009 and are from selected SADC countries. The period 1990 to 2009 is chosen because of data issues. Some countries in this period have balanced data but if you include earlier years, this attribute is lost. The SADC region is chosen because it is a functioning grouping that is facing acute health problems in physical and mental terms, in terms of lack of financial resources to combat the same, lacks comprehensive primary health care and these have the potential to negatively affect savings rates. Realising the importance of high savings rates for the development of poor nations and the lack of research that is prevalent in this region on the issue, the SADC region is the most appropriate region at this point in time.

Because some of the tests that will be carried out require balanced panels, countries in the SADC region must satisfy this between the period 1990 and 2009. There are nine countries that satisfy this and these are Botswana, Lesotho, Malawi, Madagascar, Mauritius, South Africa, Swaziland, Tanzania, and Zambia. However, Lesotho is not included in the study because it exhibits unusual behaviour in the savings rate; the gross domestic savings rates are all in the negative and extremely low while the gross national savings rate are amongst the highest in the region. Therefore, Lesotho might not be a very good representative of the savings rate behaviour in the region.

The data were stacked in Stata 11.2© where all analysis was done. In addition to using official Stata programmes, pvar.ado written by Inessa Love[22] was also used. The results are presented in the next chapter.

4.6 Conclusion

This chapter has presented the methodologies that have been used in the study. PVAR modelling has been chosen because of possible endogeneity in the variables. System GMM shall be employed to estimate parameters. Usage of GMM also meant that the data are time demeaned and forward mean differenced. We have used Cholesky

[22] The programme was written in 2006 by Inessa Love of the World Bank. She kindly gave me permission to use it in this study. The programme has been used in several papers by different authors.

decomposition to separate shocks of one variable from shocks of another. Finally, the PVAR is used to estimate the influence of health on the gross domestic savings rates in selected SADC countries for the period 1990-2009.

CHAPTER FIVE

EMPIRICAL ANALYSIS

5.0 Chapter Overview

This chapter presents and where possible and applicable discusses the results that have been obtained. Section 5.1 presents the description of the data set, section 5.2 presents unit root results and section 5.3 looks at choice of lag length, section 5.4 contains the results of the PVAR at lag order 2 while section 5.5 looks at robustness tests by examining the results at lag lengths 1 and 3. Section 5.6 concludes with the summary of the results. In the next chapter, the study shall be summarized and concluded.

5.1. Description of the Data

The data are sourced from the World Development Indicators (2011 online edition) of the World Bank and the Human Development Index (2010) of the United Nations Development programme. The data are on life expectancy, productive age, real interest rates, economic growth rates and gross domestic savings rates. Current member states of SADC with balanced data for the periods 1990-2009 were considered. Only Lesotho was excluded from the sample.

Table 1: Descriptive Statistics for Countries in the Study

	Mean	Minimum	Maximum	Standard Deviation
LEXP	56.997 years	41.625 years	75.25 years	9.594
PDCTAGE	55.987 percent	49.208 percent	70.097 percent	6.132
RINTR	7.599 percent	-48.094 percent	35.92 percent	11.308
GROWTH	3.776 percent	-12.674 percent	16.7 percent	3.778
GDS	14.636 percent	-5.455 percent	43.824 percent	12.119

Refer to Table 1 above which shows the descriptive statistics for the countries included in the study. There are 8 panels and the number of observations per variable per panel is 20. Therefore, each variable has 160 observations and the study has employed 800 observations.

The descriptive results indicate that life expectancy in the region has got the mean of 56.997 years and standard deviation of 9.594. The range of life expectancy is (41.625, 75.250) years. This means that the average life expectancy is lower than the maximum age at which an individual would be characterised as being in the productive age. The implication of this is that, on the average, people in the region would be less inclined to save for retirement purposes.

On average, 55.987 percent of the population study is in the productive age with standard deviation of 6.131 and range of (49.208, 70.097) percent. Average real interest rates are positive and the mean of 7.599 percent is statistically different from zero. The minimum interest rate is (-48.093) percent and the maximum is 35.920 percent. During the period of study, countries in the sample registered an average economic growth rate of 3.776 percent with standard deviation of 3.778. The rate of economic growth in the sample varies from (-12.674, 16.7) percent. The economic growth rate is also significantly positive.

Gross domestic savings rates during the period of study range from (-5.455) percent to 43.824 percent with a mean of 14.636 percent and standard deviation of 12.119. The mean is statistically different from zero and is also statistically positive[23]. Moreover, the mean compares well with that used in the Bloom et al study (2003) which was at 17.6 percent, with the maximum being 46.8 percent and the minimum of -14.4 percent. However, if you include Lesotho in the sample, the statistics of life expectancy, productive age, real interest rate and economic growth rate remain the same. Gross domestic savings rate statistics however change. The average mean falls from 14.636 percent to 9.455 percent. The standard deviation also changes from 12.119 to 18.847 and the range changes from (-5.455, 43.824) to (-56.639, 43.824). Thus Lesotho has got the ability to have influential powers on the results. Therefore,

[23] It has been argued that savings and their rates are negligible in poor countries (see Deaton, 1989). We conduct one sample t test to see if savings rates are really equal to zero. We also do this with interest rates and economic growth. All the variables are statistically positive.

Lesotho is dropped from the sample even though it has balanced data for the period of study.

5.2 Unit Root Tests

The Unit root tests conducted in this study are panel in nature. This is because the standard unit root tests like the Dickey Fuller, Augmented Dickey Fuller and Phillips Perron tests readily reject the hypothesis of stationarity or unit root in panel models and as such are inappropriate. The Harris Tzavalis panel unit root tests are employed in this model because of their capability to take into account small samples. Panel means are also removed[24] and crosssectional means are subtracted. The unit root tests results are presented in appendix 1.

For all the variables, the results indicate that you reject the null that panels contain unit roots at 10 percent, 5 percent and 1 percent significance levels. Therefore, the alternative that panels are stationary is adopted. Since the results indicate that you strongly reject the null that panels contain unit roots, a basic PVAR will be specified.

5.3 Choice of Lag Length

As discussed in methodology, there is no proper way of choosing lag length for panel vector autoregression. Moreover, since probability bands in this thesis are obtained using Monte Carlo simulations, this can only be done up to lag length three because beyond that, the matrix is no longer diagonal if you try to compute the error bands. This then means that the choices of lag lengths are between lag length one, two and three. This study shall employ all lags with lag length two used for the study of the problem and lag lengths one and three used for robustness checking of the results. Lag length two is chosen because it allows for robustness checks for a higher and a lower lag length.

5.4 Model Results

Before estimating the model, the data is time demeaned then forward mean differenced. Cholesky decomposition is applied, the matrix is diagonal for all the

[24] This is done to avoid possible biases.

three lags estimated and therefore it is possible to isolate shocks of one innovation from the other.

5.4.1 Impulse Response at Lag 2

Refer to appendices 2.1 to 2.5, for impulse response tables. These show the orthogonalised impulse response tables for lags 1 to 3. The results applicable to lag 2 are in bold. Also refer to Appendix 3.2 for impulse response graphs without error bands. 5% Error bands are calculated for each side of the estimated coefficient. We use 10000 Monte Carlo repetitions, although fewer repetitions are yielding similar results. The 10000 number is however chosen because large numbers are likely to be more consistent and credible than smaller ones.

5.4.1.1 Response to a Shock in Life Expectancy

If you hold all other shocks equal to zero, a one standard deviation shock to life expectancy, does not lead to a significant change in gross domestic savings rates in time $j = 0$. Therefore, we fail to reject the null that a shock to life expectancy does not significantly lead to a change in gross domestic savings rates at 10 percent level of significance. If you also hold all other shocks equal to zero, a shock in life expectancy will have a positive but insignificant impact on gross domestic savings rates for the periods $j = 1, 2, 3, 4, 5, 6$. Therefore, we fail to reject the null associated with hypothesis 2 at 10 percent level of significance. Although a shock to life expectancy produces the expected sign with respect gross domestic savings rates, the results are statistically insignificant.

There are several ways in which the result associated with null 1 can be explained. The first one is that shocks to life expectancy do not lead to significant increases in economic growth in the current period which means that savings also do not increase significantly. Secondly, increases in life expectancy do not lead to reduction in current consumption in favour of consumption tomorrow. This behaviour is explained in the context of the life cycle hypothesis by the fact that you have intergenerational households in the region and therefore, the expectation is that people will be taken care of by their descendants and therefore increases in life expectancy would not act as an incentive to save. While these explain the acceptance of the second null at 10

percent level of significance, an additional reason can be provided. Although a current shock to life expectancy yields significant economic growth in future periods, growth might serve to increase consumption more than it does with savings. This result is consistent with Bloom et al (2010) although the reason in the SADC would be existence of intergenerational households.

The other results indicate that a current time shock to life expectancy will positively and significantly affect life expectancy in current time and in the next six years, if you hold all other shocks equal to zero. It will also affect productive age for periods $j = 2,3,$ positively and significantly. The impact on productive age in current time will be insignificant. The impact on the growth rate of income is significant and positive for $j = 1,2,3,4.$ The impact of a current time shock to life expectancy on real interest rate is insignificant.

5.4.1.2 Response to a Shock in Productive Age

A shock in productive age, holding all other shocks equal to zero, will only positively and significantly affect itself for the periods $j = 0,1,2,3,4,5,6$ and economic growth for periods $j = 1,3,4,5,6.$ Surprisingly, as the percentage of people in the productive age increases, gross domestic savings rates are expected to fall for periods $j = 0,1,2$ although crucially, this is insignificant.

5.4.1.3 Response to a Shock in Real Interest Rates

A one standard deviation innovation in the real rate of interest is expected to positively and significantly affect productive age in the periods $j = 2,3,4,5,6$, holding other shocks equal to zero. This will also have a significant positive impact on real interest rates in the periods $j = 0,1,2,3$. A rise in interest rates will also lead to a positive and significant change in economic growth rates for periods $j = 2,3,4,5,6$ and to a significant positive impact on gross domestic savings rates but only in the current time. Thus shocking real interest rates to increase gross domestic savings rates will only lead to current time significant results but not in the future.

5.4.1.4 Response to a Shock in Economic Growth

Holding other shocks equal to zero, a one standard deviation shock in the growth rate of the economy is expected to positively and significantly affect growth rate only in the current period. This will also positively affect gross domestic savings rates for the periods $j = 0,1,2,3$ and thereafter the relationship will be insignificant. The effect of a shock in economic growth on the remaining variables will be insignificant.

5.4.1.5 Response to a Shock in Gross Domestic Savings Rates

Lastly, a one standard deviation shock in gross domestic savings rate in current time will positively and significantly affect gross domestic savings rates for the periods $j = 0,1,2,3,4,5,6$, if all other shocks are held equal to zero. There will also be a significant relationship between a one standard deviation shock to gross domestic savings rates and productive age only for the period $j = 6$ and economic growth for periods $j = 4,5,6$.

A one standard deviation shock to gross domestic savings rates leads to no response from life expectancy in current time. Therefore, we fail to reject the null hypothesis 3. However, gross domestic savings rates will lead to increases in life expectancy and this is significant for periods $j = 1,2,3,4,5,6$. Therefore, we reject the null in hypothesis 4 and adopt the alternative that a one standard deviation shock to gross domestic savings rates will impact life expectancy in the future. This means that while the modified life cycle hypothesis is not vindicated in terms of life expectancy having a significant increase in gross domestic savings rates, there exists a positive relationship from gross domestic savings rates to life expectancy. The result can be explained in that most people in the region do not have resources to fund for their own health. Therefore, government programmes that provide health services have got the impact of dramatically improving the health status of the people without corresponding increases in savings from the citizens.

5.4.2 Future Error Variance Decomposition at Lag 2

Future error variance decomposition is also used in this study to investigate whether a current one standard deviation shock to life expectancy will influence gross domestic savings rates in future. Similarly, we also investigate whether a current one standard deviation shock to gross domestic savings rates will influence life expectancy in future. Therefore our interest is in investigating null hypotheses 2 and 4.

Table 2: Future Error Variance Decomposition at Lag Two

The percentage variation in the row variable explained by the column variable at lag 2. These are calculated for every tenth year.

STEP	VARIABLE	LEXP	PDCTAGE	RINTR	GROWTH	GDS
10	LEXP	85.912	0.501	3.785	0.358	9.444
10	PDCTAGE	8.013	73.86	11.54	0.073	6.515
10	RINTR	4.497	1.392	91.7	1.426	0.985
10	GROWTH	8.448	6.445	7.904	72.518	4.684
10	GDS	1.739	2.184	7.881	12.153	76.044
20	LEXP	67.198	4.603	9.872	1.061	17.265
20	PDCTAGE	10.879	51.847	19.983	0.688	16.602
20	RINTR	4.566	2.188	90.323	1.455	1.477
20	GROWTH	9.213	8.782	10.625	63.181	8.2
20	GDS	1.897	3.996	9.783	11.496	72.828

The results of the future error variance decomposition indicate that all variables are expected to be exogenous to their respective systems in the next twenty years. A variable is said to be exogenous if future cumulative variations in the variable can be accounted for by more than 50% by shocks to the variable itself. However, exogeneity shall not be used to determine significance in this thesis. Instead, if shocks to a variable account for 10 percent or more in future variations of another variable or itself, then the variable will be said to be significant. (see Camara, 2009)

Since shocks to life expectancy are expected to account for 1.739 percent of all variations in the gross domestic savings rates in the next ten years and 1.897 percent in the next twenty years and since shocks to gross domestic savings rates will account for over 50 percent in variations in gross domestic savings rates, we fail to reject the null in hypothesis 2.

On the other hand, whilst life expectancy would be considered as being exogenous to the PVAR system, gross domestic savings rates account for 9.44 percent in total variations in life expectancy after ten years and 17.27 percent after twenty years. Therefore, hypothesis 4 would be rejected at forecast horizon of twenty years.

5.5 Robustness Tests

5.5.1 Lag One Results

5.5.1.1 Impulse Response at Lag One

If you hold the past constant and also hold all other shocks equal to zero, a one standard deviation shock to life expectancy does not lead to a significant change in gross domestic savings rates for all periods. Therefore you accept the null that a shock to life expectancy will not significantly affect gross domestic savings rates in current time at 10 percent level of significance. You also fail to reject the second hypothesis that a one standard deviation shock to life expectancy will not significantly yield changes in gross domestic savings rates at 10 percent significance level. Thus the model results are robust to lag length one.

A one standard deviation shock to life expectancy, holding all other shocks equal to zero, will however lead insignificant changes in growth rates and thus robustness of the results do not extend to this result. The results at lag one indicate that the behaviour of life expectancy in response to a shock in itself remains the same.

Crucially, the result that was obtained at lag two that a shock to gross domestic savings rates will have a positive impact on life expectancy is maintained at lag one, the only difference is that this time this result extends for periods $j = 1, 2, 3, 4, 5, 6$. This means that we reject null hypothesis 4. However, the result pertaining to null hypothesis 3 is robust to lag length one.

5.5.1.2 Future Error Variance Decomposition at Lag One

The future error variance decomposition at lag length 1 are shown in table 3 below

Table 3: Future Error Variance Decomposition at Lag One

The percentage variation in the row variable explained by the column variable at lag 1

STEP	VARIABLE	LEXP	PDCTAGE	RINTR	GROWTH	GDS
10	LEXP	72.522	0.699	0.555	6.989	19.234
10	PDCTAGE	28.386	67.548	2.132	0.0185	1.915
10	RINTR	0.353	1.549	93.837	0.965	3.296
10	GROWTH	0.002	6.5535	2.474	89.104	1.864
10	GDS	0.853	2.004	5.857	14.707	76.58
20	LEXP	67.284	4.18	1.416	0.74	19.72
20	PDCTAGE	34.123	62.031	2.301	0.033	1.512
20	RINTR	0.355	1.555	93.754	0.978	3.357
20	GROWTH	0.063	6.859	2.463	88.622	1.993
20	GDS	1.884	2.768	5.767	14.435	75.143

The result that all variables are exogenous to the system is maintained at lag one. Shocks to life expectancy account for only 0.85 percent in total gross domestic savings rates cumulative variations after 10 years and 1.884 percent after 20 years. However, shocks to gross domestic savings rates account for 19.234 percent cumulative variations in life expectancy after ten years and 19.72 percent after twenty years. Therefore, the null hypothesis 4 is rejected for both periods ten and twenty.

5.5.2 Robustness Tests at Lag Three

5.5.2.1 Impulse Response at Lag Three

If you hold the past constant and also hold all other shocks equal to zero, a one standard deviation shock to life expectancy does not lead to a significant change in gross domestic savings rates for all periods. Therefore you accept the null that a one standard deviation shock to life expectancy will not significantly affect gross domestic savings rates in current time at 10 percent level of significance. You also fail to reject the second hypothesis that a shock to life expectancy will not significantly yield changes in gross domestic savings rates at 10 percent significance level. Thus the results are also robust to lag length three.

The results on growth rate indicate that the significance of a shock to life expectancy on economic growth is maintained only for the periods $j = 2,3$. The other interesting thing is that a shock to gross domestic savings rates will continue to have a positive and significant effect on life expectancy for periods $j = 2,3,4,5,6$. Therefore the result pertaining to null hypothesis 4 is robust to lag length three. The results pertaining to hypothesis 3 are also robust to lag length three since a one standard deviation shock to gross domestic savings rates has no impact on life expectancy.

5.5.2.2 Future Error Variance Decomposition at Lag Three

Table 4: Future Error Variance Decomposition at Lag Three

STEP	VARIABLE	LEXP	PDCTAGE	RINTR	GROWTH	GDS
10	LEXP	32.85	53.344	2.08	0.498	11.227
10	PDCTAGE	0.788	87.84	2.867	7.459	1.045
10	RINTR	0.802	7.458	84.573	4.775	2.392
10	GROWTH	1.959	28.718	3.327	61.53	4.467
10	GDS	0.832	1.955	0.909	12.673	83.63
20	LEXP	3.798	81.123	3.243	9.657	2.175
20	PDCTAGE	1.781	78.523	3.658	13.174	2.864
20	RINTR	0.76	19.952	70.468	6.559	2.261
20	GROWTH	1.933	45.181	3.85	44.567	4.469
20	GDS	0.984	3.859	0.922	12.521	81.715

The results of future error variance decomposition at lag three indicate that all but one variable are exogenous to the system. Variations in Life expectancy are expected to be explained 32 percent by life expectancy and 53 percent by productive age in the next ten years. Productive age will explain variations in life expectancy by 81 percent in the next twenty years. Economic growth also ceases to be exogenous to the system at step is equal to twenty years because it only accounts for 44 percent of all variations in itself. Productive age will account for 45 percent in all variations in the economic growth rate at this stage.

Shocks to life expectancy will only account for 0.83 percent and 0.98 percent of all variations in gross domestic savings rates for the forecast horizons ten and twenty years respectively. This implies that hypothesis 2 is rejected. However hypothesis 4 is accepted at forecast horizon twenty since gross domestic savings rates account for only 2.175 percent in the cumulative variations of life expectancy. Then the results at

lag two are robust for both impulse response analysis and future error variance decomposition. The results indicate that health will not have a significant impact on the gross domestic savings rates in the next twenty years. To the contrary, it is expected that gross domestic savings rates will significantly affect health as proxied by life expectancy at least in the next six years. These results are robust to lags one, two and three.

5.6 Conclusion

Innovation accounting has been used in this thesis to determine whether health has an impact on the gross domestic savings rate in selected SADC countries. The results indicate that innovations to life expectancy do not significantly influence gross domestic savings rate. On the contrary, it is innovations to gross domestic savings rate that positively and significantly influence life expectancy and consequently health.

CHAPTER SIX

LIMITATIONS, POLICY RECOMMENDATIONS AND CONCLUSION

6.0 Introduction

This chapter summarizes the results, states limitations of the study, policy implications of the findings and concludes the study. The Chapter is arranged as follows; Section 6.1 Summarizes the results, in Section 6.2 policy implications are presented, Section 6.3 discusses possible limitations of the study and lastly in section 6.4, the study concludes and areas for future study are specified.

6.1 Summary

This study has looked at the possible two way relationship between health and gross domestic savings rate using a panel VAR framework. The panel VAR framework adopted and implemented herein is standard as proposed by Holtz-Eakin et al (1988) and as implemented in Love and Zicchino (2006). This study differs from the Love and Zicchino study in that we implemented stationarity tests owing to small sample size and we also conducted robustness tests. A panel VAR of order 2 was implemented.

The results indicate that holding the past constant and also holding other shocks equal to zero, a one standard deviation shock to life expectancy in current time does not significantly influence gross domestic savings rate in current time although the sign is positive as expected. This then means we fail to reject the first null at 10 percent level of significance. We also fail to reject the second null at 10 percent level of significance although the expected sign is met. Innovations to life expectancy are also not expected to account for much in cumulative variations in gross domestic savings rates in the next ten to twenty years. Therefore, we also fail to reject the second null

hypothesis. Therefore, shocks to life expectancy do not significantly influence gross domestic savings rates. These results are robust to both lags one and three.

However, a shock to gross domestic savings rates will have a positive and statistically significant influence on life expectancy, holding all other shocks equal to zero and also holding the past constant. We therefore reject the fourth null although we cannot reject the third. These results are robust to both lags 1 and 3. However, shocks to gross domestic savings rates will account for significant variations in life expectancy only after twenty years.

6.2 Policy Implications

This study has found that holding all other shocks equal to zero, innovations to life expectancy are expected to have a positive but insignificant relationship with gross domestic savings rate. The future error variance decomposition also indicates variations in gross domestic savings rate will be accounted for by the variable itself. This means that gross domestic savings rate is exogenous to the system. The only way to increase gross domestic savings rate is to shock gross domestic savings rate.

The study has also found that it is actually the gross domestic savings rates that significantly influence life expectancy. Increases in gross domestic savings rate are expected to improve the health status of individuals in the region. This scenario might mean that usage of gross domestic savings by governments to fund health might be justified. Although there is cyclicality between health and savings in the region, this is not significant. Funding health using gross domestic savings should not be expected to eventually significantly influence the rates of savings.

6.3 Limitations of the Study

The study is limited in several aspects. Firstly, it uses one aspect of the savings rate which is the gross domestic savings rate. This means that gross national savings rate have not been considered. The inclusion of gross national savings rate would have been appropriate because resources in form of savings are not limited to those sourced from within the economy but also from outside. It is also possible that not all gross domestic savings are available for use in a particular country but rather are used by foreign countries.

The second limitation is that this study has employed the commonly used measure of productive age (14-64 years). While this gives an advantage of ease of comparability, there is a potential that we have included a significant proportion of individuals who are still in school and therefore are not productive. The third limitation of the study concerns choice of the lag length. The choice of the lag length has been arbitrarily set at 2. Whereas, this helps us to avoid using methods that might not take into account individual heterogeneity, the specific optimal model cannot be chosen this way. However, we performed robustness tests to check if the arbitrary choice of model order does not negatively impact the study. Also, the life cycle demography hypothesis is generally regarded as not the best in poor countries because the micro foundations of the model might not be met at household level. However, usage of the model has been in an atheoretic context and because of intergenerational households and transfers, usage of the life cycle demography hypothesis is appropriate.

The last limitation concerns software for implementing the study. The study has used a user written programme to implement the PVAR. Although, we have implemented the standard PVAR, we could not do additional tests because the programme could not store estimates. For instance, panel autocorrelation tests could have been performed to ascertain whether it is possible to impose the strict condition of no autocorrelation. The model has also been estimated at 10 percent level of significance because of software limitations.

6.4 Conclusion and Areas for Future Research

We have used innovation accounting to determine the possible effects of health on gross domestic savings rates in selected SADC countries. The theoretical basis was drawn from the life cycle demography hypothesis that includes health. 5 percent error bands were developed using Monte Carlo analysis. The general finding is that innovations to health are not expected to significantly gross domestic savings rates at 10 percent level of significance. However, innovations to gross domestic savings rates are expected to account for significant changes in life expectancy, holding all other innovations equal to zero.

The Research question investigated herein can be further investigated by including gross domestic product or per capita income. (Bloom et al, 2003; Kwack and Lee,

2005). The question of causality between health and savings rates can also be investigated using instrumental variables in a pooled OLS or GMM setting. You could also use gross national savings rates to capture other dynamics of health or both measures of savings rates. You can also use a PVAR that uses historical ordering rather than Cholesky decomposition or no ordering restrictions to obtain generalised impulse response functions. Lastly, you can use other measures of health to determine the possible impact of health on the savings rates in the SADC.

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APPENDICES

Appendix 1: Harris Tzavalis Unit Root Test

H_o: Panels contain unit roots

H_a: Panels are stationary

VARIABLE	STATISTIC	Z	P-VALUE	CONCLUSION
LEXP	0.0000	-36.9865	0.0000*	Reject H_o
PDCTAGE	0.0000	-36.9865	0.0000*	Reject H_o
RINTR	0.0000	-36.9865	0.0000*	Reject H_o
GROWTH	0.0000	-36.9865	0.0000*	Reject H_o
GDS	0.0000	-36.9865	0.0000*	Reject H_o

NOTE: * denotes statistical significance at 1%.

Panel means are removed to avoid bias. Cross sectional means are also removed. The small sample adjustment to T is applied.

Appendix 2 - Impulse Response Tables

These are for lags 1, 2 and 3. 5% error bands are computed using Monte Carlo analysis with 10000 repetitions. For the entire tables LEB denotes lower error band. Likewise, HEB denotes high error band. When LEB< β <HEB does not contain a zero, then the variable is said to be significant at 10% level. Lag 2 results are in bold. The impulse responses are orthogonalised

Appendix 2.1- Impulse Response to a One Standard Deviation Shock in Life Expectancy

		Lag 1			**Lag 2**			Lag 3		
STEP	VARIABLE	L EB	β	HEB	**L EB**	β	**HEB**	L EB	β	HEB
0	Lexp	0.474	0.529	0.579	**0.239**	**0.267**	**0.292**	0.122	0.137	0.150
1	Lexp	0.467	0.528	0.585	**0.411**	**0.47**	**0.525**	0.215	0.244	0.271
2	Lexp	0.453	0.525	0.594	**0.514**	**0.615**	**0.725**	0.309	0.309	0.393
3	Lexp	0.436	0.52	0.605	**0.555**	**0.715**	**0.905**	0.285	0.339	0.408
4	Lexp	0.418	0.517	0.618	**0.545**	**0.776**	**1.071**	0.275	0.341	0.393
5	Lexp	0.4	0.513	0.634	**0.501**	**0.807**	**1.24**	0.24	0.318	0.406
6	Lexp	0.381	0.51	0.653	**0.431**	**0.815**	**1.409**	0.275	0.28	0.367
0	Pdctage	-0.113	-0.091	-0.067	**-0.001**	**0.004**	**0.023**	-0.003	0.0	0.0
1	Pdctage	-0.117	-0.093	-0.067	**0**	**0.011**	**0.038**	-0.008	0.0	0.009
2	Pdctage	-0.122	-0.095	-0.067	**0.001**	**0.02**	**0.041**	-0.014	0.003	0.02
3	Pdctage	-0.129	-0.098	-0.066	**0.001**	**0.031**	**0.063**	-0.22	0.08	0.038
4	Pdctage	-0.137	-0.1	-0.064	**-0.001**	**0.41**	**0.088**	-0.032	0.14	0.061
5	Pdctage	-0.146	-0.103	-0.063	**-0.004**	**0.052**	**0.116**	-0.044	0.023	0.09
6	Pdctage	-0.155	-0.106	-0.059	**-0.008**	**0.062**	**0.147**	-0.055	0.34	0.125
0	Rintr	-1.521	-0.425	0.595	**-1.393**	**-0.409**	**0.588**	-0.666	0.258	1.198
1	Rintr	-0.971	-0.263	0.423	**-1.654**	**-0.728**	**0.22**	-0.600	-0.123	0.39
2	Rintr	-0.72	-0.156	0.328	**-1.826**	**-0.8**	**0.316**	-0.834	-0.345	0.207
3	Rintr	-0.593	-0.088	0.339	**-1.947**	**-0.777**	**0.436**	-0.895	-0.389	0.12
4	Rintr	-0.54	-0.047	0.375	**-1.959**	**-0.686**	**0.589**	-0.703	-0.221	0.284
5	Rintr	-0.517	-0.022	0.406	**-1.925**	**-0.56**	**0.715**	-0.563	-0.098	0.388
6	Rintr	-0.5	-0.088	0.437	**-1.877**	**-0.429**	**0.812**	-0.445	0.13	0.512
0	Growth	-0.486	-0.046	0.575	**-0.098**	**0.43**	**0.935**	-0.569	-0.089	0.392
1	Growth	-0.159	-0.019	0.117	**0.085**	**0.51**	**0.94**	0.081	0.273	0.467
2	Growth	-0.116	-0.008	0.098	**0.184**	**0.504**	**0.831**	0.08	0.321	0.549
3	Growth	-0.113	-0.009	0.088	**0.077**	**0.447**	**0.817**	0.065	0.262	0.476
4	Growth	-0.115	-0.009	0.091	**0.057**	**0.404**	**0.833**	-0.021	0.18	0.388
5	Growth	-0.118	-0.01	0.09	**-0.025**	**0.364**	**0.882**	-0.065	0.14	0.396
6	Growth	-0.123	-0.012	0.093	**-0.074**	**0.333**	**0.954**	-0.144	0.112	0.397
0	Gds	-0.692	-0.146	0.401	**-0.229**	**0.32**	**0.861**	-0.24	0.272	0.782
1	Gds	-0.618	-0.159	0.285	**-0.371**	**0.3**	**0.954**	-0.126	0.275	0.671
2	Gds	-0.589	-0.171	0.209	**-0.554**	**0.311**	**1.146**	-0.307	0.147	0.587
3	Gds	-0.59	-0.177	0.187	**-0.728**	**0.299**	**1.214**	-0.386	0.129	0.612
4	Gds	-0.613	-0.181	0.189	**-0.865**	**0.275**	**1.253**	-0.38	0.163	0.647
5	Gds	-0.643	-0.182	0.201	**-0.981**	**0.245**	**1.298**	-0.427	0.149	0.649
6	Gds	-0.664	-0.184	0.213	**-1.057**	**0.215**	**1.353**	-0.499	0.103	0.616

Appendix 2.2-Impulse Response to a One Standard Deviation Shock in Productive Age

Lag 1 **Lag 2** Lag 3

STEP	VARIABLE	LEB	β	HEB	**LEB**	β	**HEB**	LEB	β	HEB
0	Lexp	0	0	0	**0.0**	**0.0**	**0.0**	0	0	0
1	Lexp	-0.029	0.009	0.044	**-0.024**	**0.002**	**0.03**	-0.015	0	0.016
2	Lexp	-0.048	-0.001	0.053	**-0.068**	**0.006**	**0.086**	-0.055	-0.01	0.037
3	Lexp	-0.075	-0.012	0.06	**-0.123**	**0.012**	**0.17**	-0.128	-0.043	0.047
4	Lexp	-0.104	-0.025	0.0645	**-0.182**	**0.021**	**0.276**	-0.234	-0.098	0.047
5	Lexp	-0.133	-0.039	0.067	**-0.238**	**0.034**	**0.402**	-0.376	-0.179	0.03
6	Lexp	-0.161	-0.053	0.068	**-0.289**	**0.049**	**0.553**	-0.549	-0.284	-0.004
0	Pdctage	0.14	0.157	0.171	**0.033**	**0.038**	**0.041**	0.017	0.019	0.021
1	Pdctage	0.139	0.158	0.175	**0.064**	**0.073**	**0.08**	0.05	0.056	0.062
2	Pdctage	0.137	0.159	0.178	**0.091**	**0.105**	**0.117**	0.095	0.11	0.124
3	Pdctage	0.135	0.159	0.182	**0.112**	**0.132**	**0.152**	0.149	0.178	0.206
4	Pdctage	0.131	0.158	0.186	**0.129**	**0.156**	**0.186**	0.209	0.257	0.309
5	Pdctage	0.128	0.158	0.19	**0.141**	**0.177**	**0.218**	0.269	0.345	0.435
6	Pdctage	0.124	0.157	0.195	**0.148**	**0.193**	**0.251**	0.325	0.439	0.584
0	Rintr	-2.077	-1.038	0.056	**-0.896**	**0.106**	**1.095**	-0.826	0.12	1.072
1	Rintr	-1.187	-0.397	0.392	**-0.885**	**-0.166**	**0.593**	-0.693	-0.001	0.71
2	Rintr	-0.903	-0.321	0.141	**-0.855**	**-0.132**	**0.737**	-1.392	-0.485	0.42
3	Rintr	-0.7	-0.221	0.13	**-1.181**	**-0.319**	**0.663**	-1.467	-0.337	0.846
4	Rintr	-0.588	-0.16	0.134	**-1.218**	**-0.325**	**0.717**	-2.223	-0.761	0.689
5	Rintr	-0.508	-0.117	0.16	**-1.378**	**-0.371**	**0.716**	-2.404	-0.729	0.985
6	Rintr	-0.454	-0.087	0.181	**-1.461**	**-0.373**	**0.731**	-2.853	-0.803	1.147
0	Growth	0.4341	0.967	0.236	**-0.726**	**-0.203**	**0.313**	0.395	0.872	1.335
1	Growth	-0.272	-0.006	0.261	**0.436**	**0.436**	**0.737**	-0.298	0.061	0.399
2	Growth	0.025	0.118	0.188	**-0.035**	**0.293**	**0.577**	0.086	0.420	0.793
3	Growth	-0.007	0.098	0.19	**0.101**	**0.378**	**0.661**	0.042	0.513	1.015
4	Growth	0.014	0.096	0.184	**0.034**	**0.35**	**0.667**	0.191	0.634	1.244
5	Growth	0.01	0.093	0.183	**0.058**	**0.358**	**0.754**	0.147	0.729	1.487
6	Growth	0.012	0.09	0.183	**0.019**	**0.351**	**0.812**	0.165	0.799	1.790
0	Gds	-0.136	0.406	0.942	**-0.940**	**-0.392**	**0.163**	-0.502	0.016	0.0.538
1	Gds	-0.044	0.401	0.847	**-0.678**	**-0.187**	**0.286**	-0.672	-0.095	0.515
2	Gds	-0.045	0.316	0.7	**-0.622**	**-0.011**	**0.531**	-1.044	-0.201	0.704
3	Gds	-0.04	0.268	0.611	**-0.587**	**0.116**	**0.738**	-1.397	-0.175	0.086
4	Gds	-0.043	0.234	0.56	**-0.589**	**0.213**	**0.893**	-1.884	-0.295	0.31
5	Gds	-0.049	0.211	0.525	**-0.594**	**0.277**	**1.027**	-2.291	-0.319	1.648
6	Gds	-0.056	0.195	0.514	**-0.602**	**0.321**	**1.154**	-2.668	-0.301	2.026

Appendix 2.3-Impulse Response to a One Standard Deviation Shock in Real Interest Rate

		Lag 1			**Lag 2**			Lag 3		
STEP	VARIABLE	L EB	β	HEB	**LEB**	β	**HEB**	L EB	β	HEB
0	Lexp	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Lexp	-0.052	-0.008	0.038	**-0.016**	**0.004**	**0.025**	-0.025	-0.009	0.08
2	Lexp	-0.072	-0.001	0.079	**-0.178**	**0.032**	**0.086**	-0.48	-0.013	0.022
3	Lexp	-0.08	0.012	0.123	**-0.024**	**0.065**	**0.174**	-0.74	-0.02	0.034
4	Lexp	-0.084	0.027	0.166	**-0.035**	**0.102**	**0.282**	-0.104	-0.03	0.042
5	Lexp	-0.083	0.041	0.207	**-0.047**	**0.137**	**0.406**	-0.14	-0.045	0.047
6	Lexp	-0.082	0.053	0.242	**-0.062**	**0.171**	**0.545**	-0.181	-0.063	0.047
0	Pdctage	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Pdctage	-0.032	-0.017	-0.001	**-0.019**	**0.004**	**0.01**	0.001	0.004	0.07
2	Pdctage	-0.052	-0.026	-0.001	**0.001**	**0.014**	**0.027**	0.005	0.014	0.026
3	Pdctage	-0.066	-0.03	0.001	**0.006**	**0.027**	**0.048**	0.008	0.026	0.045
4	Pdctage	-0.074	-0.032	0.003	**0.012**	**0.041**	**0.073**	0.01	0.041	0.073
5	Pdctage	-0.08	-0.032	0.005	**0.017**	**0.057**	**0.101**	0.011	0.057	0.109
6	Pdctage	-0.084	-0.032	0.008	**0.023**	**0.072**	**0.132**	0.011	0.076	0.152
0	Rintr	6.805	7.648	8.301	**6.125**	**6.913**	**7.517**	5.622	6.397	6.994
1	Rintr	2.908	4.463	6.014	**1.118**	**2.825**	**4.49**	0.18	1.58	2.982
2	Rintr	1.069	2.529	4.515	**1.066**	**2.113**	**3.634**	0.4	1.094	2.043
3	Rintr	0.36	1.398	3.342	**0.158**	**1.206**	**2.754**	-0.578	0.274	1.098
4	Rintr	0.073	0.743	2.43	**-0.245**	**0.628**	**2.123**	-0.435	0.145	0.817
5	Rintr	-0.083	0.371	1.741	**-0.533**	**0.288**	**1.655**	-0.797	-0.085	0.507
6	Rintr	-0.221	0.166	1.238	**-0.806**	**0.043**	**1.322**	-0.469	0.09	0.731
0	Growth	-0.004	0.52	1.032	**-0.093**	**0.428**	**0.957**	-0.373	0.105	0.575
1	Growth	-0.201	0.247	0.706	**-0.181**	**0.276**	**0.734**	-0.345	0.094	0.547
2	Growth	-0.078	0.172	0.516	**0.053**	**0.527**	**1.015**	-0.418	0.002	0.404
3	Growth	-0.067	0.11	0.423	**0.069**	**0.37**	**0.776**	0.109	0.558	0.992
4	Growth	-0.053	0.07	0.338	**0.12**	**0.408**	**0.822**	-0.218	0.101	0.416
5	Growth	-0.048	0.044	0.273	**0.095**	**0.364**	**0.821**	0.062	0.311	0.657
6	Growth	-0.045	0.027	0.223	**0.094**	**0.361**	**0.867**	-0.123	0.167	0.51
0	Gds	0.16	0.714	1.233	**0.038**	**0.596**	**1.4**	-0.37	0.164	0.675
1	Gds	0.046	0.73	1.401	**-0.268**	**0.451**	**1.179**	-0.821	-0.157	0.506
2	Gds	-0.102	0.646	1.538	**-0.147**	**0.589**	**1.426**	-1.182	-0.414	0.347
3	Gds	-0.15	0.536	1.519	**-0.191**	**0.601**	**1.54**	-0.857	-0.024	0.704
4	Gds	-0.16	0.424	1.392	**-0.199**	**0.597**	**1.593**	-0.809	0.024	0.735
5	Gds	-0.144	0.324	1.235	**-0.223**	**0.575**	**1.579**	-0.716	0.63	0.731
6	Gds	-0.127	0.24	1.054	**-0.244**	**0.543**	**1.556**	-0.628	0.142	0.825

Appendix 2.4- Impulse Response to a One Standard Deviation Shock in Economic Growth Rate

		Lag 1			**Lag 2**			Lag 3		
STEP	VARIABLE	L EB	β	HEB	**LEB**	β	**HEB**	L EB	β	HEB
0	Lexp	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Lexp	-0.052	-0.008	0.038	**-0.016**	**0.004**	**0.025**	-0.025	-0.009	0.08
2	Lexp	-0.072	-0.001	0.079	**-0.178**	**0.032**	**0.086**	-0.48	-0.013	0.022
3	Lexp	-0.08	0.012	0.123	**-0.024**	**0.065**	**0.174**	-0.74	-0.02	0.034
4	Lexp	-0.084	0.027	0.166	**-0.035**	**0.102**	**0.282**	-0.104	-0.03	0.042
5	Lexp	-0.083	0.041	0.207	**-0.047**	**0.137**	**0.406**	-0.14	-0.045	0.047
6	Lexp	-0.082	0.053	0.242	**-0.062**	**0.171**	**0.545**	-0.181	-0.063	0.047
0	Pdctage	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Pdctage	-0.032	-0.017	-0.001	**-0.019**	**0.004**	**0.01**	0.001	0.004	0.07
2	Pdctage	-0.052	-0.026	-0.001	**0.001**	**0.014**	**0.027**	0.005	0.014	0.026
3	Pdctage	-0.066	-0.03	0.001	**0.006**	**0.027**	**0.048**	0.008	0.026	0.045
4	Pdctage	-0.074	-0.032	0.003	**0.012**	**0.041**	**0.073**	0.01	0.041	0.073
5	Pdctage	-0.08	-0.032	0.005	**0.017**	**0.057**	**0.101**	0.011	0.057	0.109
6	Pdctage	-0.084	-0.032	0.008	**0.023**	**0.072**	**0.132**	0.011	0.076	0.152
0	Rintr	6.805	7.648	8.301	**6.125**	**6.913**	**7.517**	5.622	6.397	6.994
1	Rintr	2.908	4.463	6.014	**1.118**	**2.825**	**4.49**	0.18	1.58	2.982
2	Rintr	1.069	2.529	4.515	**1.066**	**2.113**	**3.634**	0.4	1.094	2.043
3	Rintr	0.36	1.398	3.342	**0.158**	**1.206**	**2.754**	-0.578	0.274	1.098
4	Rintr	0.073	0.743	2.43	**-0.245**	**0.628**	**2.123**	-0.435	0.145	0.817
5	Rintr	-0.083	0.371	1.741	**-0.533**	**0.288**	**1.655**	-0.797	-0.085	0.507
6	Rintr	-0.221	0.166	1.238	**-0.806**	**0.043**	**1.322**	-0.469	0.09	0.731
0	Growth	-0.004	0.52	1.032	**-0.093**	**0.428**	**0.957**	-0.373	0.105	0.575
1	Growth	-0.201	0.247	0.706	**-0.181**	**0.276**	**0.734**	-0.345	0.094	0.547
2	Growth	-0.078	0.172	0.516	**0.053**	**0.527**	**1.015**	-0.418	0.002	0.404
3	Growth	-0.067	0.11	0.423	**0.069**	**0.37**	**0.776**	0.109	0.558	0.992
4	Growth	-0.053	0.07	0.338	**0.12**	**0.408**	**0.822**	-0.218	0.101	0.416
5	Growth	-0.048	0.044	0.273	**0.095**	**0.364**	**0.821**	0.062	0.311	0.657
6	Growth	-0.045	0.027	0.223	**0.094**	**0.361**	**0.867**	-0.123	0.167	0.51
0	Gds	0.16	0.714	1.233	**0.038**	**0.596**	**1.4**	-0.37	0.164	0.675
1	Gds	0.046	0.73	1.401	**-0.268**	**0.451**	**1.179**	-0.821	-0.157	0.506
2	Gds	-0.102	0.646	1.538	**-0.147**	**0.589**	**1.426**	-1.182	-0.414	0.347
3	Gds	-0.15	0.536	1.519	**-0.191**	**0.601**	**1.54**	-0.857	-0.024	0.704
4	Gds	-0.16	0.424	1.392	**-0.199**	**0.597**	**1.593**	-0.809	0.024	0.735
5	Gds	-0.144	0.324	1.235	**-0.223**	**0.575**	**1.579**	-0.716	0.63	0.731
6	Gds	-0.127	0.24	1.054	**-0.244**	**0.543**	**1.556**	-0.628	0.142	0.825

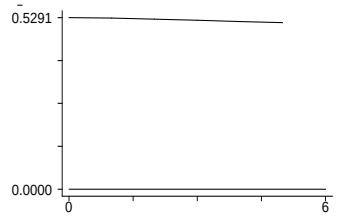
Appendix 2.5- Impulse Response to a One Standard Deviation Shock in Gross Domestic Savings Rate

		Lag 1			**Lag 2**			Lag 3		
STEP	VARIABLE	L EB	β	HEB	**L EB**	β	**HEB**	LEB	β	HEB
0	Lexp	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Lexp	0.045	0.106	0.163	**-0.01**	**0.03**	**0.07**	-0.012	0.005	0.022
2	Lexp	0.086	0.188	0.283	**0.011**	**0.08**	**0.149**	-0.007	0.033	0.07
3	Lexp	0.109	0.245	0.373	**0.039**	**0.134**	**0.237**	0.023	0.082	0.137
4	Lexp	0.122	0.283	0.44	**0.065**	**0.188**	**0.332**	0.059	0.135	0.207
5	Lexp	0.125	0.307	0.493	**0.083**	**0.237**	**0.431**	0.089	0.177	0.268
6	Lexp	0.121	0.321	0.534	**0.093**	**0.279**	**0.538**	0.107	0.206	0.319
0	Pdctage	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Pdctage	-0.006	0.011	0.027	**-0.009**	**-0.002**	**0.004**	-0.004	-0.001	0.002
2	Pdctage	-0.009	0.019	0.048	**-0.011**	**0.002**	**0.014**	-0.008	0.001	0.01
3	Pdctage	-0.012	0.025	0.065	**-0.011**	**0.011**	**0.03**	-0.014	0.006	0.025
4	Pdctage	-0.015	0.029	0.079	**-0.008**	**0.022**	**0.049**	-0.022	0.014	0.048
5	Pdctage	-0.018	0.031	0.089	**-0.005**	**0.036**	**0.071**	-0.031	0.025	0.079
6	Pdctage	-0.022	0.033	0.098	**-0.001**	**0.05**	**0.094**	-0.044	0.039	0.117
0	Rintr	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Rintr	-1.462	-0.7	0.063	**-1.275**	**-0.497**	**0.293**	-1.426	-0.641	0.138
2	Rintr	-1.921	-0.81	0.19	**-1.151**	**-0.174**	**0.806**	-0.829	0.153	1.073
3	Rintr	-2.057	-0.792	0.225	**-1.161**	**-0.096**	**0.874**	-0.907	-0.054	0.726
4	Rintr	-1.963	-0.07	0.248	**-1.149**	**-0.191**	**0.669**	-1.161	-0.481	0.262
5	Rintr	-1.787	-0.579	0.258	**-1.113**	**-0.204**	**0.572**	-0.785	-0.165	0.496
6	Rintr	-1.571	-0.466	0.262	**-1.135**	**-0.258**	**0.46**	-1.183	-0.486	0.091
0	Growth	-1.	0.	0.0	**0.0**	**0.0**	**0.0**	0.0	0.0	0.0
1	Growth	-0.019	0.37	0.752	**-0.727**	**-0.221**	**0.286**	-0.666	-0.25	0.174
2	Growth	-0.021	0.228	0. 52	**-0.103**	**0.286**	**0.67**	0.179	0.684	1.168
3	Growth	-0.021	0.184	0. 471	**-0.049**	**0.217**	**0.534**	-0.729	-0.22	0.244
4	Growth	-0.026	0.146	0. 408	**0.084**	**0.326**	**0.637**	-0.184	0.076	0.411
5	Growth	-0.027	0.12	0. 365	**0.083**	**0.323**	**0.636**	-0.22	0.203	0.497
6	Growth	-0.029	0.101	0. 333	**0.098**	**0.344**	**0.709**	-0.118	0.17	0.51
0	Gds	3.174	3.614	3. 912	**3.183**	**3.637**	**3.94**	3.041	3.488	3.786
1	Gds	2.061	2.638	3. 142	**1.678**	**2.415**	**3.122**	1.547	2.21	2.807
2	Gds	1.235	1.944	2. 706	**1.109**	**1.841**	**2.747**	0.936	1.679	2.485
3	Gds	0.695	1.418	2.343	**0.605**	**1.425**	**2.489**	0.733	1.458	2.272
4	Gds	0.358	1.029	2.032	**0.39**	**1.135**	**2.281**	0.402	1.092	2.00
5	Gds	0.149	0.741	1.761	**0.282**	**0.929**	**2.082**	0.33	0.962	1.841
6	Gds	0.015	0.531	1.533	**0.198**	**7760.**	**1.938**	0.065	0.694	1.615

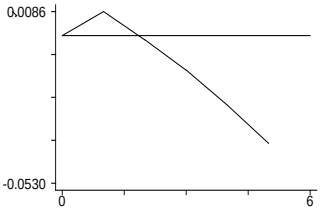
Appendix 3: Impulse Response Graphs

NOTE: Error bands are omitted in the graphs for a clear shape. The impulse responses are orthogonalised.

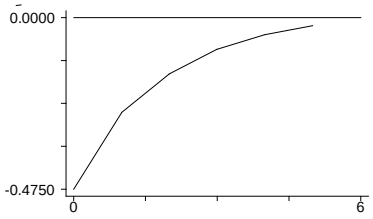
Appendix 3.1 Impulse Response at Lag Length 1 (Each shock to a variable is one standard deviation)



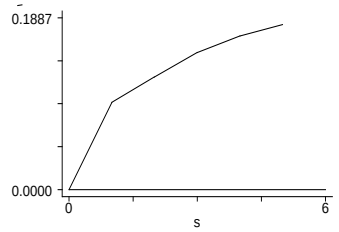
response of lexp to lexp shock



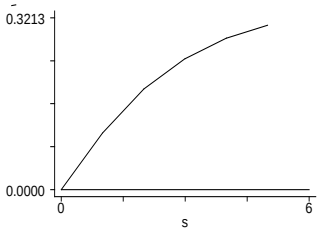
response of lexp to pdctage shock



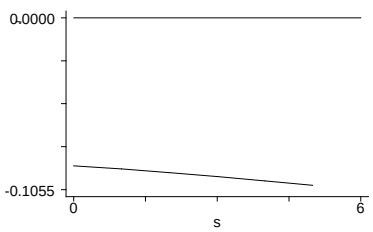
response of rintr to lexp shock



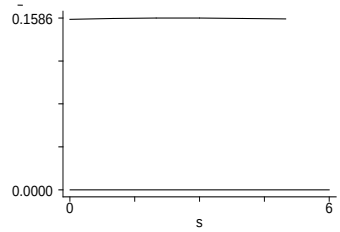
response of lexp to growth shock



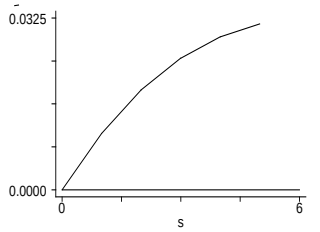
response of lexp to gds shock



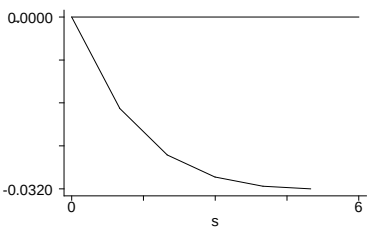
response of pdctage to lexp shock



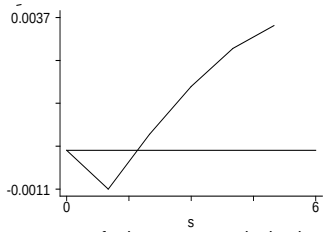
response of pdctage to pdctage shock



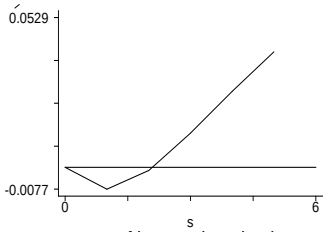
response of pdctage to gds shock



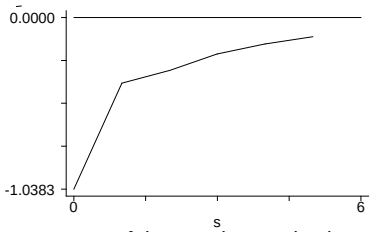
response of pdctage to rintr shock



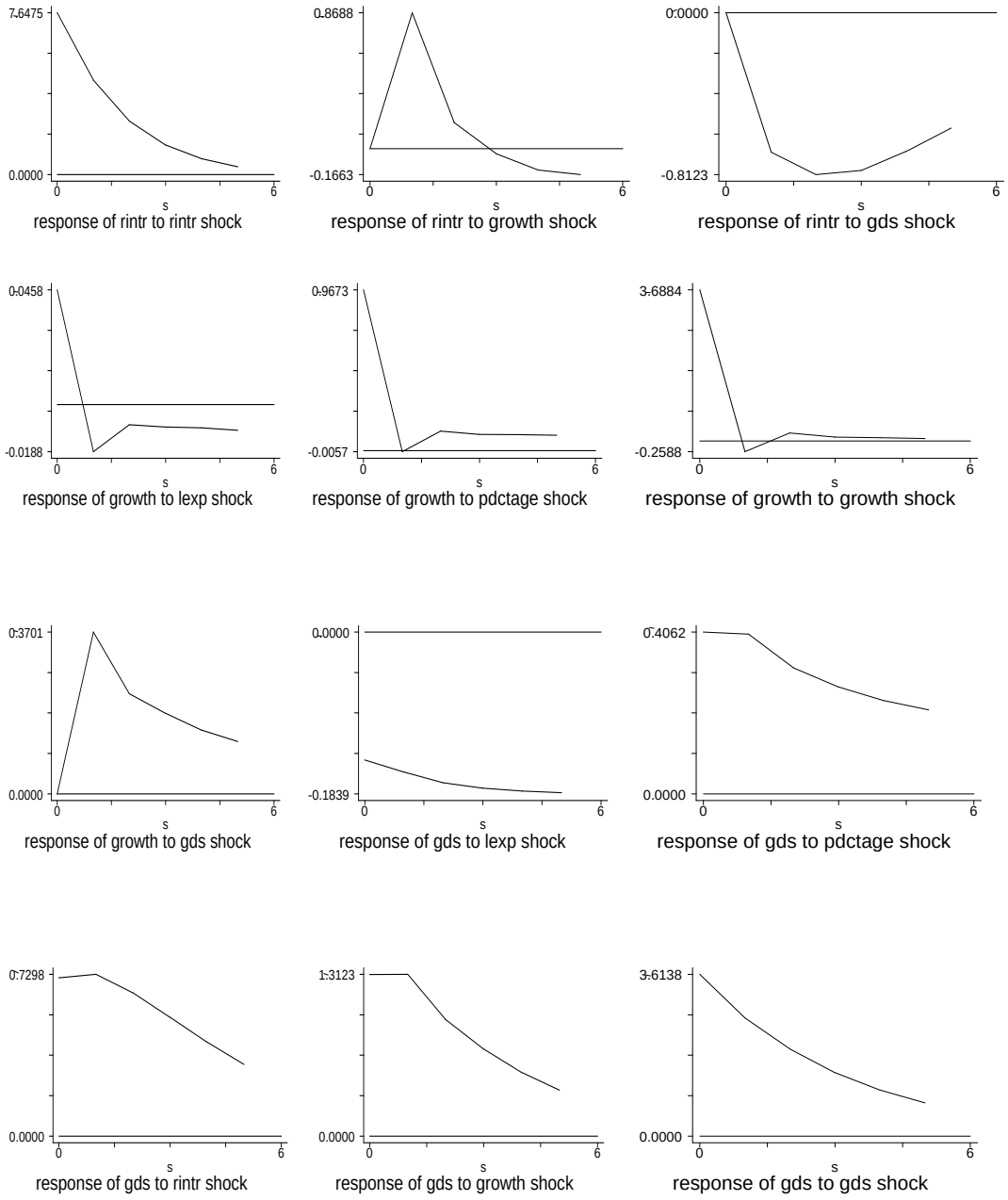
response of pdctage to growth shock



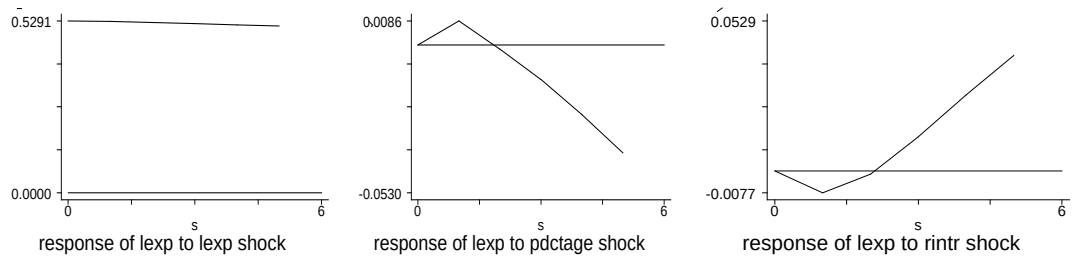
response of lexp to rintr shock

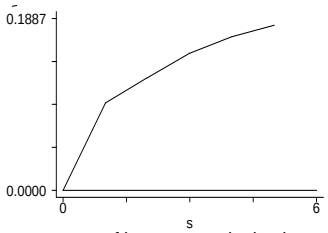


response of rintr to pdctage shock

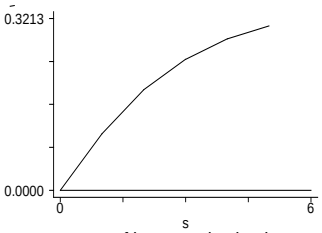


Appendix 3.2: Impulse Response at Lag Length 2

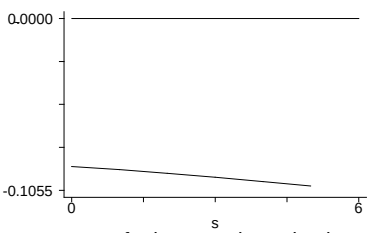




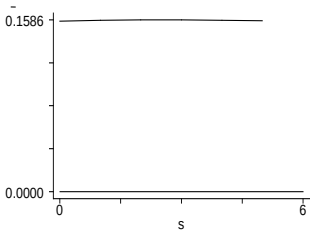
response of lexp to growth shock



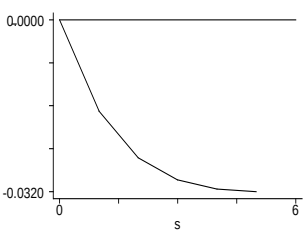
response of lexp to gds shock



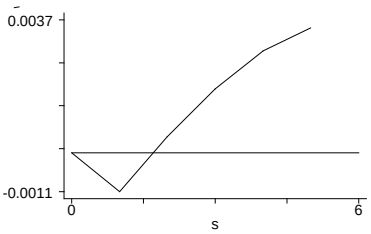
response of pdctage to lexp shock



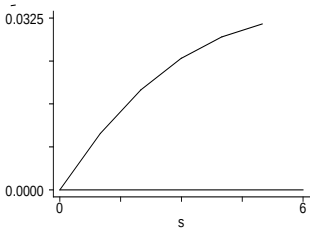
response of pdctage to pdctage shock



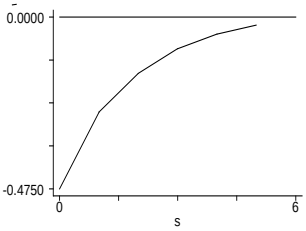
response of pdctage to rintr shock



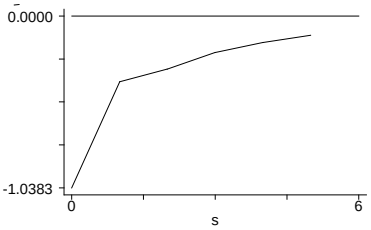
response of pdctage to growth shock



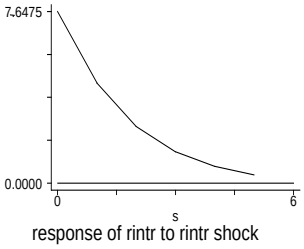
response of pdctage to gds shock



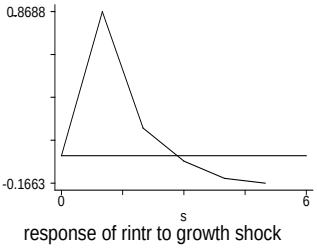
response of rintr to lexp shock



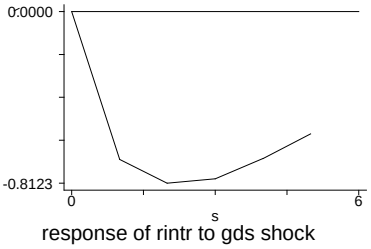
response of rintr to pdctage shock



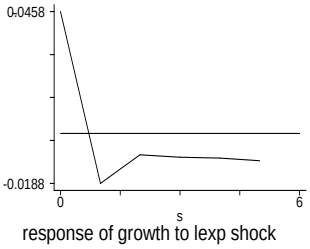
response of rintr to rintr shock



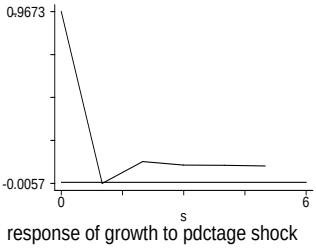
response of rintr to growth shock



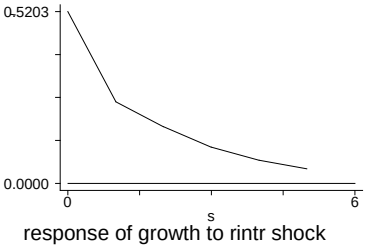
response of rintr to gds shock



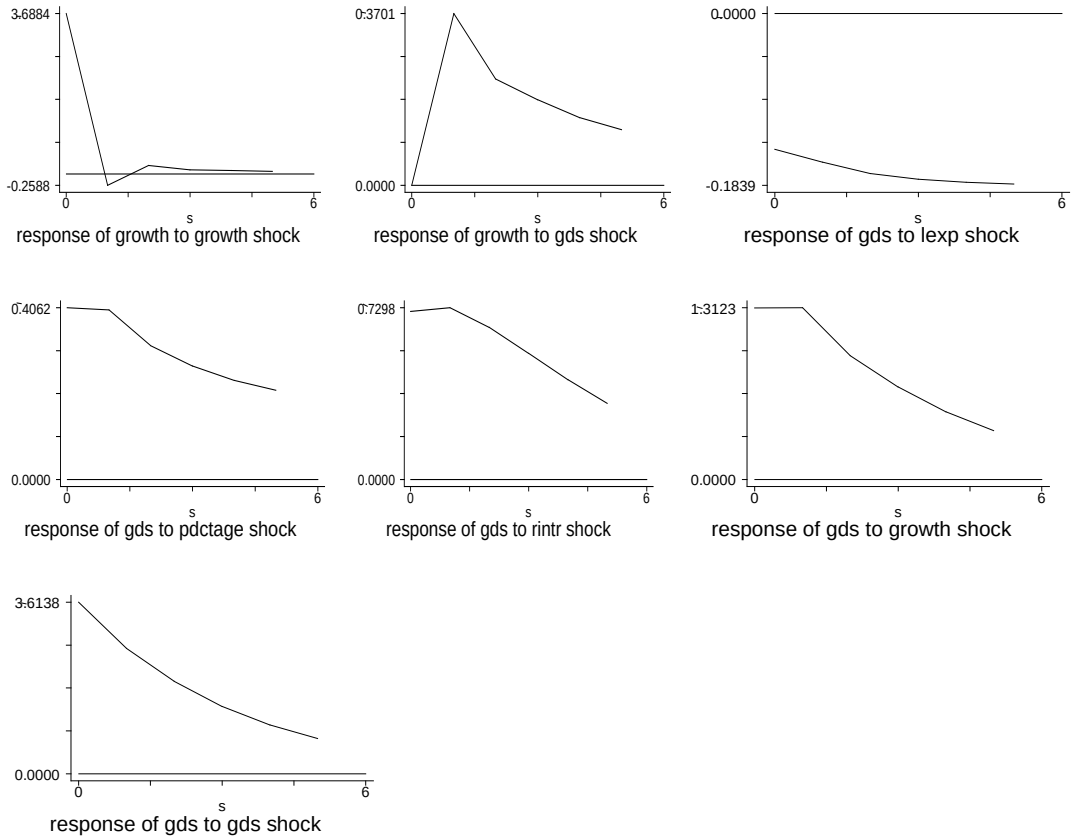
response of growth to lexp shock



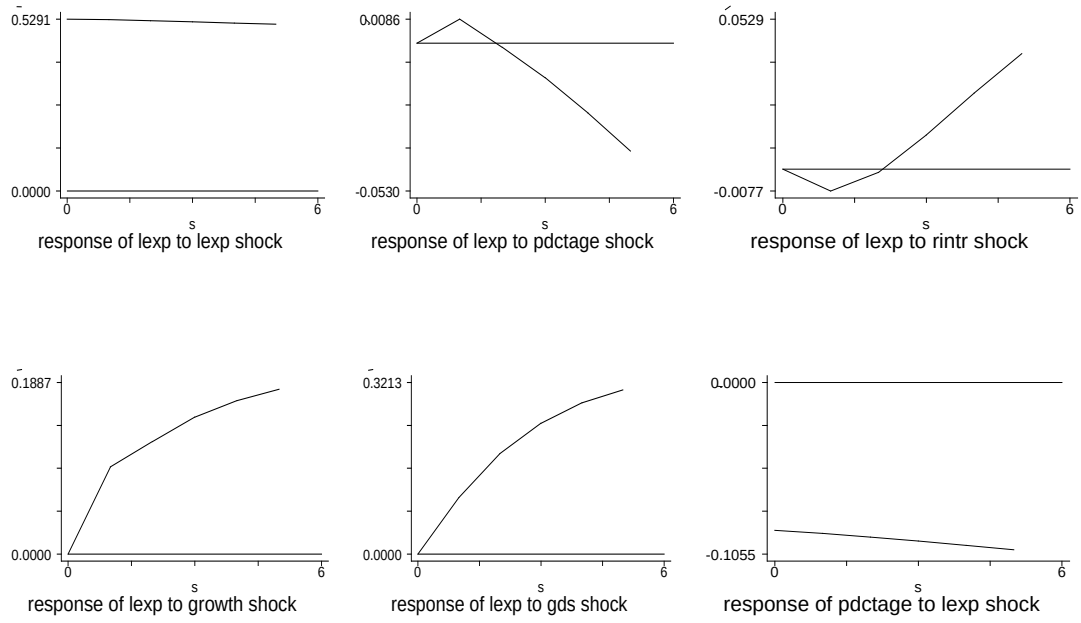
response of growth to pdctage shock

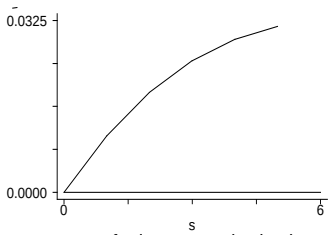


response of growth to rintr shock

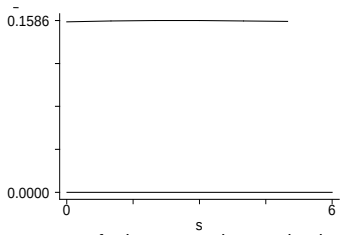


Appendix 3.3: Impulse Response at Lag Length 3

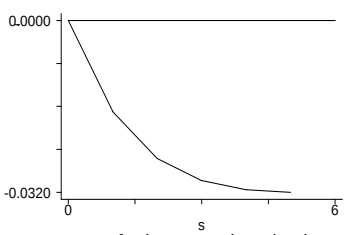




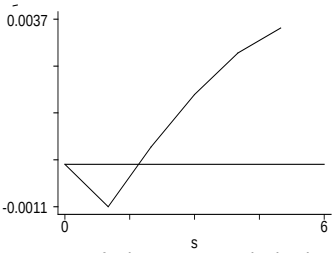
response of pdctage to gds shock



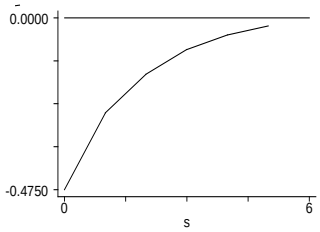
response of pdctage to pdctage shock



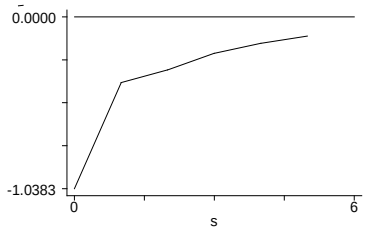
response of pdctage to rintr shock



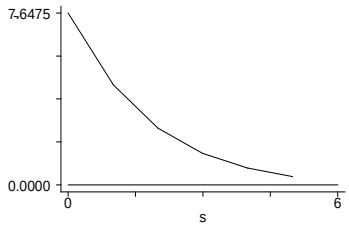
response of pdctage to growth shock



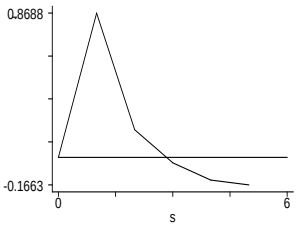
response of rintr to lexp shock



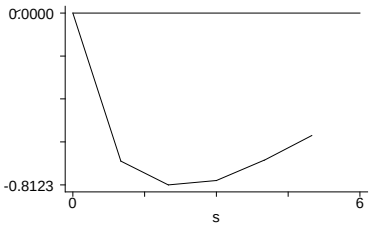
response of rintr to pdctage shock



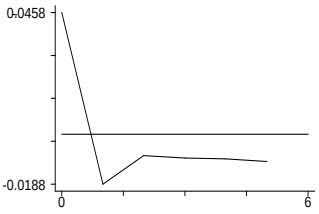
response of rintr to rintr shock



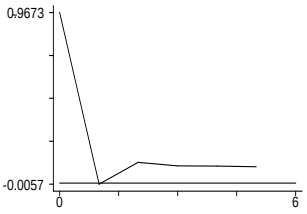
response of rintr to growth shock



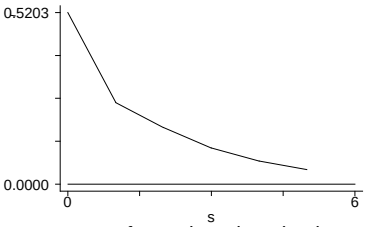
response of rintr to gds shock



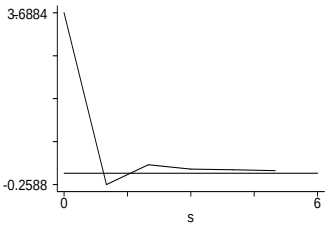
response of growth to lexp shock



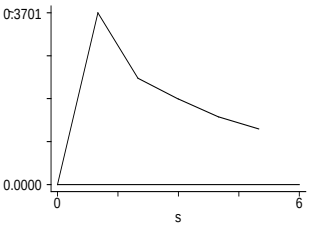
response of growth to pdctage shock



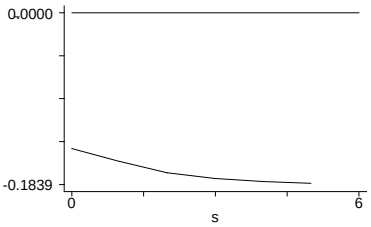
response of growth to rintr shock



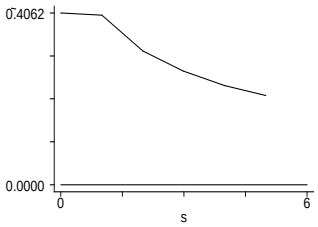
response of growth to growth shock



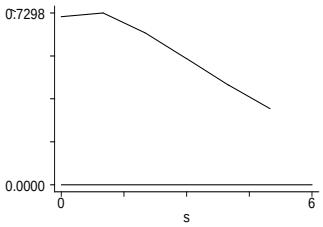
response of growth to gds shock



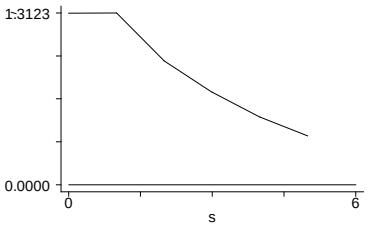
response of gds to lexp shock



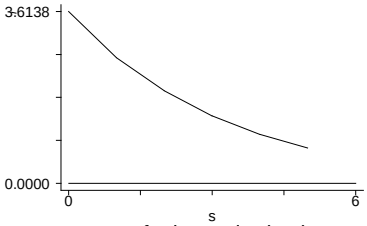
response of gds to pdctage shock



response of gds to rintr shock



response of gds to growth shock



response of gds to gds shock