

UNIVERSITY OF KWAZULU-NATAL

CONSUMPTION AND HOUSE PRICES IN SOUTH AFRICA

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DECLARATION

I, **December Jacob Twala** declare that:

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ABSTRACT

Many countries such as Australia, Ireland, Netherlands, United Kingdom (UK), Spain, United States of America (USA) and South Africa (SA) among others have experienced an increase in housing prices, since the late 1990s. In SA, the abrupt increase in residential property prices, particularly during the period 1999 to 2007, resulted in an improvement in the level of households' net wealth position. Empirical investigations, mainly from developed countries, provide evidence indicating that a house price increase has a significant impact on the households' wealth, and thus house price gains increase housing collateral for homeowners which make it possible for them to take out equity in the form of refinancing or selling of the house to finance consumption.

With the above in mind, this study investigates the relationship between aggregate expenditure on consumption by households and residential house prices in South Africa. Following the permanent-income/lifecycle hypothesis (PI-LCH), this study applies the vector error model (VECM) into the 1980:Q1 to 2007:Q4 quarterly data sample. The overall finding of the study indicates there is indeed a long-run positive relationship between housing prices and consumption in South Africa.

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LIST OF ACRONYMS

ABSA	Amalgamated Banks of South Africa
BER	Bureau of Economic Research
BMR	Bureau of Market Research
FNB	First National Bank
HDB	Housing and Development Board
OECD	Organization for Economic-Cooperation and Development
NCA	National Credit Act
NBER	National Bureau of Economic Research
UK	United Kingdom
US	United States of America
SA	South Africa
SARB	South African Reserve Bank
SARS	South Africa Revenue Services
Stats SA	Statistics South Africa

CHAPTER ONE

INTRODUCTION

1.1 Introduction

In an attempt to make a contribution towards consumption function analysis, this study provides an empirical investigation on the relationship between housing prices and private household consumption in South Africa (SA). With minimum access to literature on studies conducted in developing countries, the study is therefore heavily dependent on evidence obtained from those conducted predominantly in developed nations. This chapter, therefore, starts by presenting the background to the study which is then followed by the aim. It then goes on to further specify the problem statement and the hypothesis to be tested as well as outlining the theoretical approach and the model specification. The conclusion provides a breakdown outlining the entire structure of the study.

1.2 Background of the Study

Many countries amongst others Australia, Ireland, Netherlands, United Kingdom (UK), Spain, United States of America (US), SA etc. have experienced an increase in housing prices, since the late 1990s. Residential property market indicators such as the level of real prices and the ratio of house to rentals and income levels have reached record highs (ABSA 2005 and 2006). Ensuing from this booming property market, house prices have received a great deal of attention from policy-makers and economic commentators. Hence, as correctly pointed out by Ahearne, Ammer, Doyle, Kole and Martin, (2005), it therefore becomes necessary to examine the effects of changes in residential house prices on consumption expenditure by households.

Aoki, Proudman and Vliegheet (2002) maintain that the effects of the housing price on consumption may be explained by using customers' expectations. This view, which is not pursued in this study, argues that consumers' optimism about economic prospects are likely to have a positive impact on the consumption of both housing and non-housing goods. Thus, if house price increases are moving together with increases in housing transactions, these transactions may therefore directly influence consumption as consumers purchase goods that are complementary to housing, such as major appliances, carpets and furniture.

The most commonly celebrated view¹ on the relationship between housing prices and consumption maintains that, consumption might be directly influenced by housing prices through credit market effects (Campbell & Cocco, 2004)². Unlike borrowing on unsecured but punitive facilities such as credit cards or personal loans, houses generally provide sufficient and cheaper collateral security for home owning borrowers (Aoki et al. 2002). Thus an increase in house prices makes more collateral available to homeowners, which in turn may encourage them to borrow more, in the form of mortgage equity withdrawal (MEW)³, to finance desired levels of consumption and housing investment (Ahearne et al, 2005). For borrowing-constrained homeowners, an increase in housing prices relaxes borrowing constraints, even if there is no wealth effect associated with the house price increase. As a result, increase in house prices may lead to an increase in consumption not because of a wealth effect, but because it allows borrowing-constrained homeowners to smooth consumption over the life cycle (Attannasio & Wakefield, 2008).

Campbell and Cocco (2004), provide the general macroeconomic theory perspective which maintains that an abrupt increase in housing demand might ensue from a positive shock in economic activity. Subsequently, house prices accelerate leading to a rise in homeowners' net worth. Ensuing from this shock, the authors maintain that the external

¹ Due to its practicality, data issues and popularity, this view is closely followed in this study.

² Amongst others, also see Attannasio and Wakefield (2008) as well as Thoson and Tang (2004).

³ MEW is a type of loan in which the borrower uses the equity in their home as collateral. These loans are sometimes useful to help finance major home repairs, medical bills or tertiary education. A home equity loan creates a security against the borrower's house, and reduces actual home equity. This type of a loan is only applicable when there is sufficient security value in the property to cover the amount.

finance premium decreases, leading to a further rise in housing demand and this also spills over into consumption demand. This view gained momentum, particularly after economies such as UK, US, Australia, SA and many more deregulated their retail financial markets making it easier and cheaper for consumers to borrow against housing collateral to finance consumption. Hence, Nickel (2004) shows that cheaper access to home equity means that, for a given house price increase, more additional borrowing will be dedicated to consumption relative to housing investment. The author, therefore, maintains that this may stimulate consumption by homeowners who would be likely to finance their higher consumption pattern through borrowing in the form of MEW. Subsequently, the response of consumption to an unanticipated change in interest rates will therefore be larger, and the response of house prices and housing investment will be smaller.

Using data from SA and UK, Aron and Muellbauer (2000a) support the argument of linking consumption to housing prices by showing that financial liberalisation has a tendency of reducing the credit constraints on households engaging in upward adjustment of consumption when a significant growth in income is expected. Their findings evince that for first-time buyers of housing, financial liberalisation ameliorates by reducing deposits required of first-time buyers of housing; while on the other hand increasing the availability of collateral security for the borrowers who already own houses.

However, as pointed out by Campbell and Cocco (2004:1-2), the net gain arising from the increase in the nominal price of a housing stock is ambiguous. Emanating from the argument that higher user cost of housing would offset the increase in house prices; said increase does not necessarily yield to an overall increase in the households' wealth. The authors further argue that, since reasoning behind the large housing wealth theory is subtle "...for instance if the financial wealth is defined as the sum of liquid financial assets and the value of real estate minus debt outstanding, it then becomes clear that an increase in house prices leads to an increase in homeowners' financial wealth". But this does not necessarily imply that their real wealth is also higher. In addition, "since housing is consumption good, and for homeowners who expect to live in the current house for a

very long time, a higher house price is simply a compensation for a higher implicit rental cost of living in the house”.

Furthermore, “...for the homeowners that plan to trade down, or and access their housing wealth through an equity release scheme, the overall wealth effect from an increase in house prices might be positive, facilitating an increase in consumption”. Regarding those households intending the sale of their houses as a result of an abrupt increase in housing prices, the effects might be abated by the prices of prospective houses. Meanwhile, current consumption by non-homeowners planning to buy houses in the future will drop as a result of the rise in housing prices. Generally, higher housing prices are accompanied by higher rentals which have adverse effects on the long-time rentals, particularly the younger generations (Campbell & Cocco, 2004). Nevertheless, irrespective of either owning a house or not, changes in house prices have a direct effect on aggregate consumption (Phang, 2003).

1.3 Trends in Housing Prices in SA

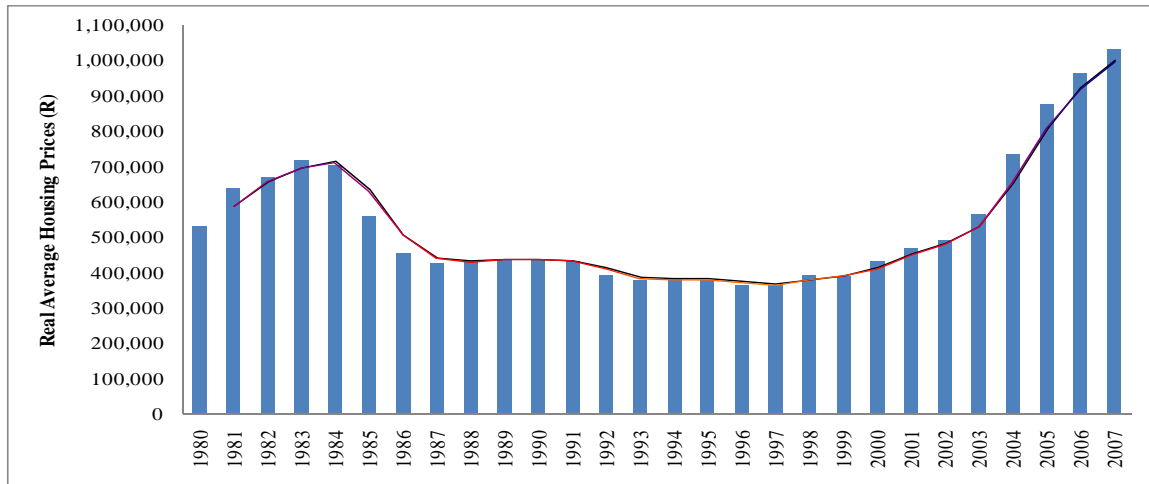
With this as a background, using ABSA’s calculations, real house prices⁴ increased from an average of approximately R502 121 in the first quarter of 1980 to an approximate average of R1 031 395 in the final quarter of 2007, thus recording an average annual price growth rate of about 2.48 percent in real terms [Figure 1.1 (a)]. The housing prices recorded positive year-on-year percentage changes all the way through to 1983 in real terms, with the largest negative downturn of 20.6 percent recorded in 1985.

Between 2000 and 2005, the South African residential property market recorded a robust average annual price growth rate of approximately 15.1 percent in real terms. During this period the market was driven by a wide range of factors, including the lowest inflation rates since the 1960s and the lowest interest rates in more than 20 years, causing real house prices to increase to all-time highs in 2005 (ABSA, 2006). The South African

⁴ The average real housing prices are calculated at 2000 prices, for all middle class (80 square meters to 400 square meters) new and old houses.

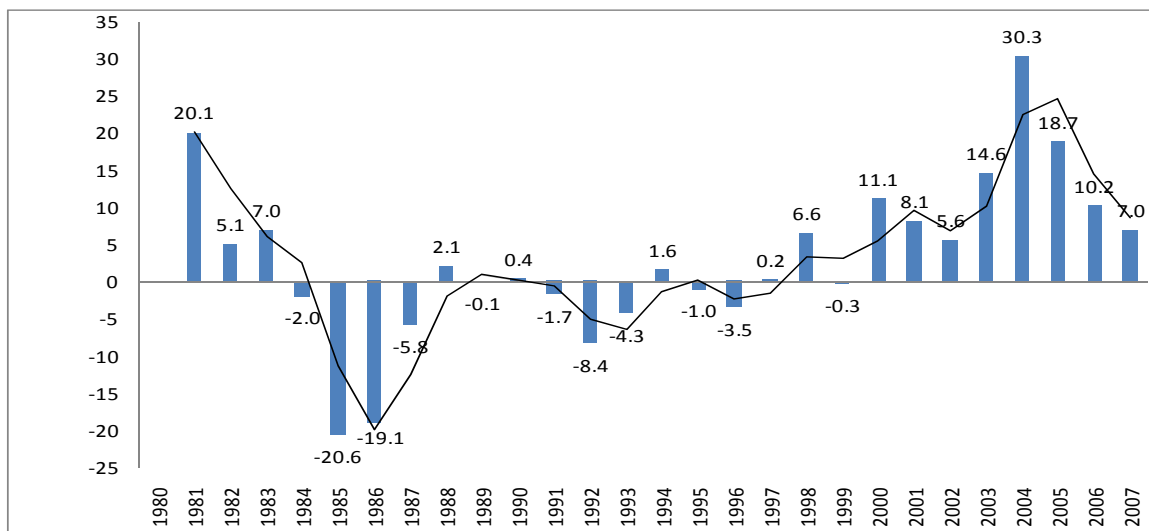
housing prices recorded the highest annualised real growth rate of 30.3 percent in 2004 before slowing down to an annualised real growth rate of 7 percent in 2007 [figure 1.1(b)]⁵.

Figure 1.1 (a): Average Real Housing Prices in South Africa, (2000 Prices), 1980 to 2007



Source: Own calculations using data obtained from ABSA (2009)

Figure 1.1 (b): South African Annual Percentage Change in Real Housing Prices (2000 Prices), 1980 to 2007



Source: Own calculations using data obtained from ABSA (2009)

⁵ Own calculations based on the 1960 to 2008 monthly data obtained from ABSA (See Section 4.3.1 for more details on the data utilized).

Due to the abrupt increase in residential property prices, particularly, during the period 1999 to 2007, the level of households' net wealth position was improved. The value of residential buildings owned by South Africans accelerated from a low of 17.2 percent of total assets or R211.4 billion in 1995 to 18.9 percent in 2000. This has contributed to the net wealth of households increasing to an estimated R3.308.5 billion, or 348 percent of households' total disposable income, in 2005 (ABSA, 2007). The anecdotal booming of the residential property market further augmented the level of mortgage advances by households which increased by 125.2 percent from R176.9 billion in 2000 to an estimated R398.3 billion in 2005 (ABSA, 2007).

The main factors agitated to have influenced the property prices are among others, historically low interest rates, ensuing from lower inflation and the strong performance of the property market because of the underperformance of other asset classes such as equities. As a result, new home-buyers have increasingly taken out larger loans as property prices have increased, while existing homeowners increased their mortgage loans to turn their massive appreciation on their properties into cash for consumption purposes. This has caused ratios of households and mortgage debt-to-disposable income in countries such as SA, Australia, Ireland, Netherlands, Spain, UK and the US to increase to levels never seen before (ABSA, 2006).

In addition to the economic growth, households' disposable income and adjustments to personal and property tax rates are quoted as having positively influenced the residential market in SA. Other economic factors such as residential fixed capital formation, the construction sector, building material, household wealth, household consumption expenditure, net household saving, mortgage debt, credit extension by the financial sector, government revenue etc. are also cited to have contributed towards the sky-rocketing prices of the residential property market (ABSA, 2007). The question is, therefore, raised as to how this rise in net wealth has influenced aggregate consumer expenditure.

In 2007 the property prices were still increasing, however, according to ABSA House Price Indices the trend in house price growth indicated that, in real terms, the year-on-year house price was declining. This decline was mainly driven by the stringent increase in households' real disposable income and the full implementation of the National Credit Act (NCA)⁶ in June 2007, which saw a tightening of lending requirements applicable to consumers and financial institutions (ABSA, 2008).

1.4 Trends in Households' Disposable Income and Expenditure on Consumption

Though there is a range of macroeconomic variables affecting the entire economic performance of a country, for the purpose of this study⁷, however, this subsection only focuses on the households' disposable income, expenditure on consumption by households and the real gross domestic product (real GDP).

1.4.1 Disposable Income of Households

Despite the negative annualised percentage change recorded in the years 1981 (-2.7 percent), 1985 (-1.2 percent), 1986 (-3.1 percent) and 1992 (-1.5 percent), real disposable income of households recovered in 1993 and recorded an annualised growth rate of 1 percent. Households' real disposable income uninterruptedly increased from an annual increase of 1 percent in 1993, peaked at 7.7 percent in 2006 and settled at around 6.5 percent⁸ in 2007 (Figure 1.2). Such an increase in disposable income for a country with

⁶ NCA is the South African law that came into effect on the 1st of June 2007. NCA was created with an intention of regulating the credit industry in South Africa in order to protect consumers from poor credit practices. The Act aims at reducing reckless credit behavior by both the credit providers and consumers. Basically, the Act places a greater responsibility on credit providers to ensure that a consumer can afford the credit before any credit advancement is committed (www.nca.co.za).

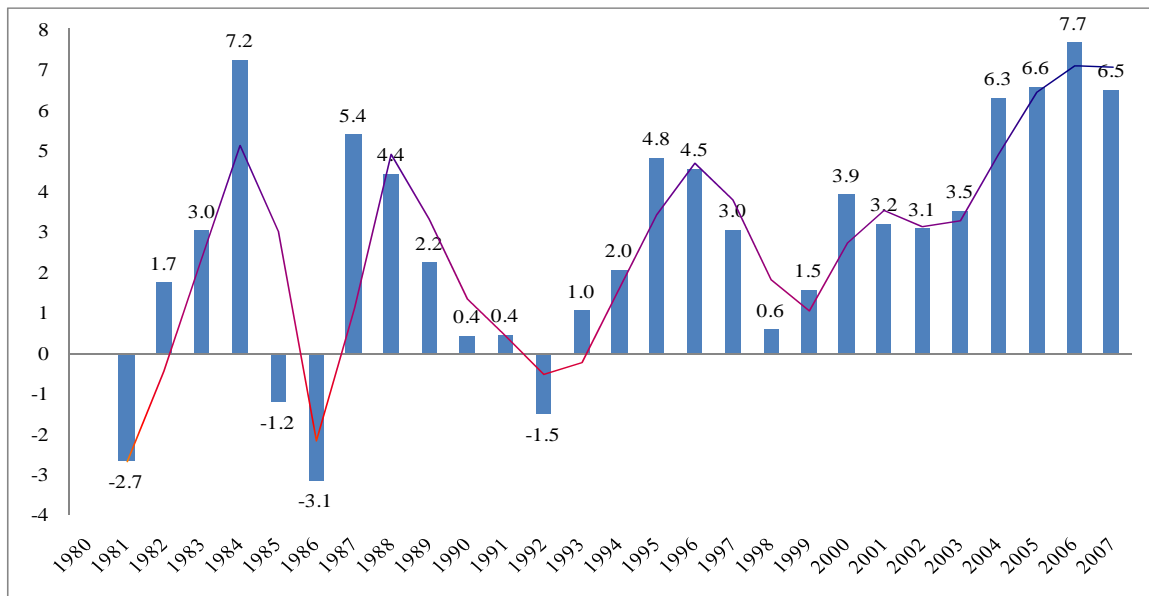
⁷ As evident in the model specified in section 4.4 (Chapter Four) which is estimated in Chapter Five, the study focuses on the relationship between expenditure on consumption, disposable income and changes in housing prices. As mentioned in chapter, consumption contributes more than 60 percent of the total Real GDP in SA; this therefore warrants a brief description of the real GDP.

⁸ Own calculations based on the seasonally adjusted disposable income of households data, constant at 2000 prices obtained from the SARB.

a high marginal propensity to consume inevitably leads to a strong response in consumer spending (SARB, 2007).

Amongst other factors, improvement in employment opportunities as well as higher wage settlements between trade union and employers are cited to have influenced growth in real disposable income of households (SARB, 2008). This abrupt increase in real disposable income was further augmented by the “personal tax relief measures as well as increases in the thresholds for tax exemption which were introduced by the South African government over the years” (SARB, 2006:1). In addition, government transfers to households in the form of disability, child and pension grants gained momentum. Over and above the general increase in disposable income, consumers further supported their consumption spending through borrowing. This, as a result, led to the rise in the ratio of household debt to disposable income from 53 percent in 1993 (SARB, 1996) to 77.5 percent in 2007 (SARB, 2007).

Figure 1.2: South African Annual Percentage Change in Real Disposable Income of Households (2000 Prices), 1980 to 2007

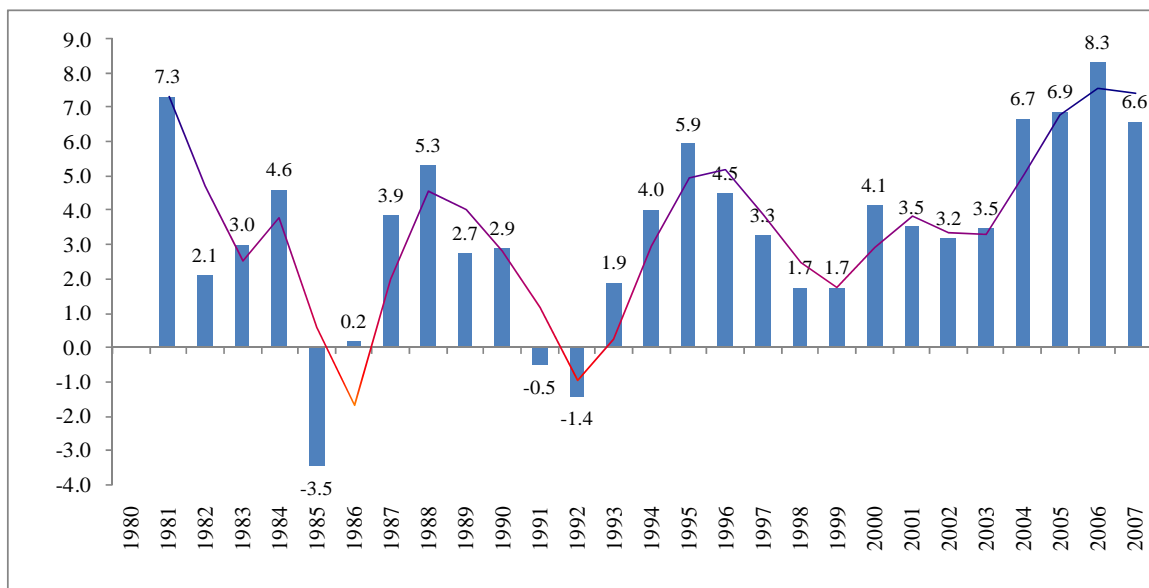


Source: Own calculations using Disposable Income of Households (Seasonally Adjusted at Constant 2000 Prices) data obtained from SARB (2009)

1.4.2 Private Households Expenditure on Consumption

Figure 1.3 shows that though private household consumption had been robustly increasing from 1980 to 2007, it however dropped in 1985, 1991 and 1992 whereby the negative annual percentage changes of -3.5 percent, -0.5 percent and -1.4 percent were recorded respectively. After having turned positive with an annualised percentage change of 1.9 percent in 1993, real private consumption expenditure strengthened progressively to the highest annual percentage increase of 8.3 percent in 2006 before settling to 6.6 percentage change⁹ in 2007. One of the key drivers of household consumption during early 2000 to 2006 relates to the availability of easily accessible mortgage facilities which allowed for the financing of recurrent household spending against the surety of real estate (SARB, 2006 & 2007).

Figure 1.3: South African Annual Percentage Change in Real Households' Expenditure on Consumption (2000 Prices), 1980 to 2007



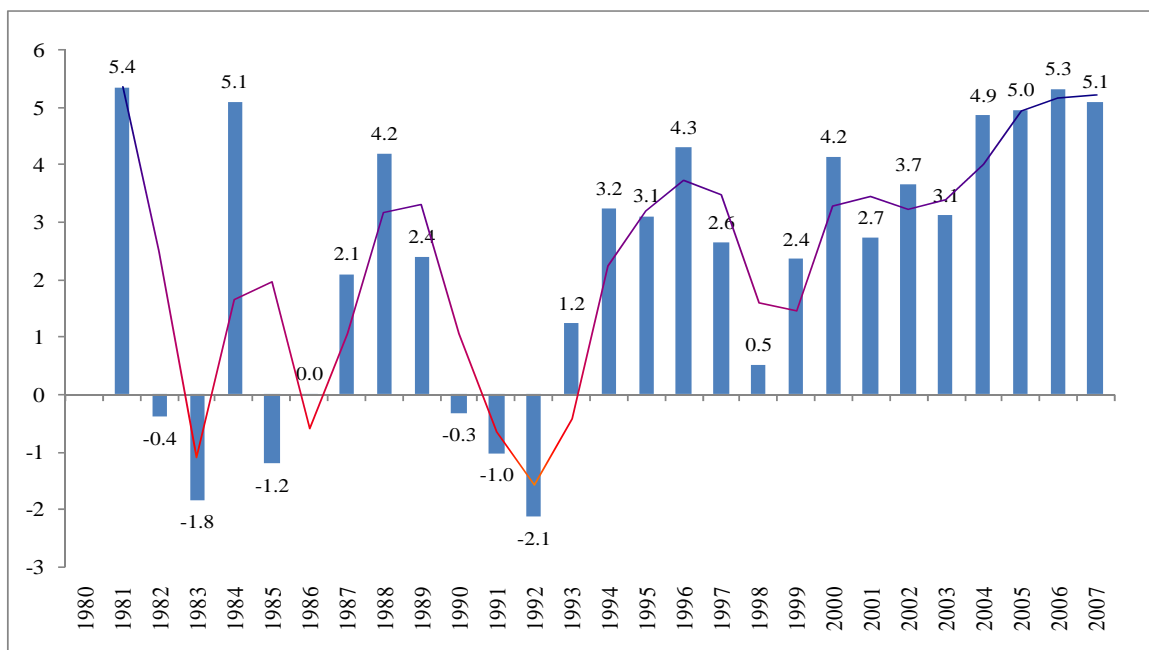
Source: Own calculations using Final Consumption Expenditure by Households (Total Seasonally Adjusted at Constant 2000 Prices) data obtained from SARB (2009)

⁹ Own calculations based on the 1980 to 2007 monthly data obtained from ABSA (See Section 4.3.1 for more details on the data utilized).

The fall in private consumption expenditure particularly during the late 90's was mainly attributed to factors such as weak consumer confidence which could have been influenced by (among others): higher interest rates, lesser job opportunities in the formal sector leading to a fall in employment, marginal growth rate in real income, falling share prices in the Johannesburg Stock Exchange (JSE) etc. (SARB, 2000). The steep rise in interest rates in 1998 led to the dramatic increase in the costs of servicing debts. As a result, "...households had much less capacity to spend, while at the same time the savings ratio came under pressure as households attempted to maintain past spending habits" (SARB, 1999:9).

1.4.3 Real Gross Domestic Product

Figure 1.4: South African Annual Growth Rate in Real GDP (2000 Prices), 1980 to 2007



Source: Own calculations using Quarterly Real GDP data obtained from the SARB (2009)

Real gross domestic product (Real GDP) in SA accelerated at an annual growth rate of 5.4 percent from the period 1980 to 1981. Following this real GDP contracted down by

-0.4 percent in 1982 and further plummeted by -1.8 percent in 1983. Though the economy abruptly peaked and recorded an annualised growth rate of around 5.1 percent in 1984, it however plunged by about -1.2 percent in 1985. Following the negative growth rates of -0.3 percent in 1990, -1 percent in 1991 and -2.1 percent in 1992; the economy recorded an uninterrupted annualised growth rate which peaked at 5.3 percent¹⁰ in 2006 and eventually settled to 5.1 percent in 2007 (Figure 1.4).

1.5 Aim of the Study

Internationally, there exists immense literature on a relationship between housing prices and private consumption by households. The core aim of these studies had been the establishment of the relationship between aggregate consumption and the change in house prices. Startlingly, in some instances results point towards a relationship, however, in other studies there are no such relationships. The differing results are mainly influenced by different methodologies and data used in various countries. This, therefore, warrants an investigation as to whether there is indeed a relationship between house prices and consumption in South Africa or not.

A dynamic model of consumption function using the vector error correction model (VECM) representation of Engle and Granger (1987) is applied with the insight that even if it could be found that consumption, disposable income and housing prices are non-stationary they might be cointegrated. VECM is used with a view of determining whether an increase in residential property prices has an impact on consumption expenditure by private households. This study therefore, seeks to find out, if there was any relationship between the residential house prices and consumption in South Africa during the period 1980:Q1 to 2007:Q4.

¹⁰ Own Calculations based on the data obtained from SARB. (See Section 4.3.1 for more details on the data utilized)

1.6 Problem Statement

The main research problem is formulated as follows:

To examine with reference to the South African residential property market, any relationship between private households' expenditure on consumption and the prices of residential property. The null hypothesis adopted in this study is stated as: "*there is no relationship between the property prices and private expenditure on consumption by households*".

1.7 Structure of the Study

Chapter Two provides an in-depth analysis of the permanent-income/life-cycle model, which is the widely accepted economic theory that seeks to explain the consumption function. The chapter starts by providing a brief review on the simple Keynesian consumption model and then proceeds by presenting a thorough description of both the permanent-income hypothesis as well as the life-cycle hypothesis showing a link between consumption and households' wealth.

Chapter Three presents a broad literature review upon which this dissertation is based. The chapter provides relevant literature which investigates an empirical link between consumption and housing prices largely in the US, UK, SA and other parts of the world.

Chapter Four focuses on the step-by-step process of developing the model specified. The chapter starts by presenting the general framework of the model specification, which is then followed by the theoretical requirement of conducting both the unit root and the cointegration tests. The chapter concludes by presenting the model specification employed in this study.

Results together with their interpretation, analysis and discussion are contained in *Chapter Five*. *Chapter Six* presents conclusion, recommendations for a suitable monetary policy in South Africa, delimitation of the study and a need for further research.

CHAPTER TWO

THEORETICAL FRAMEWORK: CONSUMPTION

2.1 Introduction

A sizeable body of theoretical literature indicates that consumption is the most crucial component which contributes the largest proportion of more than 50 percent of the total aggregate demand (Eliot, 1979). In SA, final expenditure on consumption by households constituted about 63 percent of the gross domestic product (GDP) in 2005 (SARB, 2006). Given the contribution of this high consumption towards GDP, it is therefore not surprising that, there is a significant amount of studies, particularly in the first world countries that have been undertaken to investigate factors influencing consumption (Griffiths & Wall, 1993).

The mainstream macroeconomic theory suggests that consumer spending is determined by the consumer's purchasing power¹¹. As explained by Elliot (1979), arising from this theory, the general consensus of the growing body of empirical evidence suggests that liquid assets contribute extensively towards the explanation of fluctuations in consumer spending.

This chapter provides an outline of the widely accepted theoretical and technical tools that are applied in the analysis of consumption. It begins by providing a brief review of the traditional Keynesian theory of consumption followed by extensive analysis of the permanent-income/life-cycle theory of consumption.

¹¹ A consumer's purchasing power is the total amount of current purchases by a consumer when spending all currently earned income, borrowing and spending the maximum amount possible against future income, spending the proceeds from liquidating all savings accounts and selling off the stocks and other assets owned (Eliot, 1979).

2.2 The Consumption Function: Keynesian Model

In his book “The General Theory of Employment, Interest and Money”, Keynes laid a solid foundation in the development of the macroeconomic theory from which economic activity is largely determined by aggregate demand¹² (Mankiw, 1994). While examining the components of aggregate demand, particularly consumption, Keynes developed a simple consumption function which states that consumption is a linear function of the current level of disposable income. He argued that consumers in en-masse are likely to increase their level of consumption following an increase in the level of income, but not to the same extent to which income increased (Galbraith & Darity, 1994). The general Keynesian consumption function is expressed as:

$$C = C_0 + bY_d. \quad (2.1)$$

From equation (2.1), C denotes consumer expenditure, C_0 is a constant or autonomous expenditure, while b represents the marginal propensity to consume (MPC)¹³. Since the proportional increase in consumption is less than the proportional increase in income, b is therefore less than one. Keynes posited that C_0 represents autonomous consumption or that portion of consumption which is not influenced by disposable income thus financed through borrowing or withdrawal from previous savings (Griffiths & Wall, 1993).

Though Keynes’ consumption function is generally accepted as the cornerstone in the consumption theory, it however concluded that consumption is mainly determined by the current level of disposable income. Thus ignoring other determinants such the expected future income, real interest rates, demographic aspects such as consumer’s age and life

¹² The Keynesian macroeconomic model of aggregate demand (AD) is generally postulated as: $AD = C + I + G + X - Z$; indicating that Aggregate demand is the sum of private expenditure on consumption by households (C), expenditure by the private sector on investment (I), government expenditure on the provision of public goods and services (G), expenditure by foreigners on locally produced goods and services (X) less expenditure on foreign produced goods and services (Z).

¹³ MPC is the amount consumed out from the last rand of income received and Y_d , is the level of disposable income.

expectancy, financial deregulation and asset price fluctuations, etc. In tandem to this criticism, new consumption school of thought known as Post-Keynesian emerged (Jorgen & Whitta-Jacobsen, 2005).

The Post-Keynesian school of thought augments the Keynesian consumption function by incorporating all the variables ignored by Keynes. These schools of thought further argue that in addition to current disposable income, actual consumption can deviate from the estimated due to either changes in unemployment, inflated house prices, financial wealth prices or changing incomes, all of which make consumers more optimistic about the future. Corollary to this argument, it is therefore corroborated that in addition to the current disposable income, current consumption is also influenced by the expected future income (Mille, 1996). The two most popular Post-Keynesian schools of thought, which form part of the foundation for this dissertation, are the life-cycle hypothesis (LCH) and the permanent-income hypothesis (PIH). Both these schools of thought accentuate and postulate the argument that consumers do not plan their consumption only on current disposable income, but also on the basis of their life time income expectations (Mayer, 1972).

2.3 Wealth Effects and Consumption

Since disposable income is made of returns from both human and non-human wealth, and further that wealth can be stored, income from wealth is used to offset both planned and unexpected labour income. Arising from this argument, wealth has been extensively analysed and tested as a possible determinant of consumption. Thus, Franco and Modigliani gave a well-supported corroboration that wealth may be used to balance consumers' life time income streams, implying that wealth may be considered as the life time resources available to consumer (Evans, 1969).

Under the auspices of the so called “wealth effects”, in the early life consumers maintain their current consumption levels through borrowing against future income, then build wealth and repay debts in middle life and eventually spend down their wealth and rely on

government transfer payments in retirement (Belsky & Prakken, 2004). Thus, using econometric modeling, the theory estimates the ratio of consumption emanating from the increase in wealth. In essence the theory argues that consumers are likely to increase their consumption in anticipation of the increase in the future income or future wealth (Tresor-Economic, 2007). However, since wealth effects normally have lags that determine the speed at which an increase in wealth could influence consumer spending, thus the wealth effects are not instant. This theory, therefore, explains the mechanism by which consumer spending is stimulated by an increase in wealth. According this theory, households consume as a function of their permanent income, anticipating future income streams or of their wealth (financial and housing)¹⁴, which is equivalent to the present value of the anticipated pool of future income. As a result of the increase in housing wealth, homeowners could then have the capacity to increase their borrowing in proportion to the rise in property value. The portion of the additional cash not intended for the purchase or renovation of a home is referred to as mortgage equity withdrawal (MEW)¹⁵. The capital thus released can be used to finance consumption, purchase non-housing assets or repay other debts. This, therefore, leads to a situation in which households are able to ease credit conditions and thus enable them to increase their consumption (HM Treasury, 2003).

There are five transmission channels through which changes in housing prices would affect changes in consumption (Ludwig & Slok, 2002). These transmission channels are stated as follows:

- (a) *Realised wealth effect*: This is the transmission mechanism followed by the study which argues that net wealth for home-owning households increases in tandem to increases in house prices, resulting to an increase in consumption today. If house

¹⁴ Financial wealth refers to a change in wealth arising from the change in the value of the household's financial assets. Housing wealth on the other hand refers to a rise in house prices which in turn yields to an increase in housing wealth for households owning property (Belsky & Prakken, 2004).

¹⁵ Aron and Muellbauer (2000) link MEW to the credit market liberalisation which directly impacts on consumption. For instance a direct, positive effect on debt could result from the different facets of financial liberalisation, with, for example, more freely available credit card loans, lower housing down-payments as a fraction of house values, and housing equity loans more freely available to existing owners.

prices increase, it becomes possible for consumers to take out equity in the form of refinancing or selling of the house. The realised gain is expected to have a positive impact on private consumption.

- (b) *Unrealised wealth effect*: Some households do not refinance or sell their houses when house prices are increasing. Nevertheless, this might still have a positive impact on consumption due to the increase in the discounted value of wealth. As a result consumers can spend more today on the expectation that they are “richer” than they were before.
- (c) *Budget constraint effect*: For house renters the increase in house prices has a negative impact on private consumption. As house prices increase, budget constraints become tighter for renters due to higher rentals imposed by landlords.
- (d) *Liquidity constraints effect*: This has an indirect effect. As house prices increase, households might be constrained in gaining access to credit markets.
- (e) *Substitution effect*: For households planning to buy houses, they might choose to postpone their decisions, buy smaller houses or reduce private consumption.

2.4 Permanent-Income Hypothesis

In 1957, Milton Friedman vigorously questioned the Keynesian model on the basis that MPC is constant, that is consumers spend the same fraction of additional income earned. Using empirical evidence from both time series and cross-sectional data, Friedman unequivocally demonstrated that consumption depends on average income earned over the course of an individual’s anticipated life time. He referred to this theory as the PIH (Galbraith & Darity, 1994).

When deciding about consumption people in general take into account their long-term income prospects. As a result, rational consumers¹⁶ prefer to smooth consumption flow rather than spending their entire disposable income on current consumption (Dornbusch, Fischer & Startz, 2004). Consumer income in any time period is therefore made up of permanent (Y^p) and transitory (Y^t). The PIH, therefore, evinces that consumption is determined by both transitory and permanent income (Galbraith & Darity, 1994).

Mille (1996) describes permanent income¹⁷ as the amount of income which is positively correlated to the level of education, skills and the experience possessed. Due to its nature, permanent income is generally assumed to be some form of a long-run average income, which can be counted on in the future. Hence, it is regarded as the steady rate of expenditure a person could maintain for the rest of his or her life time, given the present level of wealth and the income earned now and in the future (Dornbusch et al, 2004).

Transitory income¹⁸ on the other hand reflects the deviation of current income away from permanent income, thus its mean is almost zero and is, therefore, uncorrelated with permanent income. If the individual consumer is having an unexpectedly good period, then transitory income becomes positive or negative if the individual is having a bad time (Romer, 1996). Consumer's current income (Y) is therefore the sum of permanent income and transitory income, which is stated as:

$$Y = Y^p + Y^t. \quad (2.2)$$

The regression of consumption on current income can therefore be stated as:

$$C_i = a + bY_i + e_i. \quad (2.3)$$

¹⁶ General microeconomic theory defines a rational consumer as an individual consumer or households who spends his or her limited level of disposable income and obtains the highest possible level of satisfaction in a given time period (Sloman, 1999).

¹⁷ Permanent income is the amount of income a consumer expects to get so often e.g. salary over a long period and will vary proportionately with the actual level of income.

¹⁸ Transitory income refers to the part of income which fluctuates depending on the luck of an individual consumer (Dornbusch et al, 2004).

As demonstrated in Romer (1996), since equation (2.3) is a univariate regression, the estimated coefficient b on the permanent income is the ratio of the covariance of the independent (Y_t) and dependant (C_t) variables to the variance of the independent variable (Y_t), implying that:

$$\begin{aligned}
 \hat{b} &= \frac{Cov(Y_t, C_t)}{Var(Y_t)} \\
 &= \frac{Cov(Y_t^p + Y_t^t, Y_t^p)}{Var(Y_t^p + Y_t^t)} \\
 &= \frac{Var(Y_t^p)}{Var(Y_t^p) + Var(Y_t^t)}.
 \end{aligned} \tag{2.4}$$

Equation (2.4) demonstrates that consumption equals permanent income, which is represented as ($C = Y^p$). The second line in equation (2.4) shows that current income is the reflection of the sum of permanent and transitory income. The latter part evinces that permanent and transitory incomes are not correlated (Romer, 1996). A further analysis of equation (2.4) leads to:

$$\begin{aligned}
 \hat{a} &= \bar{C} - \hat{b}\bar{Y} \\
 &= \bar{Y}^p - \hat{b}(\bar{Y}^p + \bar{Y}^t) \\
 &= (1 - \hat{b})\bar{Y}^p,
 \end{aligned} \tag{2.5}$$

which demonstrates that the estimated constant (\hat{a}) equals to the mean value of the explanatory variable minus the estimated slope of the coefficient times the mean. The estimated parameter provides a prediction which postulates that consumption is a function of the fluctuations in both transitory income and permanent income. This, therefore, implies that an increase in current income is associated with an increase in consumption only to a degree that it reflects an increase in permanent income. When the change in permanent income is much greater than the change in transitory income, almost

all differences in current income reflect differences in permanent income; thus consumption rises almost 100 percent with current income. However, when the change in permanent income is small relative to the change in transitory income, little of the change in current income comes from the change in permanent income, and so consumption increases little with current income (Romer, 1996).

PIH further demonstrates that consumption is a constant proportion of permanent income, such that:

$$C = kY_p, \text{ where } k = F(i, w, x). \quad (2.6)$$

The proportion of (k) is determined by factors such as interest rates (i), ratio of non-human to human wealth (w) as well as (x) which includes age and taste as major components. If the interest rate rises, then individuals with financial assets are assumed to feel more secure as the future returns from their asset holdings increase, leading to a rise in k . Equally so, k will increase if the ratio of w rises in total wealth holding. This is, therefore, thought to increase individual security, since non-human factors e.g. money and financial assets such as shares, bonds, properties etc. are assumed to be more reliable than human wealth which is in a form of expected future labour income (Griffiths & Wall, 1993).

In an attempt to demonstrate the pivotal role of separating permanent from transitory income, Romer (1996) gives an analogy of a “windfall” gain of amount (X) in the early period of life. He argues that although this “windfall” raises current income by X amount, it, however, raises permanent income by only $\frac{X}{T}$. Thus if the individual’s “windfall” experience is fairly long, the impact on current consumption will be marginal. According to this analysis, the “windfall” implies that as much as the time pattern of income is not important to consumption, it is however critical to saving. The individual’s saving in period t , which is the difference between income and consumption is stated as:

$$S_t = Y_t - C_t. \quad (2.7)$$

Substituting C_t in (2.8) yields to:

$$\left(Y_t - \frac{1}{T} \sum_{t=1}^T Y_t \right) - \frac{1}{T} A_0. \quad (2.8)$$

Equation (2.8) indicates that saving is high when transitory income is relatively high. Similarly, saving becomes negative when current income is less than permanent income. As a result, an individual will use saving and borrowing to smooth the path of consumption (Romer, 1996).

2.5 Life-Cycle Hypothesis

The life-cycle hypothesis (LCH) which was first developed by Franco Modigliani and Richard Brumberg in 1954, amplifies the argument that consumer spending is mainly influenced by income and wealth. Since its inception, the theory has been thoroughly analysed and extensively tested as a possible explanation of consumption (Evans, 1969). Therefore, in addition to the current disposable income, consumption is also influenced by the time period consumers expect to live, their future expected permanent income, the total expected labour income, transfers from government over a life time period etc. (Griffiths & Wall, 1993).

The LCH presents the axiom that permanent income is calculated over an individual's life span period. Thus in addition to "windfall" income, transitory income is also decided by occupation and the status of the individual. LCH, therefore, pays particular attention to the age of the consumer, with the consumer trying to spread consumption over a life time in which income fluctuates widely. During the young stage of life, when income is lower, consumption is sustained through borrowing or drawing on past savings (Miller, 1993). Meanwhile, during the middle age period and higher income, individuals tend to consume less and save more to finance consumption after retirement (Jorgen & Whitta-Jacobsen,

2005). Given its nature, LCH, therefore, helps in linking consumption and saving to demographic aspects, particularly to the age distribution of the population (Dornbusch et al, 2004).

The theory further maintains that since some consumers have access to credit facilities, it is possible for them to spend more than what they earn through borrowing in anticipation of future income. Consumers are, however, sometimes unable to borrow enough to sustain current consumption, implying that consumption expenditure could rise faster than income due to the unlocking of liquidity constraint¹⁹ (Dornbusch et al, 2004).

Transpiring from the analysis in both *sections (2.3) and (2.4)*, it therefore becomes evident that PIH focuses particular attention on forecasting the level of income available to consumer over a life time period. Yet LCH, as outlined in *section 2.5*, put more emphasis on individuals' choices which are about maintaining a stable standard of living in the face of changes in income over a life time period. These schools of thought have since then merged into what is commonly referred to as the life-cycle/permanent-income hypothesis (LC-PIH) (Dornbusch et al, 2004). The following section, therefore, discusses these two theories as a single economic theory of consumption.

2.6 Consumption under Certainty: Life-Cycle/Permanent-Income Hypothesis

The LC-PIH is based on the assumption that each rational consumer aims at utility (U) maximisation over a life time period (T). As pointed out in Dixit (1990), life time utility is the sum of period-by-period utilities which is stated as:

$$U = \sum_{t=1}^T U(C_t). \tag{2.9}$$

¹⁹ An individual consumer experiences liquidity constraints if he or she cannot borrow to sustain current consumption in the expectation of higher income in the future (Dornbusch et al, 2004).

In equation (2.9), C_t represents consumption in period t . Consumption decision is however constrained by the availability of life time resources such as income and wealth (Romer, 1996), which leads to the following budget constraint:

$$\sum_{t=1}^T C_t \leq A_0 + \sum_{\tau=1}^T Y_{\tau}. \quad (2.10)$$

Equation (2.10) demonstrates that an individual consumer has an initial wealth of A_0 and labour incomes of Y_1, Y_2, \dots, Y_T in his or her life periods (T). The consumer is assumed to be taking initial wealth and labour income as given; has access to credit and can save at an exogenous market-related interest rate. The individual consumer is, however, subjected to the constraint that outstanding debts must be repaid at the end of his or her life time (Dixit, 1990). This, therefore, dictates the consumer to behave within the constraint as stipulated in equation (2.10). Since marginal utility from consumption is always positive, the individual satisfies the budget constraint with equality (Romer, 1996). Thus, following the application of the Lagrangian optimum utility analysis, the individual consumer's budget constraint becomes:

$$L = \sum_{t=1}^T u(C_t) + \lambda \left(A_0 + \sum_{t=1}^T Y_t - \sum_{t=1}^T C_t \right). \quad (2.11)$$

The Lagrangian first-order condition for C_t is therefore stated as:

$$u'(C_t) = \lambda. \quad (2.12)$$

Equation (2.12) is assumed to be applicable in the consumer's life time, resulting in the consumer's marginal utility remaining constant over his or her life time. Thus given the testimony that marginal utility is intuitively determined by consumption, this therefore implies that consumption is constant in each time period ($C_1 = C_2 = \dots = C_T$) (Rome, 1996). This intuition is then substituted into the budget constraint, yielding to:

$$C_t = \frac{1}{T} \left(A_0 + \sum_{t=1}^T Y_t \right). \quad (2.13)$$

The components contained in brackets reflect the individual consumer's total life time resources including permanent income. Equation (2.13) therefore maintains that a rational individual divides his or her life time resources equally among each period of life (Romer, 1996). As a result of the postulation from (2.12) to (2.14), the LC-PIH then presents the consumption function as:

$$C_t = r(A_t + H_t) \equiv Y_t^p. \quad (2.14)$$

Consumption at a given period is presented as C_t , r is the rate of return from financial assets, A_t denotes the financial wealth, H_t and Y_t^p denote human wealth and permanent income respectively at a time. Intuitively, equation (2.14) therefore demonstrates that consumption is indeed determined by both the levels of financial wealth and human wealth. The consumer's total wealth at the beginning of period t is given by A_t and H_t , indicating that consumption in period t is the total annuity value of total wealth that is the return on wealth in each period. The return which is presented as $r(A_t + H_t)$, refers to the permanent income, which is a flow that could be earned forever on the stock of total wealth. Thus each individual household chooses to consume in each period the exact permanent income calculated on the basis of expectations of future labour income (Dixit, 1990). Since consumption at a time must be equal to permanent income, the consumption function in (2.14) could be written as:

$$Y_{t+1}^p = r(A_{t+1} + H_{t+1}). \quad (2.15)$$

As explained by Dixit (1990), by taking the expectation of Y_{t+1}^p at a time t , then subtracting the resulting expression from (2.15) and that $E_t A_{t+1} = A_{t+1}$, since realised

consumers income Y_t is included in the consumer's information set at period t , this therefore yields to:

$$Y_{t+1}^p - E_t Y_{t+1}^p = r(A_{t+1} - E_t H_{t+1}). \quad (2.16)$$

In equation (2.16), the permanent income calculated at time $t+1$, conditional on information available at that time, differs from the expectation found *one* period earlier, conditional on information at period t , only if there were a “windfall” in permanent income at period $t+1$ (Dixit, 1990). In other words the “windfall” in permanent income at period $t+1$, is equal to the annuity value of the “windfall” in human wealth arising from new information on labour income, available only at period $t+1$. Since $C_t = Y_t^p$, this then yields to:

$$E_t Y_{t+1}^p = Y_t^p. \quad (2.17)$$

All information available at period t is used to calculate permanent income (Y_t^p), which is also the best forecast of the next period's permanent income (Dixit, 1990). Using the results from equation (2.18), the evolution of permanent income over time can be stated as:

$$Y_{t+1}^p = Y_t^p + r \left[\frac{1}{1+r} \sum_{i=0}^{\infty} \left(\frac{1}{1+r} \right)^i (E_{t+1} - E_t) Y_{t+1+i} \right]. \quad (2.18)$$

The “windfall” income from human wealth in period $t+1$ is expressed as the revision expectations on future income. Thus permanent income can change over time only if those expectations change, that is, when the additional information that accrues to the consumer in period $t+1$, $(E_{t+1} - E_t) Y_{t+1+i} \equiv E_{t+1} Y_{t+1+i} - E_t Y_{t+1+i}$ is greater than zero for all i . Changes in consumption over time will, therefore, follow changes in permanent income such that, the consumption function can be written as:

$$\begin{aligned}
C_{t+1} &= C_t + r \left[\frac{1}{1+r} \sum_{i=0}^{\infty} \left(\frac{1}{1+r} \right)^i (E_{t+1} - E_t) Y_{t+1+i} \right] \\
&= C_t + U_{t+1}.
\end{aligned}
\tag{2.19}$$

From equation (2.19), it can be concluded that the change in consumption between current and future periods cannot be foreseen as of time t . This conclusion is based on the assertion that changes in consumption depends only on information available in $t+1$ (Dixit, 1990).

2.7 Conclusion

This chapter has provided an in-depth analysis of the consumption function. It began by providing a brief review of the Keynesian function then proceeded to give an outline of the PIH and LCH theories of consumption. Using the mathematical techniques, the PIH and LCH models demonstrate that a consumer tries to maintain relatively smooth consumption over his or her life time. The theory delineates that consumption behaviour is geared to consumers' long-term consumption opportunities, implying that consumption is influenced by both permanent income and wealth (Dornbusch et al, 2004). The following chapter provides a detailed analysis of the existing literature on the relationship between and the movement in housing prices and consumption.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This chapter provides the literature review upon which the dissertation is based. Particular attention is paid towards empirical evidence showing an economic relationship between housing wealth and consumption. However, given the reality that little has been written about the subject in SA and other developing countries, a larger proportion of evidence is therefore drawn from studies conducted mainly in the developed nations. The chapter begins with an outline of the empirical studies conducted largely in the US. This is then followed by the findings pervasive in UK and other parts of the world, eventually the chapter concludes by providing a literature review of the limited number of studies conducted in SA.

3.2 Evidence from the United States of America

In the quest for the wealth effect analysis, Iacoviello (2004) applied the Euler equation for consumption to the quarterly data from 1986:Q1 to 2002:Q4 period. Iacoviello developed a two-agent, dynamic general equilibrium model in which equity arising from housing price is used as a collateral security for borrowing purposes. His results provide ample corroboration for housing prices as one of the key drivers of changes in consumption.

Rapach and Straus (2006) on the other hand used “consumption proxy”²⁰ in each of the seven states of the Federal Reserve System’s Eighth District States²¹ in the US. Applying

²⁰ Due to consumption data limitation constraints, the authors used available data on personal disposable income and personal saving recorded by the Bureau of Economic Analysis (BEA). Personal savings income consists of dividend, interest and rental income from the previous accumulated savings.

the standard OLS procedures to the 1975:Q1 to 2004:Q4 data, their estimated result came to the conclusion that a reasonable upward change in the households wealth arising from the increase in housing prices yields to a sizeable increase in aggregate expenditure on consumption of most of the districts studied.

While applying the Euler equation into the “wealth effects” economic perspective, Carroll (2004) uses data from 2001:Q1 to 2003:Q3 and still came to the same conclusion that higher residential property prices are likely to encourage consumption under the auspices of improved wealth. His findings suggest that the immediate (i.e. the next quarter) marginal propensity (MPC) from a change in housing wealth is about one-and-a-half cents, with a final long-run effect of about nine cents.

Unlike the preceding studies conducted in the US, Sousa (2008) put all the wealth together without separating the housing prices from the stock market wealth and thus estimated the long-term link between the various types of wealth (financial, housing, stock market and non-stock market wealth). In his model he uses quarterly and seasonally adjusted data from the sample period 1953:Q4 to 2004:Q4. His findings similarly conclude that there exists a long-run link between house prices and consumption.

Using data from Consumer Expenditure Survey (CEX) and Survey of Consumer Finances (SCF) Bostic, Gabriel, and Painter (2005) performed a similar analysis. They however, compiled household’s balance sheets for the periods starting from 1980 to 2001. Guided by the permanent income hypothesis they also concluded that wealth effect is most significant to consumption among homeowners.

Nieuwerburgh (2004) acknowledges the reality that consumption and housing choices are made jointly, as part of a household’s optimising behavior; thus making it difficult to infer regression results as inferring causality because of the existence of the endogeneity

²¹ The Seven States investigated are Arkansas, Illinois, Indiana, Kentucky, Missouri, Mississippi and Tennessee.

problem. Nevertheless, after having used data from 1989 to 2002 he suggests that housing prices affect asset returns through the role of housing as collateral.

3.3 Evidence from the United Kingdom and other Parts of the World

Attanasio et al. (2005) use Family Expenditure Survey (FES) data in England from 1978 to 2002 and add several house price concepts to their model which assist in providing explanation to the fluctuation in consumption over time. Following the life-cycle theory, the authors provide evidence suggesting that homeowners are likely to use housing wealth as a form of collateral security for borrowing purposes. Their estimated results show that in a given period, consumption by a household depends amongst others on the household's age group, the age of the head of household, a range of household's demographic aspects, characteristics or features etc. Attanasio et al. therefore conclude that wealth and collateral opportunities contribute immensely towards consumption, the effects of which are much stronger for the younger households. Their conclusion further suggests that the housing wealth arising from the increase in residential property prices might eventually lead to a drop in the expected net future wealth of non-homeowners particularly the younger ones whose rent is likely to increase in tandem with house prices.

Using the 1974:Q1 to 1999:Q4 sample period in the United Kingdom (UK), Aoki et al. (2004) applied a financial accelerator effect into the general equilibrium model. Their results show that collateral form of housing wealth has a key role in reducing the costs of borrowing. Their conclusion evinces that a positive shock to economic activity leads to a rise in demand for housing, which results to a rise in prices of residential properties and so an increase in house-owners' net wealth. They further posit that access to lower costs of borrowing emanating from housing wealth implies that, for a particular house price increase, more borrowing will be spent in private on consumption relative to house investment.

Using data from the Organization for Economic-Cooperation and Development (OECD), Girouard and Blondal (2001), show that the relaxation of regulation in the home loan market in most OECD countries which started around the 1970s has ameliorated households to borrow and finance current consumption using their housing wealth as collateral. This borrowing was calibrated to be coherent with the withdrawal of housing equity. Like many world-renowned permanent income hypotheses, Girouard and Blondal also concluded that increase in house prices contribute significantly to consumption by household through wealth effects. They further maintain that housing prices can be used as one of the economic indicators exerting pressures on demand for goods and services.

In a study of 16 OECD countries which include Belgium, Denmark, Finland, etc. Ludwig and Slok (2002) delineate that there is a mounting evidence of short-run adjustment from income, stock prices and house prices on consumption. In corroboration with the existing literature on housing prices and consumption studies, the authors conclude that consumption adjusts to its long-run relationship with lags. Using data from the 1985 to 2000 sample period, they show that, both elasticities of house prices and stock market prices have positive effects on consumption. They, however, argue that the estimated elasticity of house prices on consumption is significantly larger than the elasticity of stock market prices for the combined sample of all countries sampled.

Most studies investigating the relationship between housing wealth and consumption follow the cointegration methodology presented in Chapter Four. Instead of following suite, Slacalek (2009) applies an estimation method based on the sluggishness of aggregate consumption growth. The key advantage of using this method is based on the argument that it yields to higher robustness to changes in underlying parameters such as expected income growth, financial market institutions or demographics. The author uses quarterly data from 16 countries²² found that the MPC resulting from housing equity is

²² Data from a period of 35 years is obtained from Australia, Canada, France, Germany, Italy, Japan, the UK, US, Austria, Belgium, Denmark, Finland, Ireland, the Netherlands, Spain and Sweden.

close to 0.05, there are however distinct, statistically significant differences between countries. These results confirm the findings by Ludwig and Slok (2002).

Thomson and Tang (2002) applied the Dynamic Ordinary Least Square (DOLS) and Dynamic Generalized Least Squares (DGLS) models into the Australian data from 1988:Q2 to 2003:Q1 period. Empirical evidence from their results also strongly suggests that there is indeed a substantial long-run relation between consumption and housing wealth. The authors show that, after short-run adjustments, in the long-run, a one dollar increase in housing wealth results in a six cent increase in annual household consumption.

In tandem to the conventional study by Thomson and Tang (2002), Dvornak and Kohler (2003) applied the PI-LCH into the 1984:Q4 to 2001:Q4 Australian data and show that in the long-run, a permanent one dollar increase in wealth emanating from an increase in housing prices is estimated to be a three cent increase in consumption.

A study by Purfield (2007), who uses India's annual data from 1975 to 2005 and applies a Vector Error Correction Model (VECM) econometric model in the determinants of consumption, finds that the macro impact of asset prices is relatively small.

While applying the VECM, Chen (2006) used Swedish data beginning from 1980:Q1 to 2004:Q4 and found the existence of a long-run or co-integrating relationship between consumption, disposable income, financial wealth and the housing wealth. His findings indicate that there is a significant relationship between housing wealth and overall expenditure on consumption by households.

In Hong Kong, Cutler (2004) also applied the life-cycle consumption model into the 1985:Q2 to 2000:Q4 data. His estimates posit that there is a solid and significant relationship between the movement in the residential property prices and the fluctuations in the expenditure on consumption by households. This relationship was found to be quite strong during the 1997 to 1998 downturn which was associated with a major decline

in the level of real consumption in Hong Kong. After having allowed for asymmetric response, Cutler's results reveal that home-owning households have a tendency to increase their level of consumption when they expect a future growth in the housing prices. The author maintains that in Singapore the government has imposed restrictions limiting the extent to which housing loans can be financed. As a result, collateral is found to be having a lesser effect on consumption.

Contrary to the overwhelming findings of a positive relationship between housing prices in US, UK, Australia and other countries, O' Sullivan and Hogan (2003) found no evidence of any relationship between private consumption and house wealth in Ireland. The authors used data on private consumption, nominal and real second house prices, short-term interest rate, personal disposable income and government consumption during the 1972 to 2002 period. Ensuing from the empirical evidence the authors conclude that the consumption growth during the period under investigation had not been financed by borrowing against housing wealth. Their estimates suggest that the abrupt increase in personal income explains all of the increase in the consumption patterns with a zero MPC arising from housing wealth.

Similar results are also reported by Phang (2002) who used aggregate consumption data in Singapore during the period 1981 to 2000. His estimation results reveal that the sharp increase in the housing prices during the period under review does not exhibit any positive effect on aggregate consumption. Basing his argument on the findings, Phang rejects the permanent income hypothesis.

3.4 Evidence from South Africa

In attempt to estimate the South African consumption function, Pretorius and Knox (1995) applied the Error Correction Model (ECM). As a result of the unavailability of official data on households' balance sheet, the authors failed to take into account variables such as consumers' wealth, debts and proxies for effects of financial liberalisation on consumption. Their explanatory variables are disposable income, direct

taxes on household, consumer credit, interest rates and investment in private residential buildings. Since their estimated equation didn't take into account the wealth effects (both housing and financial wealth), their results are therefore irrelevant to this study.

Following the PI-LCH, Aron and Muellbauer (2000) present a model suggesting an indirect but positive relationship between household consumption and financial liberalisation. Their model shows a correlation between financial liberalisation and credit constraints on house-owning households who anticipate future income growth. For those households owning houses, financial liberalisation increases the availability of collaterally secured loans while at the same time reducing deposit requirements for first-time buyers of residential properties.

Akin to Campbell and Cocco (2005), Aron and Muellbauer (2006) use empirical data from UK and SA to show that financial liberalisation increases borrowing capacity which in turn leads to financial assets booming and hence accelerating further borrowing and higher spending behaviour. Since financial liberalisation is an unobservable variable, Aron and Muellbauer use linear spline function²³ as a proxy to estimate its parameters using cross-equation restrictions. Their findings provide empirical evidence indicating that the failure to allow for financial liberalisation²⁴ for both the consumption function and debt equation results in the inability account for structural breaks in the equation. Nevertheless, their results provide evidence indicating that in the long-run, the estimated South African MPC arising from housing wealth ranges between seven percent and fourteen percent.

²³ Aron and Muellbauer (2000) treated financial liberalisation as an unobservable indicator entering both household debt and consumption equations. The financial liberalisation credit conditions index indicator, CCI, is proxied by a linear spline function, and the parameters of this function are estimated jointly with the consumption and debt equations.

²⁴ The process of liberalizing financial market in SA started as early as in the mid 80s following the de Kock Commission reports (1978, 1985) advocating a more market-oriented monetary policy. In the 1990s pensions were increasingly used to provide additional collateral for housing loans; while from 1995, special mortgage accounts (access bond accounts.) allowed households to borrow and pay back flexibly from these accounts up to an agreed limit set by the value of their housing collateral (Aron & Muellbauer, 2000).

3.5 Conclusion

This chapter presented an overview of the overwhelming evidence suggesting a positive correlation between housing wealth and expenditure on consumption, particularly in the US, the UK, Europe and other developed and developing nations. Contrarily, evidence from studies conducted in Ireland and Singapore suggest that there is no correlation between the variables under consideration. Instead, consumers' disposable income, interest rate and other factors such as credit regulations are argued to be the sole determinants of consumption. Evidence presented in this chapter further shows that PI-LCH is the general macroeconomic model adopted in explaining consumption patterns.

The remaining sections of the study will therefore focus on the long-run relationship between consumption and housing prices and then apply the PIH-LC theory to empirically investigate as to whether there are any relationships between changes in housing prices and consumption in South Africa and to what extent they exist, if there are any.

CHAPTER FOUR

EMPIRICAL INVESTIGATION

4.1 Introduction

The preceding chapter presented an overview of the overwhelming evidence suggesting a positive relationship between housing wealth and consumption. This chapter therefore focuses on the development and specification of the model suitable for the analysis of this relationship within the South African context. It starts by presenting the general framework for the model specification which is followed by the theoretical requirement of conducting both unit root and cointegration testing. The chapter proceeds by describing the relevant variables used in the study and concludes by presenting a vector error correction model (VECM), which is the specified model adopted for the analysis of the relationship between housing prices and consumption in SA.

4.2 Model Specification

The basic principle in the permanent-income/life-cycle hypothesis (PI-LCH) is that consumption decision is made to optimise utility over the life time (Thomson & Tang, 2004). However, the level of consumption will only be affected by permanent changes in income or wealth²⁵ (Chen, 2006). Phang (2003) and Souca (2008)²⁶, provide extensive literature on the empirical test of the PI-LCH.

The methodology adopted in this dissertation is similar to the one applied by Chen (2006) in his analysis of housing wealth and expenditure on consumption in Sweden. The multivariate conventional model specification is chosen as the co-integrating relationship between expenditure on consumption, disposable income and housing wealth particularly housing prices. For the purpose of this study, housing prices are used as a

²⁵ Wealth is made up of two components: financial and human wealth (*See Section 2.5 in Chapter Two*).

²⁶ Also see Ludwig and Slok (2002), Campbell and Cocco (2004) and Girouard and Blondal (2001).

proxy for households' wealth resulting from changes in housing prices. The randomly selected sample period for the study starts from the quarter one of 1980 to quarter four of 2007 (i.e. 1980:Q1 to 2007:Q4). Based on the discussion in *Chapter Three*, the appropriate model is therefore specified as:

$$\text{Log}C_t = \alpha_0 + \text{Log}\alpha_1 Y_t^d + \text{Log}\alpha_2 Y_t^{hp} + \varepsilon_t. \quad (4.1)$$

Where t refers to time, while C_t , Y_t^d , Y_t^{hp} and ε_t denote households' expenditure on consumption, households' disposable income at a time, housing prices and the error term respectively. All the variables are stated in logarithmic form so that the estimated coefficients could be treated as elasticities.

4.2.1 Unit Root Test

The standard econometric theory cautions that any regression run on time series data should be stationary, unless they are co-integrated (Harris, 1995). It is, however, common that time series variables can influence another with a time lag. Thus if the variables are non-stationary, this could lead to the problem of spurious regression (Koop, 2005).

If the time series data exhibits the non-stationary pattern, the Ordinary Least Square (OLS) estimation results might yield incorrect conclusions. For instance, even if the true value of the coefficient of the explanatory variable is zero, OLS could yield to a significant estimate which is totally different from zero. Statistical tests may indicate that the coefficient is not zero, however, the coefficient of determination (R^2) could be high even though there is no economic relationship between the variables under consideration (Dougherty, 2002)²⁷. Subsequent to this problem, there is a compelling need to conduct both the unit root as well as the cointegration tests for all time series variables under consideration.

²⁷ Also see Gujarati (1995), Harvey (1981) or Gouriéroux and Monfort (1990)

Taking this reality into account, and apply a simple univariate model, which is expressed in the first order autoregressive as:

$$Y_t = \rho Y_{t-1} + u_t. \quad (4.2)$$

In this simple univariate regression, the current dependent variable Y_t is influenced by its lagged variable Y_{t-1} plus the error term u_t . The variable Y_t will be stationary if $|\rho| < 1$, however if $\rho = 1$, then Y_t will be non stationary, implying that there is a presence of the unit root in the model (Harris, 1995). If the model contains non-stationary variables, this may then result in a problem of spurious regression, whereby it is falsely concluded that an economic relationship exists between the unrelated non-stationary series.

Equation (4.2) is alternatively expressed as:

$$\begin{aligned} \Delta Y_t &= (\rho - 1)Y_{t-1} + u_t \\ &= \delta Y_{t-1} + u_t, \end{aligned} \quad (4.3)$$

where $\delta = (\rho - 1)$ and Δ denote the first-difference operator. As explained in Gujarati (1995), since $\Delta Y_t = Y_t - Y_{t-1}$, this therefore implies that equations (4.2) and (4.3) are the same, the difference is that, in equation (4.3) the null hypothesis becomes $\delta = 0$, hence equation (4.3) can be stated as:

$$\Delta Y_t = (Y_t - Y_{t-1}) = u_t. \quad (4.4)$$

In equation (4.4) the series is differenced *once* before it becomes stationary, implying that it contains *one* unit root, this original random walk is therefore referred to as an

integrated of *order one*, which is depicted as $I(1)^{28}$ (Harris, 1995). Thus, in an attempt to test whether the series has a unit root, the study employs the formidable Augmented Dickey-Fuller (ADF) method. Following the ADF method, the null hypothesis of a unit root is rejected in favour of the stationary alternative in each case if the test statistic is more negative than the critical value.

For both theoretical and practical reasons regression in equation (4.2) is expanded to incorporate both the time trend and the drift term presented as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t. \quad (4.5)$$

The time variable is denoted as t . The null hypothesis that $\delta = 0$, that is, there is a unit root still holds (Gujarati, 1995). If the error term u_t is autocorrelated, then (4.5) is written as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t. \quad (4.6)$$

The null hypothesis that $\delta = 0$ or $\rho = 1$, from equation (4.2) that is a unit root exists in Y still holds. The application of equation (4.6) in testing for the presence of unit root is called augmented Dickey-Fuller (ADF) test. Each of the series will be tested for unit root and the results reported in the following chapter.

4.2.2 Testing for Cointegration

Cointegration is said to exist if the series under investigation are moving together and thus converge to form a long-term equilibrium position. Even though the series themselves may be non-stationary, they may nevertheless move together over time and

²⁸ If the original series is differenced twice before it becomes stationary, it will be therefore called integrated order *two* or $I(2)$. Intuitively, if a time series has to be differenced d times before it becomes stationary, it is therefore regarded integrated of order d or $I(d)$.

the difference between them be stationary (Dougherty, 2002). If, for example, time series variables Y_t and X_{it} are both $I(d)$, then in general any linear combination of the series will also be $I(d)$; that is, the residual obtained from regressing Y_t on X_{it} are $I(d)$. Consequently, this regression could be run as:

$$Y_t = \beta_1 + \beta_2 X_{it} + e_t. \quad (4.7)$$

Though Y_t and X_{it} might be non-stationary, however the combination of these variables might be stationary when lagged, particularly when stated as:

$$e_t = Y_t - \beta_1 - \beta_2 X_{it}. \quad (4.8)$$

If it were found in equation (4.8), that u_t is $I(0)$, that is, u_t is stationary, it can therefore be concluded that Y_t and X_{it} are integrated, implying that they have a long-term relationship (Gujarati.1995)²⁹. According to this analysis, as long as the variables have a common trend, relationship must exist in at least one direction. Masih & Masih, (1999), maintains that the “evidence of cointegration among variables also rules out the possibility of the estimated relationship being spurious”.

In testing for cointegration, the study will therefore apply both the Augmented Engle-Granger and Johansen methods as outlined in Enders (2004). In this test the study will adopt the null hypothesis expressed in equation (4.7), which states that variables Y_t and X_{it} are not cointegrated. Comparison of the estimated absolute value of t -statistic with the critical values at *one percent, five percent and 10 percent* levels of significant will be made. If the values of the estimated value of t -statistics are greater than the values of the critical values in the significant levels, the study will therefore conclude that u_t is stationary, implying that even if Y_t and X_{it} are non-stationary they are cointegrated.

²⁹ Also see Harris (1995), Enders (2004) or Hamilton (1994)

4.2.3 Cointegration and Error Correction Model

If the series in equation (4.7) is non-stationary, due stationarity observed from the error-term u_t in equation (4.8), it is therefore possible to conclude that the variables under consideration are cointegrated. In the short-run the variables presented in equation (4.7) are considered to be in the disequilibrium position, as a result, u_t could be treated as an “equilibrium error”. Thus, in order to measure the speed at which households’ expenditure on consumption adjusts back to its long-run equilibrium position, it therefore becomes essential to conduct a two-step error correction estimation approach. According to this approach, residuals emanating from the long-run relationship are captured in the second dynamic specification modeling changes in consumption. The second stage regression further allows for short-run influences on consumption from changes in different forms households’ wealth (HM Treasury, 2003). The operation of ECM is thus expressed as:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_{it} + \alpha_2 \hat{u}_{t-1} + \varepsilon_t, \quad (4.9)$$

where the first difference is denoted as Δ , meanwhile \hat{u}_{t-1} denotes the one-period lagged value of the regression in equation (4.7), which is the empirical estimate of the equilibrium error term. Equation (4.9) therefore postulates the change in Y_t to the change in X_{it} and the equilibrating error in the lagged period. The short-run disturbances in X_{it} is captured by ΔX_{it} , whereas the adjustment towards the long-run equilibrium is captured by the error correction term \hat{u}_{t-1} . Coefficient α_2 on the other hand depicts the proportion of the disequilibrium in Y_t during one period which is corrected during the next period (Banerjee et al, 1993).

4.2.4 Vector Error Correctional Model

It is evident in equation (4.7) that X_{it} influences Y_t , however, due to an endogeneity problem at the same time, Y_t might also influence X_{it} , implying that there is a two way movement between the variable under consideration (Koop, 2005). As results, all the variables included in the model should be treated as endogenous. Failure to do so will result into simultaneity biased estimation. Given this difficulty, it is therefore safer to “estimate a system of equations using the VECM”, (Chen, 2006).

VECM emanates from the restricted non-stationary but cointegrated vector autoregression (VAR) series. Unlike the single equation of ECM, VECM does not require the weak endogeneity condition of independent variables. Thus as pointed out by Chen (2006), the ECM further provides the direct test of the endogeneity of one variable to another. Most importantly, VECM provides both the coefficients of the short-run adjustments as well as the coefficients of the cointegration in the long-run. The short-run deviations from the long-run relationship are corrected back into the cointegration through the error correction term.

Since the model is derived from the VAR, it is therefore crucial to specify the preceding VAR model before specifying the VECM. VAR models gained popularity due to their framework flexibility, applicability, ability to produce economic models containing economic hypothesis that are easily interpreted using statistical tests (Kostov & Lingard, 2004). The VAR model is specified by for instance defining a vector Z , of n potentially endogenous variables, which is modeled as an unrestricted VAR involving up to k -lags of Z (Banerjee et al, 1993). The model is specified as:

$$Z_t = A_1 Z_{t-1} + \dots + A_k Z_{t-k} + u, \quad (4.10)$$

Variable Z_t represents $(n \times 1)$ and each of the A_i is an $(n \times n)$ matrix of parameters. Johnston & Dinardo (1997) argues that, “this type of VAR-model is advocated as a way

to estimate dynamic relationships among jointly endogenous variables without imposing restrictions such as structural relationships or the endogeneity of some of the variables”. It is a reduced system with each variable in Z_t regressed on only lagged values of both itself and all other variables in the system. The extension of equation (4.10) leads to the formulation of a VECM model which is stated as:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + u_t, \quad (4.11)$$

where $\Gamma_i = -(I - A_1 - \dots - A_i)$, ($i = 1, \dots, k-1$), and $(I - A_1 - \dots - A_k)$. The main advantage about equation (4.11) is that it is expressed in such a way that the system produces result estimates on both the short-run and long-run adjustment to changes in Z_t , via the estimates of $\hat{\Gamma}_i$ and $\hat{\Pi}$ respectively. A closer analysis of (4.11) reveals that $\Pi = \alpha\beta'$, where α represents the speed of adjustment to the equilibrium, while β is a matrix of long-run coefficient such that the term $\beta' Z_{t-k}$ embedded in (4.11) represents up to $(n-1)$ cointegration relationships in the multivariate model which ensure that Z_t converge to their long-run steady-state solutions (Harries, 1995)³⁰.

4.3 Data

Data used in this study is quarterly and seasonally adjusted, measured at 2000 prices; quoted in million rand; and expressed in the logarithmic form. The sample period chosen is 1980: Q1 to 2007: Q4. Data on households' expenditure on consumption and households' disposable income is sourced from the Policy and Research Unit of the South African Reserve Bank (SARB). “As the South African Central Bank, SARB collects, processes, interprets and publishes economic statistics and other information”. To this end, the Bank publishes, amongst others, Quarterly Bulletins, Annual Economic Reports³¹ etc.

³⁰ Also see Watson (1994) and Johnston and Dinardo (1997).

³¹ See the SARB website at www.resbank.co.za.

However, unlike developed countries such as UK, US, Australia etc. and some emerging economies such as Hungary, Mexico and Poland, SA has no records of any wealth estimates balance sheets. The wealth estimates that exist in SA were compiled by Aron et. al (2007a) and are not published using a market-value basis. Data on these balance sheet estimates published by the South African Reserve Bank (SARB) are on a book value and not on a market-value basis; hence require revaluation adjustments using appropriate asset price indices. In addition, some asset classes, e.g. official pensions and directly-held bonds, are published only as flow-of-funds data with no benchmarks.

Meanwhile, data on housing prices, which is already extrapolated and readily available, is sourced from the Amalgamated Banks of South Africa (ABSA) Group Limited (henceforth referred to as ABSA)³². In SA, there are only a few large financial institutions providing for personal and business clients of which ABSA is one. Amongst others, the ABSA Economic Research unit provides regular, well-researched support, advice and information regarding global and domestic economic trends and properties³³.

4.3.1 Variables

In an attempt to estimate the effect of housing wealth on consumption in South Africa, data on housing prices is used as a proxy for housing wealth. The variables used in pursuance of the study are final expenditure on consumption by households, households' disposable income and housing prices.

³² Data is from Absa Home Loans, a division of ABSA Group. The Absa House Price Indices are based on the total purchase price of houses in the 80m² to 400m² category. Prices are smoothed in an attempt to exclude the distorting effect of seasonal factors and outliers in the data. ABSA Group maintains that its data is derived from sources which are regarded as accurate and reliable and is general in nature.

³³ For more details see ABSA Group website, <http://www.absa.co.za>.

- **Consumption**

The real expenditure on consumption by households' data obtained is transformed into log terms. As in the case of Thomson and Tang (2004), this study broadly defines consumption in such a way that both durable and non-durable goods are treated as one basket. The rationale for the inclusion of both types of goods is based on the argument that firstly, in some instances, it becomes practically impossible for consumers en-masse to treat some durable goods such as clothing, footwear and households appliances as forming part of wealth. Secondly, there is a high level of inaccuracy associated with reliability of the depreciation rate of durable goods. Thirdly and most importantly, the objective of this study is to measure the overall relationship between residential property prices and consumption.

- **Income**

Households' total disposable income (Y_d)³⁴ which is quarterly, real and seasonally adjusted is the sum of both primary and secondary income. Primary income is mainly the labour income which constitutes more than 70 percent of the total household income. The remaining balance of plus or minus 30 percent is secondary income which comprises transfers from other households in the form of remittances, social grant benefits and workers' compensation and the transfers from the rest of the world (Aron et al, 2007a).

- **Housing Prices**

The South African big four commercial banks³⁵, compile data on Housing Price Indices (HPI)³⁶. Though data provided by these banks is compatible with minimum variant, for the purpose of this study, data from ABSA was randomly selected. Housing prices data

³⁴ Y_d is the level of income available to consumers to spend on consumption or save after having paid the direct tax and the transfer payments.

³⁵ The four big commercial banks in SA are ABSA, First National Bank (FNB), Standard Bank and Nedbank (Nedcor Group).

³⁶ HPI is the index of the market price of transacted private residential properties.

from ABSA is calculated based on the total purchase price of all new and old middle class houses in the 80 square metres to 400 square metres size category. Prices are smoothed so as to exclude any distorting effects arising from the seasonal factors as well as the outliers that might be contained in the data³⁷. For the purpose of this study, the monthly series data was transformed into quarterly by calculating the average values of each quarter.

4.4 Empirical Specification

4.4.1 Empirical model

Following the analysis from *section 4.2* in this chapter, a multivariate model of consumption, disposable income and house prices is developed. This model is then applied in the estimation of the effects of income and housing prices fluctuations on consumption expenditure by households. The VECM as specified by Phang (2002), Thomson and Tang (2004), Chen (2006) and Masih and Masih (1999) is adopted in this study. As in the case of most econometric models, VECM uses the Dynamic Ordinary Least Square (DOLS) methods to estimate both the short-run and the long-run relationship between the variables under investigation. The model therefore regresses the log of consumption on the logs of disposable income and housing prices. The empirical model as specified in *equation (4.1)* is therefore postulated as:

$$\text{Log}C_t = \alpha_0 + \text{Log} \alpha_1 Y_t + \text{Log} \alpha_2 HP_t + \varepsilon_t. \quad (4.12)$$

However as described in *section (4.2.4)*, *equation (4.12)* contains the problem of endogeneity, implying that Y_t could be influenced by C_t and HP_t ; or HP_t be influenced by C_t and Y_t . By following the VAR model, *equation (4.12)* is therefore expressed as:

³⁷ See ABSA website at www.absa.co.za.

$$\begin{aligned} \text{Log}C_t &= \beta_1 + \alpha_{11}\text{Log}C_{t-1} + \dots + \alpha_{1p}C_{t-p} + \delta_{11}Y_{t-1}^d + \dots + \delta_{1p}Y_{t-p}^d \\ &+ \lambda_{11}Y_{t-1}^{hp} + \dots + \lambda_{1p}Y_{t-p}^{hp} + e_{1t}; \end{aligned} \quad (4.13.1)$$

$$\begin{aligned} \text{Log}Y_t &= \beta_2 + \alpha_{21}\text{Log}Y_{t-1} + \dots + \alpha_{2p}Y_{t-p} + \delta_{21}C_{t-p} + \dots + \delta_{2p}C_{t-p} \\ &+ \lambda_{21}HP_{t-1} + \dots + \lambda_{2p}HP_{t-p} + e_{2t}; \end{aligned} \quad (4.13.2)$$

$$\begin{aligned} \text{Log}HP_t &= \beta_3 + \alpha_{31}\text{Log}HP_{t-1} + \dots + \alpha_{3p}HP_{t-p} + \delta_{31}C_{t-p} + \dots + \delta_{3p}C_{t-p} \\ &+ \lambda_{31}HP_{t-1} + \dots + \lambda_{3p}HP_{t-p} + e_{3t}. \end{aligned} \quad (4.13.3)$$

In this model, equation (4.13.1) tests whether Granger $\text{Log}Y_t$ and Granger $\text{Log}HP_t$ cause $\text{Log}C_t$, while (4.13.2) tests whether Granger $\text{Log}C_t$ and Granger $\text{Log}HP_t$ cause $\text{Log}Y_t$, whereas (4.13.3) presents the Granger causality test for $\text{Log}HP_t$ being caused or influenced by $\text{Log}C_t$ and $\text{Log}Y_t$. The model further incorporates the autoregression model which shows that dependent variable is also depending on lags of itself (Koop, 2005). As in the case of Cheng (2006), equations (4.13.1) through to (4.13.3) are then incorporated into a reduced form of VECM for $(n \times 1)$ vector of $I(d)$ process Y_t with r cointegrated vectors presented as:

$$\Delta Y_t = \alpha_t + \lambda \beta' Y_{t-k} + \Gamma(L) \Delta Y_{t-k} + e_t, \quad (4.14)$$

where ΔY_t denotes the $(n \times 1)$ vector of first difference of Y_t , α_t presents the vector of deterministic terms in the VAR, λ represents the $(n \times r)$ vector of adjustment coefficients, $\Gamma(L)$ denotes the vector of lag operator and β' denotes $(r \times n)$ cointegration vector. In this case r is the number of cointegration relations. Since the model consists of three variables, a ΔY_t represents the (3×1) vector of k difference of $\log(C, Y, HP)$ after normalization, then $\lambda \equiv (\lambda_c, \lambda_y, \lambda_{HP})$ and $\beta' \equiv (1, \beta_c, \beta_y, \beta_{HP})$. As stated earlier in

equation (4.13); C , Y and HP denote consumption, disposable income and housing prices respectively.

4.5 Conclusion

The primary focus of this chapter was to develop the model specification for the study. The chapter started by providing the general framework of the model specification which was then followed by the theoretical requirement of conducting both unit root and cointegration tests. Given the problem of endogeneity, it then became crucial to pay particular attention on the VECM which has been adopted as the specified model for the study. Now that the model is specified the next chapter will therefore present the VECM's results and analysis thereof.

CHAPTER FIVE

ESTIMATION AND RESULTS ANALYSIS

5.1 Introduction

Having specified the estimation model in the previous chapter and following the standard norm of analysing the variables in a time series data, this chapter starts by reporting on the analysis of both the unit root and cointegration test results. This is then followed by the report on both the long-run and the short-run estimates of the VECM. These estimates were obtained using the E Views computer software package³⁸. The chapter concludes by providing a brief outline of the critical issues pertaining to the findings.

5.2 Unit Root Test Results

Estimated results of the unit root test depend on whether the selected equation includes the intercept, time trend or none of them (Johnston & Dinardo, 1997). Thus, following the Augmented Dicky-Fuller (ADF) unit root test procedures in each of the series, the study therefore specifically simulates the general principle applied by Kuo, Tsai, and Chen (2003: 496) of fitting “a specification that is a plausible description of the data under both the null hypothesis and the alternative”.

As indicated in Chapter Four (*section 4.2.1*), the study employs the ADF’s procedure to investigate the statistical evidence for stationarity. The tests are applied to the levels as well as the differences of the series. Since the lag length selection affects the power performance of ADF tests, lag length selection is therefore fundamental. The inclusion of additional lagged dependent variables has a tendency of reducing the power of the ADF to detect a unit root (Chen, 2006)³⁹. “In fact ADF may indicate a unit root for some lag

³⁸ EViews is one of the statistical computer software used for the analysis economic data, with particular emphasis on time series data.

³⁹ Also see Enders (2004)

lengths but not for others” (Enders, 2004:192). For the purpose of this study, the maximum number of lags is determined using the Akaike Information Criteria (AIC).

Variables names used in the regression models are described in *Table 5.1*. *Tables 5.2* through *5.4* below provide a summary of the estimated results following the ADF procedure of unit root test and the full result estimates are provided in *Appendix A*.

Table 5.1: List of Variable Names and Description

Variable Name	Description
Log_cons	Log of Households' Total Expenditure on Consumption
Trend Cons	Trend variable for Households' Total Expenditure on Consumption
C Log_Cons	Constant for Households' Total Expenditure on Consumption
D(Dlog_Cons)	Differenced Log per Capita Households' Expenditure on Consumption
Log_inc	Log of per Capita Households' Disposable Income
Trend Inc	Trend variable for Disposable Income
C Log_inc	Constant for Households' Total Disposable Income
D(Dlog_Inc)	Differenced Log per Capita Households' Disposable Income
LOG_HP	Log of House Price
Trend HP	Trend variable for Log Housing Prices
C Log_HP	Constant for Log Housing Prices
D(Log_HP)	Differenced Log of H

The first step (*step one*) of the ADF’s unit root test procedure presents the most general unrestricted model of conducting a unit root test which is expressed as:

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \sum \beta_i \Delta Y_{t-i} + \varepsilon_t, \quad (5.1)$$

Subsequently, as indicated in Enders (2004), it is vitally important to use the regression equation that resembles the original data-generating process (DGP). By improperly omitting the intercept or time trend one could reduce the power of the unit root test close to zero. For example, the omission of an intercept and time trend as in the restricted models from *equations (5.2)* and *(5.3)* where they should be included might result in an inflated value of the estimated γ . While at the same time, the inclusion of additional

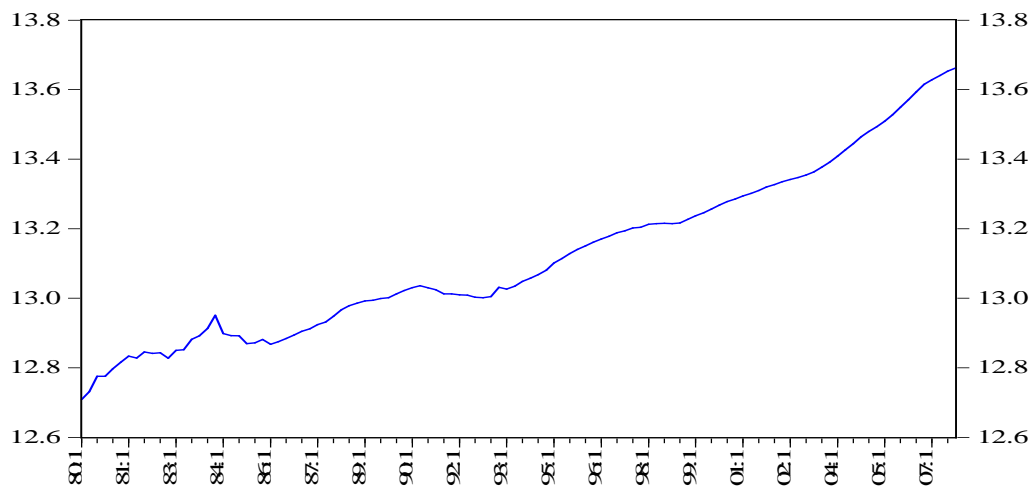
regressors might increase the critical values such that it becomes impossible to reject the true null of unit root when it should be rejected (Enders, 2004).

$$\Delta Y_t = \gamma Y_{t-1} + \sum \beta_i \Delta Y_{t-i} + \varepsilon_t, \quad (5.2)$$

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + \sum \beta_i \Delta Y_{t-i} + \varepsilon_t, \quad (5.3)$$

- **Unit Root Test - Consumption Series**

Figure 5.1: Log of Expenditure on Consumption, 1980: Q1 to 2007: Q4



Source: Own Calculations using Total and Seasonally Adjusted Final Expenditure by Households at Constant 2000 Prices in R Millions Obtained from SARB (2009).

Figure (5.1) above illustrates that households' expenditure on consumption increases over time. Though the series is trending upward, the trend is however not deterministic, particularly during the periods 1983 to 1986 and 1991 to 1993. An upward trending series is the first indication that the series per se is non-stationary hence warranting a unit root test.

The unrestrictive model in equation (5.1) containing both the intercept and the deterministic trend is used to test for the null hypothesis of $\gamma = 0$. From this model, the

computed ADF t -statistics value of -0.8760 is less than the tau (τ_τ) critical values of -4.0461 , -3.4524 and -3.1517 at 1 percent, 5 percent and 10 percent significant levels, respectively. The model therefore fails to reject the null hypothesis of $\gamma = 0$, that is unit root (Table 5.1). (See Table A1 in Appendix A for full result estimates).

Table 5.2: Augmented Dickey Fuller (ADF) Unit Root Test Results – Log of Consumption, 1980: Q1 to 2007: Q4

	Augmented Dickey-Fuller (ADF) Unit Root Test				
	<i>t-Statistics</i>	<i>P-Value</i>	Critic (1%)	Critic (5%)	Critic (10%)
Log_Cons with Trend and Constant	-0.8760	0.9542	-4.0461	-3.4524	-3.1517
Log_Cons with Constant but no Trend	1.6874	0.9996	-3.4925	-2.8887	-2.5813
Log_Cons without Trend and Constant	2.7325	0.9984	-2.5868	-1.9439	-1.6147
Differenced Log_Cons	-6.1853	0.0000	-4.0487	-3.4536	-3.1524

The unit root test is conditional to presence of the deterministic regressors, while on the other hand, the test for the presence of deterministic regressors is conditional on the presence of a unit root (Enders, 2004). This, therefore, leads to the application of the second step (*step two*) of the ADF's test which determines whether the time trend needs to be included in the model that is testing the hypothesis of $a_2 = 0$, given that the series contains a unit root ($\gamma = 0$). From equation (5.1), the point estimates of the ADF^{40} are postulated as:

$$\Delta \text{Log_Cons}_t = 0.2588 - 0.0203 \text{Log_Cons}_{t-1} + 0.0002t + 0.0721 \Delta \text{Log_Cons}_{t-1} + \varepsilon$$

(0.8795)
 (-0.8760)
 (1.2632)
 (0.7218)

(5.4)

The t -statistics of 1.2631 for the null hypothesis of $a_2 = 0$ suggests that the coefficient of the time trend is not significantly different from zero. Hence the model fails to reject the null hypothesis of $a_2 = 0$ at the conventional levels of significance, indicating that the

⁴⁰ The t -statistics values are in parentheses.

series does not contain a deterministic trend. (See Table A1 in Appendix A for full result estimates).

To test for the joint hypothesis $a_2 = \gamma = 0$, I also use the Dicky Fuller's (*DF*) *F*-statistics⁴¹ procedure of conducting a joint hypothesis test. Following *DF*'s procedure, the joint hypothesis regression in equations (5.1) is stated as $a_2 = \gamma = 0$. Since the null hypothesis is to test whether the deterministic trend should be included in the model or the two parameters jointly equal to zero, the *DF test* is therefore conducted using ϕ_3 .

With 107 observations, the calculated sample value of ϕ_3 for the restriction is 0.820 (see the calculations in Appendix B2). The *DF*'s critical *F*-statistics values of ϕ_3 with 100 observations are 5.47, 6.49 and 8.73 at 10 percent, 5 percent and 1 percent levels of significance, respectively. Since the calculated value of ϕ_3 is smaller than the *DF*'s critical values at 10 percent, 5 percent and 1 percent respectively, the null hypothesis of $a_2 = \gamma = 0$ is not rejected. The failure to reject the null hypothesis implies that the restriction $a_2 = \gamma = 0$ is not binding, meaning that the consumption series contains a unit root but without a deterministic trend. As a result the model is estimated using equation (5.3) which contains a drift but without a trend, that is **step three** of the ADF's test procedure. Using values from Table A2 in Appendix A, the substitution in equation (5.3), leads to⁴²:

$$\Delta \text{Log}_{-} \text{Cons}_t = -0.1040 + 0.0083 \text{Log}_{-} \text{Cons}_{t-1} + 0.0617 \Delta \text{Log}_{-} \text{Cons}_{t-1} + \varepsilon_t$$

(-1.6236)
(1.6874)
(0.6182)

(5.5)

In equation (5.5), the *t*-statistics for the null hypothesis of $\gamma = 0$ is 1.687. Since this *t*-statistics value is smaller than the τ_μ critical values of -3.4925, -2.8887 and -2.5813 at 1

⁴¹ Dicky and Fuller's *F*-statistics called ϕ_1 , ϕ_2 and ϕ_3 are used to test for a joint hypothesis of the coefficients.

⁴² The *t*-statistics values are in parentheses.

percent, 10 percent and 5 percent levels of significance, respectively, the null hypothesis that the series contains a unit root is still not rejected. However, the power of the test might have been reduced if the constant does not belong in the model. Subsequently, the presence of the constant, given unit root, that is $a_0 = \gamma = 0$ is tested using *DF's* ϕ_1 statistic. The calculated *DF's* ϕ_1 statistic for the restriction $a_0 = \gamma = 0$ is 1.343 (See Appendix B3 for calculation of the ϕ_1 statistic). Since the ϕ_1 statistic value of 1.343 is smaller than the critical values of 3.86, 4.71 and 6.70 at 10 percent, 5 percent and 1 percent levels of significance, respectively, it is concluded that the restriction is not binding. This conclusion implies that the null hypothesis of $a_0 = \gamma = 0$ is not rejected meaning that series contains a unit root but without a drift term.

The conclusion that the series is without both a deterministic trend and drift term is also confirmed by the *DF's* procedure of testing the null hypothesis that the data generated by the restricted regression without intercept and/or trend - equation 5.2 against the alternative unrestricted model stated in equation (5.1) is the true model using the ϕ_2 statistics. This is the same as testing the null hypothesis of $a_0 = a_2 = \gamma = 0$.

Following this procedure, the critical values of *DF's* ϕ_2 for 100 observations are 6.50, 4.88, and 4.16 and 6.50 at the 1 percent, 5 percent and 10 percent, respectively. The application of equations (5.1) and (5.2) into the 107 consumption data points indicates that the calculated 1.457 value of ϕ_2 is smaller than the 1 percent, 5 percent and 10 percent critical values. (See the calculations in appendix B1). Since the calculated value of ϕ_2 is smaller than the *DF's* critical values at conventional levels of significance, the model does not reject the null hypothesis that the restriction is binding, confirming that the series contains a unit root but without a deterministic trend and a drift term.

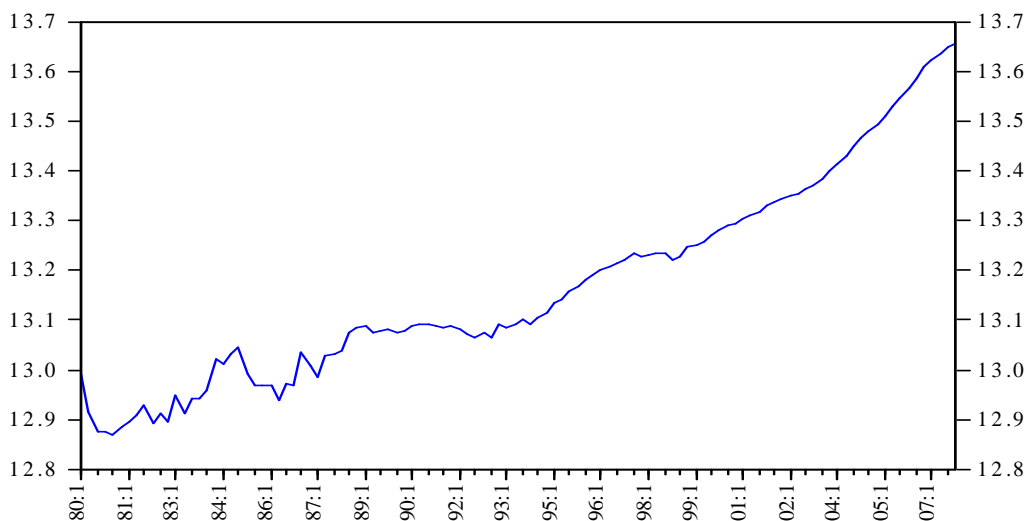
With the empirical evidence suggesting that the series is without the trend and drift, the final step is to estimate the model using equation (5.3). The use of τ -statistics from table

5.2 – with the full result estimates presented in *Table A3 in Appendix A* still fails to reject the null hypothesis that the series contains a unit root.

Furthermore, as Enders (2004) maintains, consumption and permanent income are reasonably integrated into order one $I(1)$. If the log of consumption series used in this analysis is differenced once, it becomes stationary, thus further implying that the original series is integrated of order 1 that is $I(1)$ (see *figure A1 in Appendix A*). The observation from *figure A1* is further confirmed by the t -statistics of -13.929 , which is smaller than the critical values of -2.586 , -1.944 and -1.615 at 1 percent, 5 percent and 10 percent respectively (see *table 5.2 from above and table A4 in Appendix A for full result estimates*). As a result, for the differenced log consumption series, the null hypothesis $\gamma = 0$ that the series contains a unit root is rejected at conventional levels of significance in favor of the alternative hypothesis of $\gamma \neq 0$, meaning that differenced series is stationary.

- **Unit Root Test - Disposable Income Series**

Figure 5.2: Log of Disposable Income, 1980: Q1 to 2007: Q4



Source: Own Calculations using Seasonally Adjusted data on Disposable Income at 2000 Constant Price (in R Millions), Obtained from SARB (2009)

The log disposable income exhibits a stochastic random walk non-stationary time series (*figure 5.2*). Following similar procedure as applied in consumption series; the application of *step one* of the ADF unit root test procedures indicates that the model fails to reject the null of unit root ($\gamma = 0$) at the conventional levels of significance (*Table 5.3*). (*The full result estimates are presented in Table A6 of appendix A*). This, therefore, confirms the presence of a unit root in the disposable income series.

Table 5.3: Augmented Dickey Fuller (ADF) Unit Root Test Results – Log of Disposable Income, 1980: Q1 to 2007: Q4

	Augmented Dickey-Fuller (ADF) Unit Root Test				
	<i>t</i> - <i>Statistics</i>	<i>P</i> - <i>Value</i>	Critic (1%)	Critic (5%)	Critic (10%)
Log_inc with trend and Constant	-0.2854	0.9902	-4.0452	-3.4520	-3.1514
Log_inc with Constant but no Trend	2.2132	0.9999	-3.4908	-2.8879	-2.5809
Log_inc without Constant and Trend	3.6059	0.9999	-2.5866	-1.9438	-1.6148
Differenced Log_inc	-4.3750	0.0006	-3.4992	-2.8916	-2.5828

Step two of the ADF's unit procedures tests for the presence of a time trend that is $a_2 = 0$, given the presence of the unit root $\gamma = 0$. The *t*-statistics value of the deterministic trend variable in equation (5.6) implies that the test fails to reject the null hypothesis of $a_2 = 0$, suggesting the series does not contain a deterministic trend. (*See Table A6 in Appendix A for full result estimates*)⁴³.

$$\Delta \text{Log_Inc}_t = 0.1282 - 0.0098 \text{Log_Inc}_{t-1} + 0.0001t - 0.2244 \Delta \text{Log_Inc}_{t-1} + \varepsilon$$

$$(0.2910) \quad (-0.2854) \quad (0.7112) \quad (-2.1552)$$

(5.6)

I then use the ϕ_3 , of the *DF's F*-statistics to test for the joint null hypothesis $a_2 = \gamma = 0$, with an *F*-statistics of 7.311 (*see Appendix B5*) which is greater than the 5 percent and 10 percent critical values of 6.49 and 5.47 respectively, the null hypothesis that

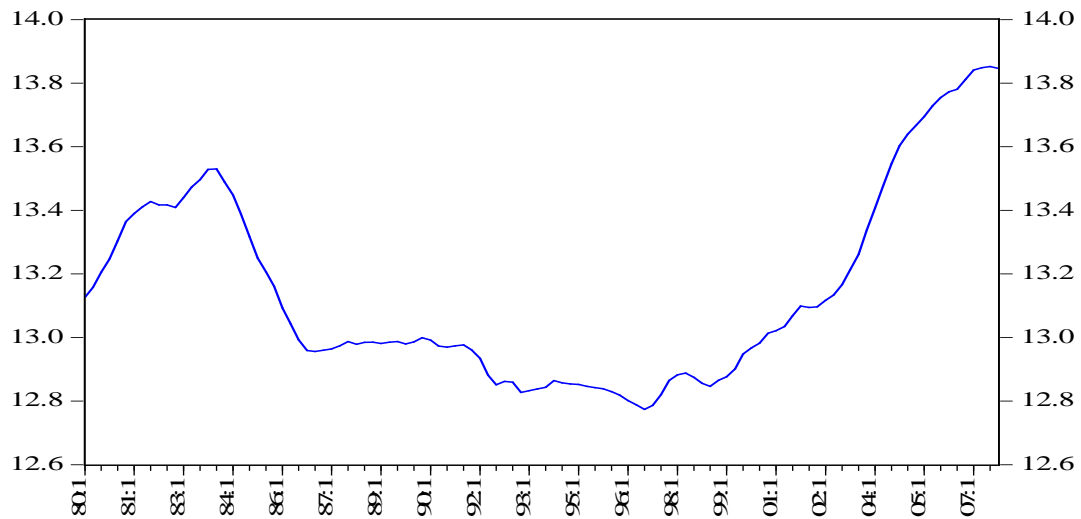
⁴³ The *t*-statistics values are in parentheses.

$a_2 = \gamma = 0$, is rejected. The rejection of the null hypothesis implies that the restriction is binding, meaning that the series contains a unit root a deterministic trend. Hence, the null hypothesis of the presence of the unit root is retested using normal distribution. The overall conclusion is that the series has a unit root and a deterministic trend.

As observed in figure A3 - Appendix A, an observation which is confirmed by unit root test results, the series becomes stationary if it is differenced once that is $I(1)$ (Table 5.3). (See tables A6 through A9 in Appendix A for full result estimates).

- **Unit Root Test – Housing Prices**

Figure 5.3: Log of House Prices, 1980: Q1 to 2007: Q4



Source: Own Calculations Using Housing Prices Data obtained from ABSA (2009)

Figure 5.3 shows that housing price series is more like a random walk. Akin to the consumption and disposable income series, the ADF test procedure is applied in the housing prices series. Similar to the findings in the consumption and disposable income series, the application of the ADF’s procedural unit root test also fails to reject the true null of $\gamma = 0$ at the conventional levels of significance. The t -statistics of 2.3694 for the null hypothesis of $a_2 = 0$ suggests that the coefficient of the time trend is significantly

differently from zero. Hence, the model rejects the null hypothesis of $a_2 = 0$ at 5 percent and 10 percent levels of significance, indicating that the series contains a deterministic trend. (See Table A11 in Appendix A for full result estimates).

Subsequently, the joint hypothesis of $a_2 = \gamma = 0$ is tested using the ϕ_3 statistics. The critical values of ϕ_3 are 8.73, 6.49 and 5.47 at 1 percent, 5 percent and 10 percent respectively. The calculated sample value of ϕ_3 statistic is 0.5231 (see Appendix B8 for the calculation of ϕ_3 statistic). Since 0.523 is far smaller than the critical values of 8.73, 6.49 and 5.47 at 5 percent and 10 percent, respectively, it is concluded that the restriction is not binding, meaning that the null hypothesis of $a_2 = \gamma = 0$ is not rejected. Given that the series contains no time trend requires procession to step three that is estimating the model without the trend. Using estimates from Table A12 in Appendix A, the model is stated as:

$$\Delta \text{Log}_{-} \text{HP} = 0.0981 - 0.0075 \text{Log}_{-} \text{HP}_{t-1} + 1.0102 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t \quad (5.7)$$

$$(1.2763) \quad (-1.2723) \quad (10.2847)$$

In equation (5.7), the t -statistics⁴⁴ for the null hypothesis $\gamma = 0$ is -1.276. Since this t -statistics value is less than the critical values of -3.493, -2.889 and -2.581 at 1 percent, 5 percent and 10 percent respectively, the null hypothesis is not rejected. Again, the power of the test could have been reduced if the intercept did not belong in the model. As a result, ϕ_1 statistics is used to test for the presence of the drift term. The calculated ϕ_1 of 0.846 is far less than the ϕ_1 critical values at the conventional levels of significance, thus leading to the conclusion that the restriction is not binding (see Appendix B9). The overall conclusion is that the housing prices series has a unit root and should be estimated without a deterministic trend and intercept.

⁴⁴ The t -statistics values are in parentheses.

Figure A5 (Appendix A) suggests that the series becomes stationary after it is differenced once indicating that housing prices series is also integrated into $I(1)$. This observation is confirmed by the unit root test results which reveal that the test rejects the null hypothesis of the presence of a unit root at the conventional levels of significance (Table 5.4). (See tables A11 through A15 in Appendix A for full result estimates).

Table 5.4: Augmented Dickey Fuller (ADF) Unit Root Test Results – Log of Housing Prices, 1980: Q1 to 2007: Q4

	Augmented Dickey-Fuller (ADF) Unit Root Test				
	<i>t-Statistics</i>	<i>P-Value</i>	Critic (1%)	Critic (5%)	Critic (10%)
Log_HP with Trend and Constant	-0.7387	0.9671	-4.0461	-3.4524	-3.1517
Log_HP with Constant but no Trend	-1.2723	0.6403	-3.4931	-2.8889	-2.5815
Log_HP without Constant and Trend	0.1875	0.7387	-2.5870	-1.9439	-1.6147
Differenced Log_HP	-6.2914	0.0000	-4.0469	-3.4528	-3.1519

5.3 Cointegration Test Results

Following the unit root test results, the study allows for linear deterministic trend in the data with an intercept and trend in the cointegration error (CE) but no trend in the vector autoregression (VAR). Consequently, in pursuance of the cointegration test, the study follows Enders’ (2004) recommendation of applying both the Engle-Granger⁴⁵ and Johansen methodologies. The first subsection is mainly devoted to the former methodology while the second part focuses on the latter.

5.3.1 The Engle-Granger Cointegration Method

Following the theoretical procedure of this method, the first step (*step one*) is to determine the order of integration in the three variables under investigation using the following equation:

⁴⁵ The application of Engle-Granger method is appropriate when there is one cointegrating vector. This implies that if the model contains more than two variables there could be more than one cointegrating vector; under such circumstances the Engle-Granger method is inappropriate (Enders, 2004).

$$\Delta Y_t = \alpha_t + \alpha_1 Y_{t-1} + \sum_{i=1}^n \alpha_{i+1} \Delta Y_{t-i} + \varepsilon_t, \quad (5.8)$$

For each series, the results of ADF unit root test are reported in tables 5.2 to 5.4 above with the full result estimates in *Appendix A*. As discussed in *section 5.2*, the null hypothesis of unit root that is $\alpha_1 = 0$ could not be rejected for all the three variables under investigation. Based on these result estimates, it was concluded that both logs of consumption and housing prices are without a trend and intercept, while log of disposable income was found to be with a deterministic trend. The empirical evidence further indicated that logs of consumption and housing prices contain *four lags* each, while log of disposable income has *one lag*. With regards to the order of integration order, the ADF unit root test suggests that the three variables are integrated into $I(1)$. Since the variables are presumed to be in the same integration order $I(1)$, the next step (*step two*) is to estimate the long-run equilibrium relationship in the form of:

$$Y_t = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + e_{yt}. \quad (5.9)$$

From equation (5.9), Y_t represents log of consumption, X_2 and X_3 denote logs of housing prices and disposable income respectively, while e_{yt} denotes residuals of Y_t . The substitution of the long-run estimates into equation (5.9) leads to:

$$\begin{aligned} \text{Log_Cons}_t &= -2.11 - 0.02 \text{Log_HP} + 1.18 \text{Log_inc} + e_{yt}. \\ &\quad (-10.8858) \quad (-2.0994) \quad (76.5495) \\ \text{Durbin-Watson} &= 0.5320 \end{aligned} \quad (5.10)$$

The main purpose of running the long-run regression model in equation (5.10) is to obtain the estimated residuals showing values of the deviations from the long-run relationship⁴⁶. Full result estimates of the long-run relationship and the estimated residuals thereof are found in *table C1* of *Appendix C*. In order to determine whether cointegration amongst variables exists, equation (5.9) is estimated as:

⁴⁶ The *t-statistics* values are in parentheses.

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \varepsilon_t \quad (5.11)$$

The \hat{e}_t series are the estimated values of the deviation from the long-run relationship. If these deviations are found to be stationary, then the variables in *equation (5.10)* will be considered cointegrated into $I(d)$. From *Table C2 in Appendix C*, the *t*-statistics value of -8.9587 exceeds the -2.585962 , -1.943741 and -1.614818 critical values at 1 percent, 5 percent and 10 percent respectively. This, therefore, leads to the conclusion that the \hat{e}_t series is stationary and hence the variables are cointegrated. The DW statistics value of 1.668 exceeds the critical value of 0.386 (at the 5 percent level), thus I reject the null hypothesis of non-stationarity. This further confirms that the variables are cointegrated. *Figure C1* also confirms this result. Similar conclusion is reached even if either housing prices or disposable income is made a dependent variable in *equations (5.8) and (5.9)* (see *Table C3 and Figure C2 in Appendix C*).

Since the results fail to reject the null hypothesis of no cointegration, implying that the three variables are jointly determined, the next step (***step three***) is therefore to estimate the error-correction model, using residuals from the equilibrium regressions. With *three* variables under investigation, the error-correction model is estimated as either:

$$\Delta Y_t = \alpha_1 + \alpha_y \hat{e}_{t-1} + \sum_{i=1} \alpha_{11}(i) \Delta y_{t-i} + \sum_{i=1} \alpha_{12}(i) z_{t-i} + \sum_{i=1} \alpha_{13}(i) w_{t-i} + \varepsilon_{yt}, \quad (5.12)$$

$$\Delta z_t = \alpha_2 + \alpha_z \hat{e}_{t-1} + \sum_{i=1} \alpha_{21}(i) \Delta z_{t-i} + \sum_{i=1} \alpha_{22}(i) y_{t-i} + \sum_{i=1} \alpha_{23}(i) w_{t-i} + \varepsilon_{zt} \quad \text{Or} \quad (5.13)$$

$$\Delta w_t = \alpha_3 + \alpha_w \hat{e}_{t-1} + \sum_{i=1} \alpha_{31}(i) \Delta w_{t-i} + \sum_{i=1} \alpha_{32}(i) y_{t-i} + \sum_{i=1} \alpha_{33}(i) w_{t-i} + \varepsilon_{wt}. \quad (5.14)$$

In *Equations (5.12) through (5.14)*; α_y , α_z and α_w capture the speed of the adjustment parameters from the short-term disequilibrium to the long-term equilibrium, while α_{11}

through to α_{33} denote the parameters of the explanatory variables. Subsequently, the use of the estimates from *Table C4 in Appendix C* yields to:

$$\Delta DLog_cons_t = 4.25E05 - 0.0006e_{t-1} - 0.45\Delta Dlog_cons + 0.09\Delta Dlog_HP_{t-1} - 0.03\Delta Dlog_inc_{t-1} + \varepsilon_{cons}$$

$$(0.04498) \quad (-0.28696) \quad (-2.02903) \quad (1.46879) \quad (-0.14810)$$

(5.15)

$$\Delta DLog_HP_t = 0.0020 + 0.0078e_{t-1} - 0.002\Delta Dlog_HP_{t-1} + 0.33\Delta Dlog_inc_{t-1} - 0.36\Delta Dlog_cons_{t-1} + \varepsilon_{cons}$$

$$(-0.80270) \quad (1.37283) \quad (-0.01314) \quad [(0.57928) \quad (-0.62281)$$

(5.16)

$$\Delta DLog_inc_t = -0.0012 + 0.0044e_{t-1} + 0.67\Delta Dlog_inc_{t-1} + 0.037\Delta Dlog_HP_{t-1} - 1.31\Delta Dlog_cons_{t-1} + \varepsilon_{cons}$$

$$(0.78374) \quad (1.24391) \quad (1.92693) \quad (0.36926) \quad (-3.63860)$$

(5.17)

Equations (5.15) through (5.17) consist of a first order VAR containing a single error-correction term $e_{cons(t-1)}$. The values of $e_{cons(t-1)}$ term are non zero in all three equations indicating that there is a long-run relationship in the series. The error-corrections are *0.06 percent*, *0.78 percent* and *0.04 percent* respectively. The values of the error-correction terms are marginal, indicating slower adjustment back to equilibrium following a disturbance in the previous period. Only $e_{cons(t-1)}$ from equation (5.11) is with the expected negative sign, which is line with the convergence towards the long-term equilibrium. Responding to the discrepancy in $e_{cons(t-1)}$, both housing prices and income are apparently increasing while consumption on the other hand is decreasing. Notably, the *t*-statistics in the parenthesis suggest that the error-correction terms are insignificant in all three equations. Finally, from *Table C5 in Appendix C*, the *DW* value of *1.96* indicates that residuals are white noise and are not serially correlated implying that the lag length period chosen is appropriate.

5.3.2 The Johansen Cointegration Method

Following the Johansen’s cointegration testing procedure, the first step (*step one*) is to determine the number of lags (k) in the vector autoregression (VAR). *Table 5.5* presents the results of the number of lags selection method using the optimum number of 6 lags in the VAR model (*Full result estimates of the VAR are provided in appendix D*). With 106 observations, based on the AIC statistics, the results show that at 5 percent level of significant, k equals to 2, indicating that the lags order of *two* are sufficient for the VAR model. The lag selection of $k = 2$ is further confirmed by the statistical results from the Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ).

Table 5.5: Statistical Values of the VAR Lag Order Selection Criteria for Logs of Consumption, Housing Prices and Disposable Income, 1980: Q1 to 2007: Q4

	Augmented Dickey-Fuller (ADF) Unit Root Test				
	<i>t-Statistics</i>	<i>P-Value</i>	Critic (1%)	Critic (5%)	Critic (10%)
Log_HP with Trend and Constant	-0.7387	0.9671	-4.0461	-3.4524	-3.1517
Log_HP with Constant but no Trend	-1.2723	0.6403	-3.4931	-2.8889	-2.5815
Log_HP without Constant and Trend	0.1875	0.7387	-2.5870	-1.9439	-1.6147
Differenced Log_HP	-6.2914	0.0000	-4.0469	-3.4528	-3.1519

Now that the k is confirmed to be equals to *two*, the *next step (step two)* is to estimate the model and determine r that is the number of cointegrating relationships among the *three* variables in the VAR. Tables 5.6 and 5.7 report on the Johansen’s cointegration rank test among the three variables under investigation. (*See full output results of the cointegration test in Appendix E*). Report in *Table 5.6* is based on the Trace analysis while *Table 5.7* provides statistical results using Maximum Eigenvalue.

Table 5.6: Cointegration Test Using Trace (λ_{Trace}), 1980: Q1 to 2007: Q4

Lag	LogL	LR	FPE	AIC	SC	HQ
0	264.6715	NA	1.44e-06	-4.937197	-4.861817	-4.906645
1	899.4167	1221.585	1.07e-11	-16.74371	-16.44219	-16.62150
2	952.3886	98.94754	4.69e-12*	-17.57337*	-17.04571*	-17.35951*
3	955.1860	5.067059	5.27e-12	-17.45634	-16.70254	-17.15082
4	969.3276	24.81443*	4.80e-12	-17.55335	-16.57341	-17.15617
5	978.6593	15.84624	4.78e-12	-17.55961	-16.35352	-17.07078
6	984.8344	10.13647	5.07e-12	-17.50631	-16.07408	-16.92582

Starting with trace (λ_{trace}), which is usually the less preferred method of testing the null that number of cointegrating vector r is less than or equal to some number against the alternative that it is one larger than that number (Enders, 2004). The first line in the t -statistics tests that $r = 0$ against $r > 0$. As the critical values of 42.9152 exceeds the statistic value of 37.7149, the test fails to reject the null $r = 0$ at the 5 percent level of significance. The test for the null that $r \leq 1$ against $r > 1$ indicates that at the 5 percent level, the t -statistics of 11.8156 is insignificant, meaning that the null cannot be rejected. Trace, therefore, concludes that there is no evidence suggesting a cointegration relationship between the variables in the VAR model.

Table 5.7: Cointegration Test Using Maximum Eigenvalue (λ_{Max}), 1980: Q1 to 2007: Q4

Unrestricted Cointegration Rank Test (Maximum Eigenvalue), 106 observations with 4 Lags				
Hypothesised No. of CE(s)	Eigenvalue	Trace Statistics	5 % Critical Value	Probability** Value
r=0*	0.2115	25.8994	25.8232	0.0489
r=1	0.0781	8.8636	19.3870	0.7384
r=2	0.0267	2.9519	12.5180	0.8822

Contrary to the trace test, results from the maximum eigenvalue reject the null hypothesis of $r = 0$ at the 5 percent level of significance against the alternative that $r = 1$. The rejection of the null is informed by the t -statistics of 25.8994 which exceeds the 5 percent critical value of 25.8232. Regarding the null hypothesis of $r = 1$ against $r = 2$, the statistics of 8.8636 is insignificant at the 5 percent level of significance, suggesting that the null cannot be rejected. Thus, the maximum eigenvalue cointegration rank test

concludes that r ; the number of cointegrating vectors at the 5 percent level of significance is *one*.

The finding that the model contains at least one cointegrating vector warrants progression to *step three* of Johansen methodology of testing for cointegration in a VAR. As pointed out in Enders (2004), step three requires an analysis of the normalised cointegrating vectors and speed of adjustment coefficients. Under this procedure, a reduced rank regression in which α and β are each restricted to be $(n \times r)$ is estimated. Since the model contains three variables that is $n = 3$ and $r = 1$, the vector is stated as (3×1) . The estimated value of the single β vector becomes the estimates of the parameters of the single cointegrating relationship. *Appendix E* provides the estimates of the normalisation process. The normalised cointegrating vector is presented as:

$$\beta_1 \text{Log_Cons}_t + \beta_2 \text{Log_HP}_t + \beta_3 \text{LogLog_inc} + \beta_4 t_t = 0 \quad (5.18)$$

Since it is concluded that that $r = 1$, thus from equation (5.18), the estimated cointegrating vector is β , hence the model has parameters β_1 , β_2 , β_3 and β_4 . The values of the parameters of β are -64.012, -1.03, 65.57 and 0.04 respectively. After normalisation with respect to β_1 , the parameters of the normalised vector become 1.00, 0.02, -1.02 and -0.0007 respectively.

The substitution in *equation (5.18)* results to:

$$1.0 \text{Log_Cons}_t + 0.02 \text{Log_HP}_t - 1.02 \text{Log_inc} - 0.0007 t_t = 0.$$

Thus:

$$\text{Log_Cons}_t = -0.02 \text{Log_HP}_t + 1.02 \text{Log_inc} + 0.0007 t_t. \quad (5.19)$$

(0.021820) (0.12326) (0.00074)

Equation (5.19) indicates that the long-run consumption elasticity with respect to housing prices is 0.02 and 1.02 with respect to disposable income.

Following the analysis from *Table 5.7* above, the study therefore accepts the hypothesis of one cointegration relationship at 5 percent level of significance. Hence, the cointegration test based on Johansen's procedure provides empirical support (as does the Engle-Granger procedure) for a long-run relationship between consumption, disposable income and housing prices. Since the vector error correction model (VECM) has a (i) “cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variable to converge to their cointegration relationships while allowing for short-run adjustment dynamics”; and (ii) “cointegration error correction term deviating from the long-run, equilibrium is gradually corrected through a series of partial short-run adjustments” (Philips, 1991: 968); thus, in order to get the true long-run and short-run coefficients of the full model, the study therefore opted to estimate a VECM.

5.4 The Vector Error Correction Model

Now that the cointegration between variables is confirmed, the next step is to estimate a VECM for consumption, disposable income and housing prices. The model is estimated using the log of housing prices and log of income to capture the persistence in the adjustment of consumption to change in income and housing prices.

5.4.1 Long-Run Relationship

Table 5.8: Long-Run Equilibrium Estimation Results, 1980: Q1 to 2007: Q4

Cointegrating Eq:	CointEq1
LOG_CONS(-1)	1.000000
LOG_HP(-1)	0.016091 (0.02182) [0.73733]
LOG_INC(-1)	-1.024408 (0.12326) [-8.31119]
@TREND(80M01)	-0.000698 (0.00074) [-0.94760]
C	0.195580

The results of the long-run relationship between the three endogenous variables are reported in Table 5.8 above (*Full result estimates are presented in Appendix F*). Ensuing from *Table 5.8*, long-run relation is presented as:

$$\Delta \text{Log}C_t = 0.196 + 0.016 \log_HP_{t-1} - 1.024 \log_inc_{t-1} - 0.0007t + \varepsilon$$

$$(0.73733) \quad (-8.31119) \quad (-0.94760)$$

(5.20)

In equation (5.20), the intercept is 0.196. Generally an intercept has no economic meaning, nevertheless it could be interpreted as that amount of consumption incurred when the disposable income and housing prices are equal to zero. The 0.016 coefficient

for Log_{HP} is treated as the elasticity of the housing wealth arising from increase in housing prices. This is, therefore, interpreted as the long-run relation between consumption and housing prices, meaning that everything else held constant, a 1 percent increase in housing prices will result to a 0.02 percent increase in consumption in the long-run. The t -statistics of 0.73733, however, suggests that the long-run relation between housing prices and consumption is statistically insignificant.

Though the estimated results are statistically insignificant, they are however consistent with Prinsloo's (2002) argument that due to the changes in the South African retail credit markets the retail finance sector has seen new developments, particularly in private-label credit cards and unsecured loans. Subsequent to these developments, households entered into mortgage loans to acquire funds for purposes other than the purchase of fixed property. In such a case the fixed properties owned by households are pledged as security for the loan. The key competition among the various financial institutions in South Africa since the first half of the 1980s has caused mortgage advances to be promoted increasingly for purposes other than the financing of transactions in fixed property.

Startlingly, the model shows a negative long-run relationship between the expenditure on consumption and the disposable income. However, as indicated by Romer (1996), consumption is a function of a permanent income. Hence, an increase in current income is associated with an increase in consumption only to a degree that reflects an increase in permanent income. Consequently, when consumers' increased income is expected to be transitory, it is unlikely that such income would induce an increase in consumption. Thus, instead of increasing consumption, a transitory income might encourage savings. Alternatively, when a change in the permanent income is small relative to the change in transitory income, little of the change in income comes from the change in permanent income and so consumption increases little with the increase in income (Griffiths & Wall, 1993).

Furthermore, as demonstrated in Romer (1996), the random walk hypothesis postulates the argument that regression results from lagged income not having strong predictive

power for consumption could arise because lagged values of income are of little use in predicting income movements and not because predictable changes in income do not produce predictable changes in consumption. Hence, the change in consumption is unpredictable, implying that no information available at time $t - 1$ can be used to forecast the change in consumption from the previous to the current period.

As stated in *section 4.2*, the model is specified in logarithmic form for coefficients to be interpreted as elasticities. The coefficient of Log_inc_{t-1} is thus treated as the income elasticity of consumption. From equation (5.20), the coefficient of log_inc is -1.02 implying that for homeowners' households, a one percent increase in the transitory income in the last quarter, will lead to a decrease of approximately 1.02 percent in the expenditure on consumption, *ceteris paribus*.

5.4.2 Short-Run Relationship

Table 5.9: Short-Run Error Correction Equilibrium Estimation Results, 1980: Q1 to 2007: Q4

Error Correction:	D(LOG_CONS)	D(LOG_HP)	D(LOG_INC)
CointEq1	0.051419 (0.05901) [0.87142]	0.052196 (0.10029) [0.52047]	0.440261 (0.09011) [4.88578]
D(LOG_HP(-1))	0.184316 (0.05776) [3.19089]	0.906822 (0.09817) [9.23682]	0.002086 (0.08821) [0.02365]
D(LOG_HP(-2))	-0.040448 (0.06303) [-0.64169]	-0.135798 (0.10713) [-1.26758]	-0.036629 (0.09626) [-0.38052]
R-squared	0.284280	0.725263	0.329484
Adj. R-squared	0.234676	0.706222	0.283013
F-statistic	5.730960	38.08913	7.090034

Table 5.9 above reports on the speed at which an out-of-equilibrium system adjusts back to the long-run equilibrium (*see full result estimates in Appendix F*). From Table 5.9, despite being statistically insignificant, approximately 5.2 percent of disequilibrium is

corrected each quarter by changes in the housing prices. Meanwhile, changes in disposable income correct about *44 percent* of disequilibrium in each quarter. In addition, the model specification which is well supported by the *F-statistic* explains approximately *28 percent* of the variation in the log of consumption.

Since the coefficient of the second lagged housing prices is also statistically insignificant, it thus becomes evident that in South Africa, it takes more than two quarters or six months before consumption could respond to changes in housing prices.

5.5 Discussion of Findings and Conclusion

The first critical issue about the estimated results relates to the constraint that due to the limited access to the relevant literature on the relationship between consumption and housing prices in South Africa, the estimated coefficients are to a large extent compared to the studies conducted in developed countries. Hence, the vast amount of international literature⁴⁷ reviewed indicates that the marginal propensity to consume (MPC) accruing from housing prices ranges between *0.03* and *0.10*, interestingly most of the studies referred to have been conducted in countries⁴⁸ that have also experienced a strong upswing in housing prices over the years.

Secondly, as observed in *Chapter Two* of this study, the important component linking housing prices and consumption is the “credit channel”. In addition to the treatment of being consumption good, a house can also be used as collateral security in advancing a consumption credit loan. Emanating from this argument, Hogan and O’Sullivan (2003) have correctly pointed out that under the central tenant of the LC-PIH, the level of consumption will only be affected by the permanent component of changes in wealth. In this study, however, income accruing from housing wealth is treated as one basket without separating the transitory income from the permanent income.

⁴⁷ See Cutler (2004), Girouard and Blondel (2001), Attanasio et al (2005) and Ludwig and Slok (2002).

⁴⁸ Amongst others the countries referred to are the US, the UK, Australia etc.

Thirdly, the estimated coefficient shows that, in South Africa, *ceteris paribus*, it takes on average more than *two quarters* before home owning consumers increase consumption in response to an increase in housing prices. A question is then posed as to why it takes longer in South Africa for consumer expenditure to increase in response to an increase in housing prices, while empirical evidence (as discussed in Chapter Three) from US, UK, Australia etc. has indicated that homeowners respond to changes in housing prices as early as in the first quarter after prices have increased.

Thus, following Hogan and O'Sullivan's (2003) argument, MPC resulting from housing wealth could be different from other forms of wealth due to: (i) where an accumulation of housing wealth is deemed to be temporary, then rational consumers would refrain from consuming it. This could be the case in SA whereby consumers might be applying a "wait and see approach" until they are certain that an increase in housing prices has indeed increased their net wealth; (ii) it might take some time for a household to be aware that their house is now worth more than the initial price paid to purchase the house. Even after the information about the new value of the house has been obtained, it might still take some time before it could be decided to take an advance loan in a form of mortgage equity withdrawal (MEW).

In tandem to this argument, once a decision is taken to apply for a MEW with a respective financial institution, the process of applying for the second bond could be very lengthy. The application needs to be approved and it comes with a number of delays and costs such as fees relating to bond initiation, administration that is charged by the financial institution, bond registration and payments to the conveyancing attorneys who usually charge a percentage of the registered home loan amount, valuation fee payable to the assessor who values the property, etc. The process is further delayed by some of the following: personal information not provided by the applicant, the local authority receiving the rates clearance certificates late, delay in the provision of guarantees, the applicant not paying the transfer costs on time or delays in forwarding personal income and expenditure documents which are required by the lending financial institution, etc⁴⁹.

⁴⁹ <http://www.secu-bond.co.za/index.htm> accessed on the 16th of October 2009.

The fourth argument in support of the results could be linked to the concept of households' savings ratio⁵⁰. South Africa has experienced a steady decline in its national saving rate⁵¹ over the past several decades; this decline has been accompanied by a fall in domestic investment. The national saving rate remained well above 20 percent in the 1970s and 1980s, however, both corporate and personal saving fell throughout most of the 1990s (Harjes & Ricci, 2006)⁵². The authors further link this low poor saving rate into some instances whereby households are willing to save, but most of them are caught in debt trap hence it becomes extremely difficult to escape from the cycle of overspending and debt accumulation.

As a result, the ratio of households' saving in SA has dropped from around 3.5 percent in the early 90s to around 1.5 percent in 2007 (SARB, 1996 and 2007). The declining saving ratio is primarily explained, amongst other factors, by the easy access to credit until 2007 encouraging people to take out loans which included mortgage loans⁵³, cultural or social trends encouraging an attitude of borrowing and spending, low interest rates etc. Meanwhile, the ratio of total household debt as a percentage of disposable income had been increasing from as low as 53 percent in 1992 to approximately 76.5 percent in 2007.

The fifth critical issue which could have an impact on the estimated results is the change in monetary policy stance which was not incorporated in the study. During the 1980s, the South African monetary policy was mainly focused on the so called liquid asset ratio-based system with quantitative controls on interest rates and credit (Aron & Muellbauer, 2007b)⁵⁴. The second set of monetary regime adopted by mid 1985 was more about the pre-announced monetary target ranges, which were about a broad definition of money (M3)⁵⁵. With effect from the early 90s, sound fiscal stance supported by a set of

⁵⁰ The saving ratio is generally defined as the unconsumed fraction of income (Harjes & Ricci, 2006).

⁵¹ The national saving rate is defined as the ratio of national saving to gross national disposable income (GNDI).

⁵² Also see Prinsloo, J. W. (2000), Bonga-Bonga, (2008), and Aron and Muellbauer (2000_a and 2000_b).

⁵³ After the introduction of the National Credit Act in 2007, access to credit started to decline.

⁵⁴ For more details on a range of reforms enacted from the early 1980s, see de Kock Commission Reports (1978 and 1985)

⁵⁵ For more details see Gidlow (1995).

economic indicators such as asset prices output-gap, balance of payments etc. were used as substitutes for the monetary targets. Eventually, as mandated by the South African Government, the SARB switched to inflation targeting monetary policy stance which was aimed at price stability while at the same time maintaining the enhancement of policy transparency, accountability and predictability (Aron & Muellbauer, 2007b).

Finally, as suggested by Dvornak and Kohler (2003:5), the longer than *two lags* delays for house-owners to increase consumption when housing prices increase could also be attributed to various other factors such as “differences in liquidity, other utility associated with owning an asset (housing services, bequest motives), income distribution across racial groups, expected permanency of changes, and psychological factors”. Hence, it becomes difficult to liquidate within a shorter period and the transaction costs of “trading up” seem to be high.

CHAPTER SIX

SUMMARY AND RECOMMENDATIONS

6.1 Introduction

In the preceding chapters, an introduction to the study together with the background of the relationship between housing prices and consumption were explored. This was followed by the presentation of the permanent-income/life-cycle theory of consumption outlining how consumption is influenced by both disposable income and wealth. Thereafter, a literature review of the relationship between consumption and housing prices, particularly from US, UK, Australia and other developed countries was outlined. The study proceeded by presenting the step-by-step process of developing the Vector Error Correction Model and the discussion of the estimated results thereof. In this chapter, the summary and recommendations of the study are presented.

6.2 Summary of Findings

This study attempted to estimate a relationship between housing wealth and consumption for South Africa using the permanent-income/life-cycle hypothesis. However, constrained by the non-availability of the official balance sheet estimates for the household sector in South Africa (Aron et al, 2007a), housing prices were used as a proxy for housing wealth. The data utilised indicates that housing prices increased from an average of about R502 121 in real terms in the first quarter of 1980 to an average of approximately R1 031 395 in the last quarter of 2007. While at the same time consumption expenditure by households accelerated from R330.5 billion to R858.5 billion in real terms.

Empirical investigations mainly from developed countries provide evidence indicating that an increase in housing prices generally results in a higher household's wealth which is in turn used as collateral in borrowing for consumption purposes (Attanasio et. al 2005). Hence, empirical evidence suggests that in the developed countries, MPC arising

from a one dollar increase in housing prices ranges between *0.03* and *0.10*. In the case of South Africa, Aron and Muellbauer (2006), found the same to be ranging between 0.07 and 0.14.

Following the specified VECM, the study used data from the first quarter of 1980 to the last quarter of 2007 and found that there is indeed a long-run relation between the expenditure on consumption by households and the changes in housing prices. *Ceteris paribus*, in the long-run, a *1 percent* increase in housing prices will result to a *0.02 percent* increase in consumption. This estimate is consistent with the findings by Aron and Muellbauer (2000). Their estimates were, however, higher than those in the UK, a discrepancy which was attributed to the likelihood of underestimating the household net wealth in SA, particularly given the fact that there is no official recording of the systematic household balance sheet in SA.

The findings of the study further suggest that there is no relationship between housing prices and consumption over a short-run (*one quarter*) period. However, the study made no attempt to account for financial liberalisation. Meanwhile Aron and Muellbauer (2006:1) argue that in most countries the relaxation of regulations controlling credit supply is often followed by a boom in the prices of residential properties. Hence, as argued by Aron and Muellbauer, “failure to control for the direct effect of such easing on consumption can have an impact on the effect of housing wealth or collateral on consumption”. This is indeed evident in this study, particularly given the fact that estimated results by Aron and Muellbauer (2007a) suggest that in SA, the coefficient of housing wealth on consumption ranges between *7 percent and 14 percent*.

6.3 Policy and Recommendations

The South African credit markets developed markedly during the 1980s and 1990s. As indicated in Aron et al. (2007b), access to second bond mortgage loans gained momentum in SA. As a result it became cheaper for home-owning households to borrow and finance consumption. Aoke et al. (2002:8), referred to this as a “positive shock to economic

activity which causes a rise in housing demand leading to a rise in house prices and so an increase in homeowners' net worth". Consequently, the drop in the costs of borrowing, leads to a further increase in demand for residential properties and thus indirectly stimulates consumption.

Given this analysis, it thus becomes important for policymakers to closely monitor any arrangements by financial institutions that make it easy for households to access housing equity withdrawals that are aimed at financing consumption (Girouard & Blondal 2005). In order to fulfill this obligation, SA via Stats SA, South African Revenue Services (SARS) or SARB needs to consider compiling official household balance sheets in order to be able to carefully monitor the direct effect of housing wealth into consumption. This in turn will assist in developing the appropriate policy in monitoring the relationship between housing wealth and consumption.

In addition, as argued by Nickel (2004:7), though the relation between housing price and consumption is complex, it is however crucial "for monetary policy because house price inflation, being positively related to household consumption, is therefore positively related to aggregate demand and hence future inflation". So even though house prices are not included in the Consumer Price Index, monetary policy must carefully consider their potential impact. This argument is also raised by Baker (2005) who cautioned that if the housing bubble is not carefully monitored, it will collapse, thus leading to mortgage defaults which will put major strains on the financial system and eventually lead the economy into recession. This was clearly evident in the recent financial collapse of 2008 and its impact on the real economy worldwide.

Lenhert (2004), however, argues that since the dynamics of the a bubble are not known for sure, while at the same time, monetary policy's lags are generally long, monetary policy authorities would find it difficult to formulate appropriate policies during bubble. Hence, central banks need to consider any potential effects that might arise as a result of changes on asset prices on inflation and the national output measured in real gross domestic product.

Meanwhile, Ludwig and Stock (2002) warned policy makers that increase in both stock prices and housing prices generally lead towards a downward trend in savings. This conclusion is based on the empirical evidence indicating a strong significance of both stock prices and house price wealth in explaining consumption. A final caution relates to the argument by Nickel (2004:10) who maintains that since monetary policy is governed by the inflation target, the extent of household debt accumulation is “unlikely to have much of a direct impact on monetary policy”, but the existing and future expected level of house price inflation will have a “direct impact on monetary policy” because of the effect on general inflation via household consumption growth.

6.4 Limitations of the Study and Further Research

The following are noted as major limitations of the study which warrant further investigation:

Firstly, due to the inaccessibility of empirical review in studies conducted in developing countries (e.g. other African countries, Brazil, Argentina etc.), evidence considered in this study is therefore mainly obtained from studies conducted in developed countries. Given the economic structures, development stages, income distribution, economic performance etc. between the developed and developing nations, this therefore makes it difficult to compare South African results with those from developed countries.

Secondly, as argued by Hogan and O’Sullivan (2003) that under the central tenant of the PI-LCH, the level of consumption will only be affected by the permanent component of changes in wealth. In this study, however, income accruing from housing wealth is treated as one basket without separating the transitory income from the permanent income. Thus, even though the results seem plausible, the study provides a general overview of the households’ reaction to changes in housing prices without a reaction specifying their behavior as a result of temporary changes to their net wealth. This, therefore, creates an opportunity for further investigation towards the relationship between consumption and housing prices. Finally, though South Africa, particularly after

1994 has experienced extensive economic policy changes which could have influenced the outcomes of the estimated results; effects of such policy changes are not captured in this study. This, therefore, opens an opportunity for further investigation which should take into account variables such as race, level of education, level of income, house ownership versus household renting houses, structural changes etc, particularly in a country like SA where inequality is still prevalent.

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Appendix A: Unit Root Test Results

Table A1: Unit Root Test – Log Households Expenditure on Consumption (Log_Con), with a Trend and Intercept

Null Hypothesis: LOG_CONS has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 4 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.875982	0.9542
Test critical values:		
1% level	-4.046072	
5% level	-3.452358	
10% level	-3.151673	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_CONS)

Method: Least Squares

Date: 01/18/10 Time: 11:09

Sample (adjusted): 1981M02 2007M04

Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CONS(-1)	-0.020298	0.023172	-0.875982	0.3831
D(LOG_CONS(-1))	0.072055	0.099822	0.721832	0.4721
D(LOG_CONS(-2))	0.216635	0.098338	2.202959	0.0299
D(LOG_CONS(-3))	0.243226	0.094679	2.568959	0.0117
D(LOG_CONS(-4))	-0.055895	0.097274	-0.574610	0.5668
C	0.258797	0.294249	0.879518	0.3812
@TREND(1980M01)	0.000205	0.000162	1.263157	0.2095
R-squared	0.188418	Mean dependent var		0.008096
Adjusted R-squared	0.139724	S.D. dependent var		0.011005
S.E. of regression	0.010207	Akaike info criterion		-6.268244
Sum squared resid	0.010419	Schwarz criterion		-6.093386
Log likelihood	342.3511	Hannan-Quinn criter.		-6.197359
F-statistic	3.869367	Durbin-Watson stat		2.022979
Prob(F-statistic)	0.001631			

Table A2: Unit Root Test - Log Expenditure on Consumption by Households (logCons), with Constant but no Trend

Null Hypothesis: LOG_CONS has a unit root

Exogenous: Constant

Lag Length: 4 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.687396	0.9996
Test critical values:		
1% level	-3.492523	
5% level	-2.888669	
10% level	-2.581313	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_CONS)

Method: Least Squares

Date: 01/19/10 Time: 16:23

Sample (adjusted): 1981M02 2007M04

Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CONS(-1)	0.008307	0.004923	1.687396	0.0946
D(LOG_CONS(-1))	0.061687	0.099777	0.618249	0.5378
D(LOG_CONS(-2))	0.195060	0.097129	2.008262	0.0473
D(LOG_CONS(-3))	0.210584	0.091352	2.305192	0.0232
D(LOG_CONS(-4))	-0.094002	0.092750	-1.013496	0.3132
C	-0.104021	0.064069	-1.623572	0.1076

R-squared	0.175469	Mean dependent var	0.008096
Adjusted R-squared	0.134651	S.D. dependent var	0.011005
S.E. of regression	0.010237	Akaike info criterion	-6.271106
Sum squared resid	0.010585	Schwarz criterion	-6.121228
Log likelihood	341.5042	Hannan-Quinn criter.	-6.210348
F-statistic	4.298778	Durbin-Watson stat	2.042051
Prob(F-statistic)	0.001380		

Table A3: Unit Root Test - Log Expenditure on Consumption by Households (Log_Cons), without Trend or Constant

Null Hypothesis: LOG_CONS has a unit root

Exogenous: None

Lag Length: 4 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.732481	0.9984
Test critical values:		
1% level	-2.586753	
5% level	-1.943853	
10% level	-1.614749	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_CONS)

Method: Least Squares

Date: 01/19/10 Time: 19:53

Sample (adjusted): 1981M02 2007M04

Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CONS(-1)	0.000316	0.000116	2.732481	0.0074
D(LOG_CONS(-1))	0.092970	0.098681	0.942133	0.3484
D(LOG_CONS(-2))	0.233638	0.094930	2.461171	0.0155
D(LOG_CONS(-3))	0.235602	0.090762	2.595812	0.0108
D(LOG_CONS(-4))	-0.078151	0.092972	-0.840586	0.4025
R-squared	0.153950	Mean dependent var		0.008096
Adjusted R-squared	0.120771	S.D. dependent var		0.011005
S.E. of regression	0.010319	Akaike info criterion		-6.264034
Sum squared resid	0.010861	Schwarz criterion		-6.139135
Log likelihood	340.1258	Hannan-Quinn criter.		-6.213402
Durbin-Watson stat	2.029226			

Table A4: Unit Root Test – Differenced $I(I)$ Log Expenditure on Consumption (Dlog_Cons), without the Trend or Drift

Null Hypothesis: D(DLOG_CONS) has a unit root

Exogenous: None

Lag Length: 1 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-13.92924	0.0000
Test critical values:		
1% level	-2.586550	
5% level	-1.943824	
10% level	-1.614767	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DLOG_CONS,2)

Method: Least Squares

Date: 04/14/10 Time: 21:21

Sample (adjusted): 1981M01 2007M04

Included observations: 108 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLOG_CONS(-1))	-2.131525	0.153025	-13.92924	0.0000
D(DLOG_CONS(-1),2)	0.371209	0.085679	4.332569	0.0000
R-squared	0.824127	Mean dependent var		0.000387
Adjusted R-squared	0.822467	S.D. dependent var		0.025659
S.E. of regression	0.010811	Akaike info criterion		-6.198103
Sum squared resid	0.012390	Schwarz criterion		-6.148434
Log likelihood	336.6975	Hannan-Quinn criter.		-6.177964
Durbin-Watson stat	2.038104			

Table A5: Unit Root Test – Differenced $I(2)$ Log Expenditure on Consumption (Dlog_Cons), with a Constant and a Deterministic Trend

**Null Hypothesis: D(DDLOG_CONS,2) has a unit root
Exogenous: Constant, Linear Trend**

Lag Length: 11 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-8.223260	0.0000
Test critical values:		
1% level	-4.056461	
5% level	-3.457301	
10% level	-3.154562	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DDLOG_CONS,3)
Method: Least Squares
Date: 03/03/10 Time: 19:53
Sample (adjusted): 1984M01 2007M04
Included observations: 96 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DDLOG_CONS(-1),2)	-33.97954	4.132125	-8.223260	0.0000
D(DDLOG_CONS(-1),3)	30.74771	4.076969	7.541804	0.0000
D(DDLOG_CONS(-2),3)	27.42897	3.912639	7.010350	0.0000
D(DDLOG_CONS(-3),3)	23.68825	3.611878	6.558431	0.0000
D(DDLOG_CONS(-4),3)	19.73017	3.193810	6.177628	0.0000
D(DDLOG_CONS(-5),3)	15.73335	2.694070	5.839994	0.0000
D(DDLOG_CONS(-6),3)	11.82635	2.155515	5.486555	0.0000
D(DDLOG_CONS(-7),3)	8.309057	1.611513	5.156059	0.0000
D(DDLOG_CONS(-8),3)	5.348880	1.095909	4.880769	0.0000
D(DDLOG_CONS(-9),3)	3.024652	0.642433	4.708118	0.0000
D(DDLOG_CONS(-10),3)	1.318426	0.293838	4.486911	0.0000
D(DDLOG_CONS(-11),3)	0.357078	0.082562	4.324971	0.0000
C	-0.000576	0.002916	-0.197497	0.8439
@TREND(1980M01)	5.08E-06	4.20E-05	0.120916	0.9041
R-squared	0.981114	Mean dependent var		0.000970
Adjusted R-squared	0.978120	S.D. dependent var		0.076914
S.E. of regression	0.011377	Akaike info criterion		-5.980391
Sum squared resid	0.010614	Schwarz criterion		-5.606424
Log likelihood	301.0588	Hannan-Quinn criter.		-5.829227
F-statistic	327.6765	Durbin-Watson stat		1.852031
Prob(F-statistic)	0.000000			

Table A6: Unit Root Test - Log Households Disposable Income (Log_Inc), with a Constant and Trend

Null Hypothesis: LOG_INC has a unit root
Exogenous: Constant, Linear Trend

Lag Length: 3 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.285433	0.9902
Test critical values:		
1% level	-4.045236	
5% level	-3.451959	
10% level	-3.151440	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_INC)

Method: Least Squares

Date: 01/19/10 Time: 16:08

Sample (adjusted): 1981M01 2007M04

Included observations: 108 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_INC(-1)	-0.009807	0.034359	-0.285433	0.7759
D(LOG_INC(-1))	-0.224439	0.104136	-2.155243	0.0335
D(LOG_INC(-2))	0.128002	0.099915	1.281117	0.2031
D(LOG_INC(-3))	0.083661	0.088463	0.945717	0.3465
C	0.128170	0.440503	0.290962	0.7717
@TREND(1980M01)	0.000148	0.000208	0.711229	0.4786

R-squared	0.109113	Mean dependent var	0.007243
Adjusted R-squared	0.065442	S.D. dependent var	0.017420
S.E. of regression	0.016840	Akaike info criterion	-5.276136
Sum squared resid	0.028927	Schwarz criterion	-5.127129
Log likelihood	290.9114	Hannan-Quinn criter.	-5.215719
F-statistic	2.498533	Durbin-Watson stat	1.979369
Prob(F-statistic)	0.035402		

Table A7: Unit Root Test - Log Households Disposable Income (Log_Inc), with a Constant but no Trend

Null Hypothesis: LOG_INC has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.213153	0.9999
Test critical values: 1% level	-3.490772	
5% level	-2.887909	
10% level	-2.580908	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_INC)

Method: Least Squares

Date: 01/19/10 Time: 19:58

Sample (adjusted): 1980M03 2007M04

Included observations: 110 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_INC(-1)	0.019485	0.008804	2.213153	0.0290
D(LOG_INC(-1))	-0.121396	0.089919	-1.350054	0.1798
C	-0.249067	0.115771	-2.151373	0.0337
R-squared	0.048370	Mean dependent var		0.006746
Adjusted R-squared	0.030582	S.D. dependent var		0.017835
S.E. of regression	0.017560	Akaike info criterion		-5.219492
Sum squared resid	0.032994	Schwarz criterion		-5.145843
Log likelihood	290.0721	Hannan-Quinn criter.		-5.189620
F-statistic	2.719315	Durbin-Watson stat		2.136156
Prob(F-statistic)	0.070478			

Table A8: Unit Root Test - Log Households Disposable Income (Log_Inc), without a Trend or Constant

Null Hypothesis: LOG_INC has a unit root

Exogenous: None

Lag Length: 3 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	3.605914	0.9999
Test critical values:		
1% level	-2.586550	
5% level	-1.943824	
10% level	-1.614767	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_INC)

Method: Least Squares

Date: 01/19/10 Time: 22:04

Sample (adjusted): 1981M01 2007M04

Included observations: 108 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_INC(-1)	0.000536	0.000149	3.605914	0.0005
D(LOG_INC(-1))	-0.207017	0.097300	-2.127606	0.0357
D(LOG_INC(-2))	0.157907	0.092743	1.702625	0.0916
D(LOG_INC(-3))	0.110737	0.084573	1.309374	0.1933
R-squared	0.087045	Mean dependent var		0.007243
Adjusted R-squared	0.060710	S.D. dependent var		0.017420
S.E. of regression	0.016883	Akaike info criterion		-5.288704
Sum squared resid	0.029643	Schwarz criterion		-5.189366
Log likelihood	289.5900	Hannan-Quinn criter.		-5.248426
Durbin-Watson stat	1.980816			

Table A9: Unit Root Test – Differenced $I(1)$ Log Disposable Income (Dlog_Inc), with a Drift Term

**Null Hypothesis: DLOG_INC has a unit root
Exogenous: Constant, Linear Trend**

Lag Length: 12 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.487937	0.0463
Test critical values:		
1% level	-4.054393	
5% level	-3.456319	
10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DLOG_INC)

Method: Least Squares

Date: 04/15/10 Time: 22:24

Sample (adjusted): 1983M03 2007M04

Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG_INC(-1)	-1.363867	0.391024	-3.487937	0.0008
D(DLOG_INC(-1))	0.309067	0.377895	0.817863	0.4158
D(DLOG_INC(-2))	0.457948	0.352341	1.299730	0.1973
D(DLOG_INC(-3))	0.569028	0.328590	1.731724	0.0870
D(DLOG_INC(-4))	0.449809	0.312109	1.441192	0.1533
D(DLOG_INC(-5))	0.381132	0.297297	1.281991	0.2034
D(DLOG_INC(-6))	0.243084	0.272688	0.891437	0.3753
D(DLOG_INC(-7))	0.190779	0.242866	0.785532	0.4344
D(DLOG_INC(-8))	0.282066	0.214168	1.317035	0.1915
D(DLOG_INC(-9))	0.278922	0.186052	1.499160	0.1376
D(DLOG_INC(-10))	0.095851	0.161491	0.593540	0.5544
D(DLOG_INC(-11))	0.168925	0.132502	1.274880	0.2059
D(DLOG_INC(-12))	0.258585	0.084080	3.075459	0.0028
C	0.000240	0.003664	0.065445	0.9480
@TREND(1980M01)	0.000148	6.44E-05	2.302480	0.0238
R-squared	0.682696	Mean dependent var		0.000449
Adjusted R-squared	0.629175	S.D. dependent var		0.024261
S.E. of regression	0.014774	Akaike info criterion		-5.451888
Sum squared resid	0.018117	Schwarz criterion		-5.056230
Log likelihood	282.1425	Hannan-Quinn criter.		-5.291853
F-statistic	12.75563	Durbin-Watson stat		1.964023
Prob(F-statistic)	0.000000			

Table A10: Unit Root Test – Differenced $I(2)$ Log Disposable Income, with a Constant

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

Exogenous: None

Lag Length: 12 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.492147	0.0000
Test critical values:		
1% level	-2.589531	
5% level	-1.944248	
10% level	-1.614510	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: $D(DDLOG_INC,3)$

Method: Least Squares

Date: 03/03/10 Time: 20:55

Sample (adjusted): 1984M02 2007M04

Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$D(DDLOG_INC(-1),2)$	-43.35156	5.786266	-7.492147	0.0000
$D(DDLOG_INC(-1),3)$	39.96714	5.728336	6.977093	0.0000
$D(DDLOG_INC(-2),3)$	36.26162	5.541677	6.543439	0.0000
$D(DDLOG_INC(-3),3)$	31.76291	5.195816	6.113171	0.0000
$D(DDLOG_INC(-4),3)$	26.81350	4.688579	5.718896	0.0000
$D(DDLOG_INC(-5),3)$	21.72572	4.048993	5.365710	0.0000
$D(DDLOG_INC(-6),3)$	16.70632	3.332563	5.013054	0.0000
$D(DDLOG_INC(-7),3)$	12.02988	2.597234	4.631803	0.0000
$D(DDLOG_INC(-8),3)$	8.027479	1.886747	4.254667	0.0001
$D(DDLOG_INC(-9),3)$	4.898844	1.243357	3.940013	0.0002
$D(DDLOG_INC(-10),3)$	2.569156	0.711069	3.613092	0.0005
$D(DDLOG_INC(-11),3)$	1.021054	0.320963	3.181221	0.0021
$D(DDLOG_INC(-12),3)$	0.266495	0.088623	3.007050	0.0035
R-squared	0.984619	Mean dependent var		-0.001384
Adjusted R-squared	0.982368	S.D. dependent var		0.143459
S.E. of regression	0.019049	Akaike info criterion		-4.957059
Sum squared resid	0.029755	Schwarz criterion		-4.607581
Log likelihood	248.4603	Hannan-Quinn criter.		-4.815844
Durbin-Watson stat	2.121900			

Table A11: Unit Root Test - Log of Housing Prices (Log_HP), with Intercept and Trend

Null Hypothesis: LOG_HP has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 4 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.738719	0.9671
Test critical values:		
1% level	-4.046072	
5% level	-3.452358	
10% level	-3.151673	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_HP)

Method: Least Squares

Date: 01/19/10 Time: 22:08

Sample (adjusted): 1981M02 2007M04

Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_HP(-1)	-0.004174	0.005650	-0.738719	0.4618
D(LOG_HP(-1))	0.925813	0.094580	9.788679	0.0000
D(LOG_HP(-2))	-0.291196	0.126762	-2.297182	0.0237
D(LOG_HP(-3))	0.375388	0.126444	2.968816	0.0037
D(LOG_HP(-4))	-0.254630	0.096103	-2.649565	0.0094
C	0.048218	0.074209	0.649754	0.5173
@TREND(1980M01)	0.000128	5.41E-05	2.369414	0.0197
R-squared	0.753545	Mean dependent var		0.005068
Adjusted R-squared	0.738758	S.D. dependent var		0.029838
S.E. of regression	0.015251	Akaike info criterion		-5.465190
Sum squared resid	0.023259	Schwarz criterion		-5.290332
Log likelihood	299.3877	Hannan-Quinn criter.		-5.394305
F-statistic	50.95903	Durbin-Watson stat		1.933001
Prob(F-statistic)	0.000000			

Table A12: Unit Root Test - Log of Housing Prices (Log_HP), with Constant but no Trend

Null Hypothesis: LOG_HP has a unit root

Exogenous: Constant

Lag Length: 5 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.272335	0.6403
Test critical values:		
1% level	-3.493129	
5% level	-2.888932	
10% level	-2.581453	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_HP)

Method: Least Squares

Date: 01/19/10 Time: 22:24

Sample (adjusted): 1981M03 2007M04

Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_HP(-1)	-0.007461	0.005864	-1.272335	0.2062
D(LOG_HP(-1))	1.010168	0.098220	10.28473	0.0000
D(LOG_HP(-2))	-0.355096	0.133706	-2.655788	0.0092
D(LOG_HP(-3))	0.437226	0.131699	3.319893	0.0013
D(LOG_HP(-4))	-0.424707	0.133649	-3.177776	0.0020
D(LOG_HP(-5))	0.206717	0.099717	2.073042	0.0408
C	0.098061	0.076829	1.276342	0.2048
R-squared	0.742609	Mean dependent var		0.004545
Adjusted R-squared	0.727010	S.D. dependent var		0.029485
S.E. of regression	0.015405	Akaike info criterion		-5.444461
Sum squared resid	0.023495	Schwarz criterion		-5.268574
Log likelihood	295.5565	Hannan-Quinn criter.		-5.373173
F-statistic	47.60487	Durbin-Watson stat		2.014372
Prob(F-statistic)	0.000000			

Table A13: Unit Root Test - Log of Housing Prices (Log_HP), with no Constant and Trend

Null Hypothesis: LOG_HP has a unit root

Exogenous: None

Lag Length: 5 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.187466	0.7387
Test critical values:		
1% level	-2.586960	
5% level	-1.943882	
10% level	-1.614731	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG_HP)

Method: Least Squares

Date: 01/19/10 Time: 22:28

Sample (adjusted): 1981M03 2007M04

Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_HP(-1)	2.20E-05	0.000117	0.187466	0.8517
D(LOG_HP(-1))	1.011020	0.098526	10.26142	0.0000
D(LOG_HP(-2))	-0.355205	0.134126	-2.648292	0.0094
D(LOG_HP(-3))	0.425960	0.131815	3.231489	0.0017
D(LOG_HP(-4))	-0.428268	0.134040	-3.195086	0.0019
D(LOG_HP(-5))	0.177478	0.097354	1.823008	0.0713
R-squared	0.738374	Mean dependent var		0.004545
Adjusted R-squared	0.725293	S.D. dependent var		0.029485
S.E. of regression	0.015454	Akaike info criterion		-5.447008
Sum squared resid	0.023881	Schwarz criterion		-5.296247
Log likelihood	294.6914	Hannan-Quinn criter.		-5.385904
Durbin-Watson stat	1.993122			

Table A14: Unit Root Test – $I(1)$ Differenced Log Housing Prices (Log_HP), with Trend

Null Hypothesis: D(DLOG_HP) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 3 (Automatic based on AIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.291382	0.0000
Test critical values:		
1% level	-4.046925	
5% level	-3.452764	
10% level	-3.151911	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DLOG_HP,2)

Method: Least Squares

Date: 01/19/10 Time: 22:33

Sample (adjusted): 1981M03 2007M04

Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLOG_HP(-1))	-1.254037	0.199326	-6.291382	0.0000
D(DLOG_HP(-1),2)	0.356307	0.174034	2.047341	0.0432
D(DLOG_HP(-2),2)	0.078795	0.132812	0.593282	0.5543
D(DLOG_HP(-3),2)	0.265640	0.096431	2.754721	0.0070
C	-0.002239	0.003386	-0.661209	0.5100
@TREND(1980M01)	2.75E-05	5.13E-05	0.536135	0.5931
R-squared	0.564508	Mean dependent var		-0.000119
Adjusted R-squared	0.542734	S.D. dependent var		0.023752
S.E. of regression	0.016061	Akaike info criterion		-5.369864
Sum squared resid	0.025797	Schwarz criterion		-5.219103
Log likelihood	290.6028	Hannan-Quinn criter.		-5.308760
F-statistic	25.92511	Durbin-Watson stat		2.037038
Prob(F-statistic)	0.000000			

**Table A15: Unit Root Test – Second Differenced Log Housing Prices (Log_HP),
without a Trend and an Intercept**

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

Exogenous: None

Lag Length: 8 (Automatic based on SIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-8.654986	0.0000
Test critical values:		
1% level	-2.588530	
5% level	-1.944105	
10% level	-1.614596	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DDLOG_HP,3)

Method: Least Squares

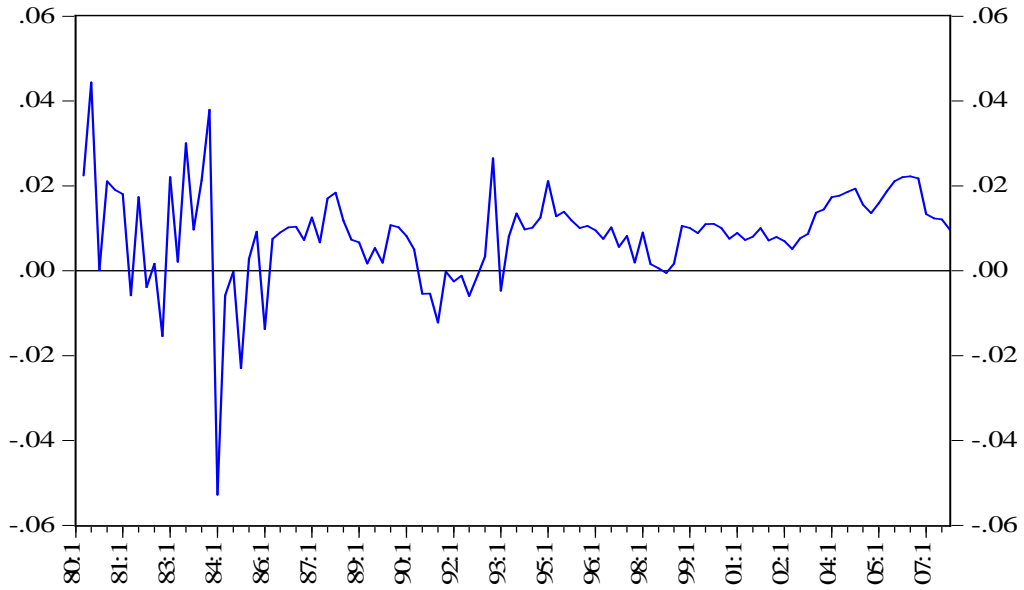
Date: 03/05/10 Time: 20:56

Sample (adjusted): 1983M02 2007M04

Included observations: 99 after adjustments

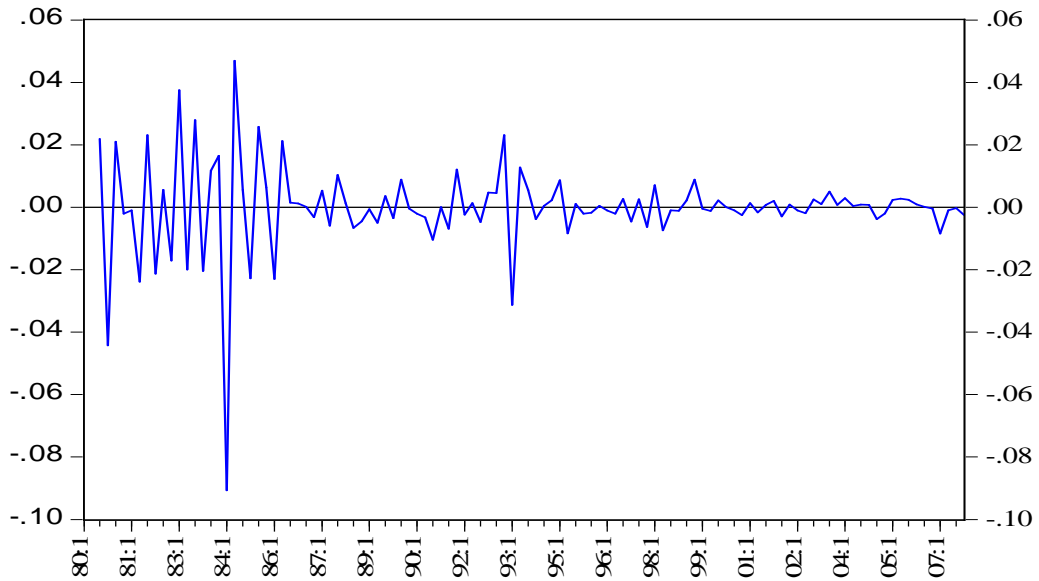
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DDLOG_HP(-1),2)	-12.39553	1.432184	-8.654986	0.0000
D(DDLOG_HP(-1),3)	9.986246	1.382805	7.221730	0.0000
D(DDLOG_HP(-2),3)	8.173701	1.270563	6.433135	0.0000
D(DDLOG_HP(-3),3)	6.440992	1.096307	5.875170	0.0000
D(DDLOG_HP(-4),3)	4.720491	0.885071	5.333458	0.0000
D(DDLOG_HP(-5),3)	3.135291	0.660939	4.743689	0.0000
D(DDLOG_HP(-6),3)	1.900735	0.440591	4.314057	0.0000
D(DDLOG_HP(-7),3)	0.968598	0.237768	4.073716	0.0001
D(DDLOG_HP(-8),3)	0.374643	0.091488	4.095013	0.0001
R-squared	0.930824	Mean dependent var		-0.000887
Adjusted R-squared	0.924675	S.D. dependent var		0.067513
S.E. of regression	0.018529	Akaike info criterion		-5.052422
Sum squared resid	0.030900	Schwarz criterion		-4.816502
Log likelihood	259.0949	Hannan-Quinn criter.		-4.956969
Durbin-Watson stat	2.058003			

Figure A1: Differenced Log Expenditure on Consumption, 1980:Q1 to 2007:Q4



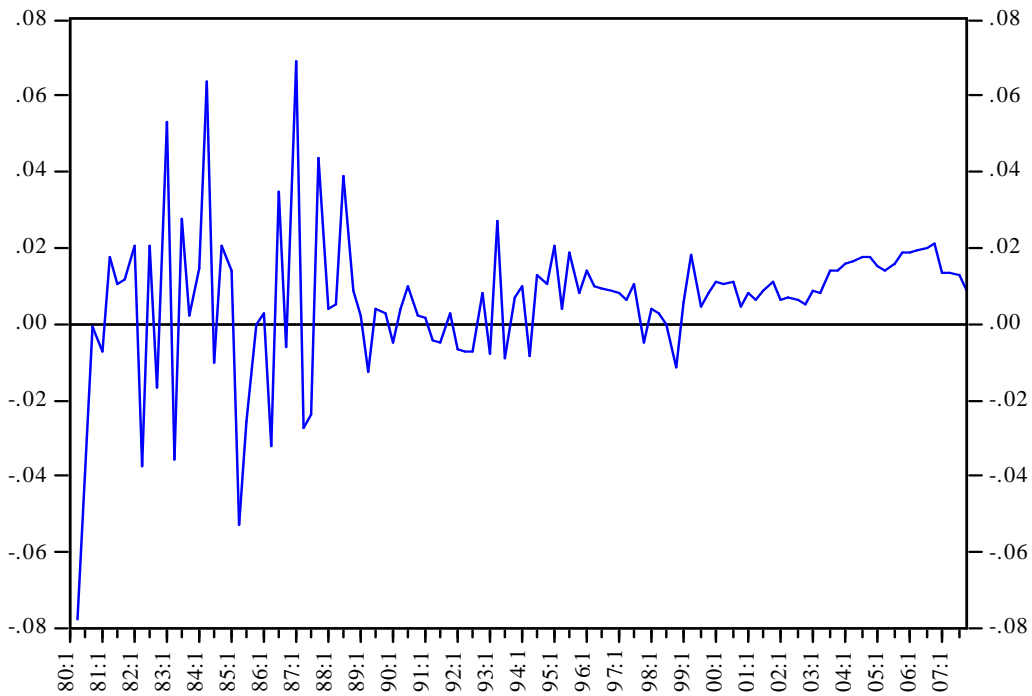
Source: Own Calculations using Total and Seasonally Adjusted Final Expenditure by Households at Constant 2000 Prices in R Millions Obtained from SARB (2009)

Figure A2: Second Differenced $I(2)$ Log Expenditure on Consumption, 1980:Q1 to 2007:Q4



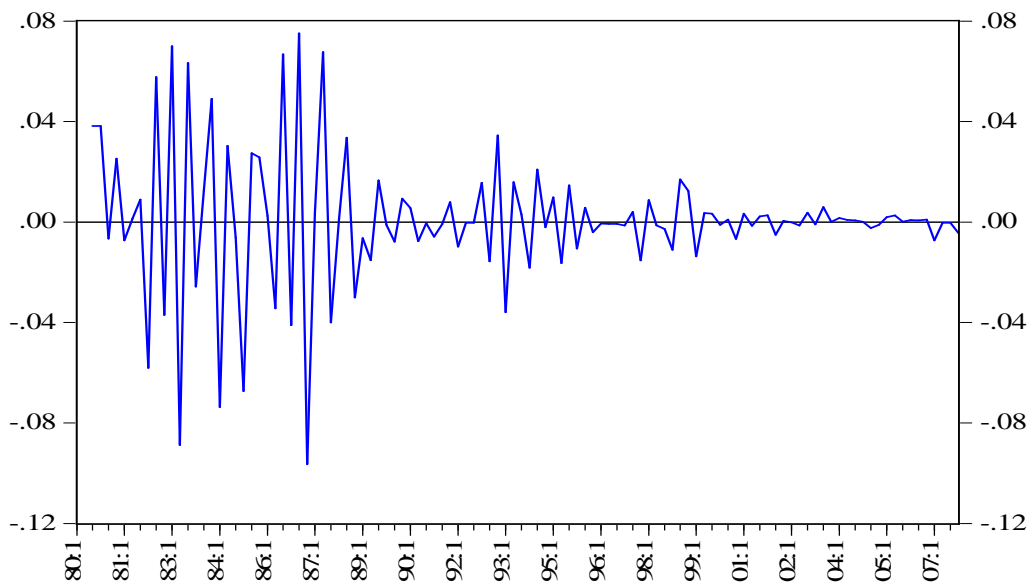
Source: Own Calculations using Seasonally Adjusted data on Disposable Income at 2000 Constant Price (in R Millions), Obtained from SARB (2009)

Figure A3: Differenced Log Disposable Income, 1980:Q1 to 2007:Q4



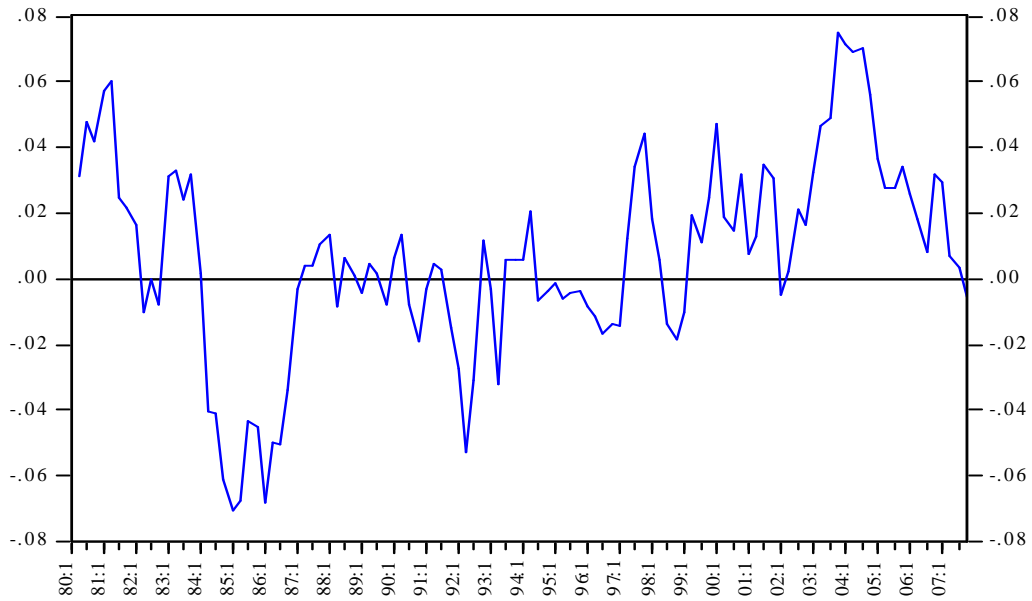
Source: Own Calculations using Seasonally Adjusted data on Disposable Income at 2000 Constant Price (in R Millions), Obtained from SARB (2009)

Figure A4: Second Differenced $I(2)$ Log Disposable Income, 1980:Q1 to 2007:Q4



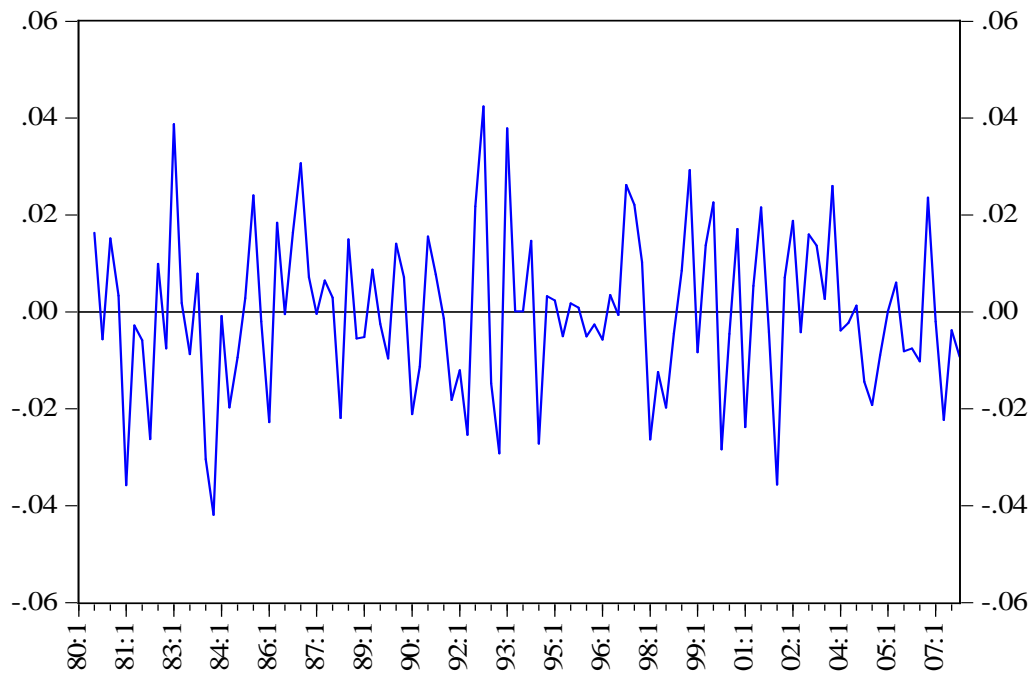
Source: Own Calculations using Seasonally Adjusted data on Disposable Income at 2000 Constant Price (in R Millions), Obtained from SARB (2009)

Figure A5: Differenced Log Housing Price (First Order), 1980:Q1 to 2007:Q4



Source: Own Calculations Using Data obtained from ABSA (2009)

Figure A6: Differenced Log Housing Price (Second Order), 1980:Q1 to 2007:Q4



Source: Own Calculations Using Data obtained from ABSA (2009)

Appendix B: Unit Root Test Calculations

Appendix B1: Testing the Null Hypothesis $a_0 = a_2 = \gamma = 0$ in the Consumption Series Using ϕ_2

Using values from *Table A1 from Appendix A*, the unrestricted model is stated as:

$$\begin{aligned} \Delta \text{Log}_{-} \text{Cons} &= 0.2588 - 0.0203 \text{Log}_{-} \text{Cons}_{t-1} + 0.0002t + 0.0721 \Delta \text{Log}_{-} \text{Cons}_{t-1} + \varepsilon_t \\ &\quad (0.2942) \quad (0.0232) \quad (0.00016) \quad (0.0998) \\ \text{SSR}_{\text{unrestricted}} &= 0.010419 \end{aligned} \tag{B1.1}$$

While on the other hand, using *Table A3 in Appendix A*, the restricted model is expressed as:

$$\begin{aligned} \Delta \text{Log}_{-} \text{Cons} &= 0.0930 \Delta \text{Log}_{-} \text{Cons}_{t-1} + \varepsilon_t \\ &\quad (0.0987) \\ \text{SSR}_{\text{restricted}} &= 0.010861 \end{aligned} \tag{B1.2}$$

$$\phi_2 = \frac{[\text{SSR}_{\text{restricted}} - \text{SSR}_{\text{unrestricted}}] / r}{\text{SSR}_{\text{unrestricted}} / (T - k)} \tag{B1.3}$$

However, with 107 observations (after adjustment) and four estimated parameters (i.e. intercept, $\text{Log}_{-} \text{Cons}_{t-1}$, $\Delta \text{Log}_{-} \text{Cons}_{t-1}$ and t), the unrestricted model contains (107 observations less four restrictions = $107 - 4 = 103$ degrees of freedom).

Since:

$$\frac{\text{SSR}_{\text{(unrestricted)}}}{(T - k)} = \frac{0.010419}{103} = 0.000101155$$

Substitution in (B1.3) yields to:

$$\phi_2 = \frac{(0.010861 - 0.010419)}{[3(0.000101155)]}$$

$$\phi_2 = \frac{0.000442}{0.000303466}$$

$$\phi_2 = 1.4565$$

Appendix B2: Testing the Null Hypothesis $a_2 = \gamma = 0$ in the Consumption Series Using ϕ_3

Equation (B1.1) is still assumed to be the unrestricted model, while estimates from table A2 from Appendix A are used in the restricted model which is stated as:

$$\Delta \text{Log}_- \text{Cons} = -0.1040 + 0.0617 \Delta \text{Log}_- \text{Cons}_{t-1} + \varepsilon_t$$

(0.0641) (0.0998)

$$\begin{aligned} SSR_{unrestricted} &= 0.010419 \\ SSR_{restricted} &= 0.010585 \end{aligned}$$

$$\phi_3 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)}$$

$$\phi_3 = \frac{(0.010585 - 0.010419)}{[2(0.000101155)]}$$

$$\phi_3 = \frac{0.000166}{0.00020231}$$

$$\phi_3 = 0.820$$

Appendix B3: Testing the Null Hypothesis $a_0 = \gamma = 0$ in the Consumption Series Using ϕ_1

Using the estimates from table A2, the unrestricted model is expressed as:

$$\Delta \text{Log}_- \text{Cons}_t = -0.1040 + 0.0083 \text{Log}_- \text{Cons}_{t-1} + 0.0617 \Delta \text{Log}_- \text{Cons}_{t-1} + \varepsilon_t$$

(0.0641) (0.0049) (0.0998) (B3.1)

Equation (B1.2) is still used as the restricted model. Thus:

$$\begin{aligned} SSR_{unrestricted} &= 0.010585 \\ SSR_{restricted} &= 0.010861 \end{aligned}$$

With 107 observations and three estimated parameters, the unrestricted model contains 103 degrees of freedom. Since $0.010585/103 = 0.000102766$, the ϕ_1 statistic is therefore calculated as:

$$\phi_1 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)} \tag{B3.2}$$

$$\phi_1 = \frac{(0.010861 - 0.010585)}{[2(0.000102766)]}$$

$$\phi_1 = \frac{0.000276}{0.00020553}$$

$$\phi_1 = 1.343$$

Appendix B4: Testing the Null Hypothesis $a_0 = a_2 = \gamma = 0$ in the Disposable Income Series Using ϕ_2

From table A6, the unrestricted model is estimated as:

$$\begin{aligned} \Delta \text{Log_inc} = & 0.1282 - 0.0098 \text{Log_inc}_{t-1} + 0.00015t - 0.2244 \Delta \text{Log_inc}_{t-1} + \varepsilon_t \\ & (0.4405) \quad (0.0344) \quad (0.0002) \quad (0.1041) \quad (B4.1) \\ \text{SSR}_{\text{unrestricted}} = & 0.028927 \\ \text{SSR}_{\text{restricted}} = & 0.029643 \end{aligned}$$

Using estimates from table A8, restricted model is formulated as:

$$\Delta \text{Log_Inc}_t = -0.2070 \Delta \text{Log_Inc}_{t-1} + \varepsilon_t \quad (B4.2)$$

(0.0973)

$$\phi_2 = \frac{[\text{SSR}_{(\text{restricted})} - \text{SSR}_{(\text{unrestricted})}]/r}{\text{SSR}_{(\text{unrestricted})}/(T-k)} \quad (B4.3)$$

Given the 108 observations and the 4 parameters, the degree of freedom (dof) is:

$$\text{Dof:} = T - k = 108 - 4 = 104$$

Since:

$$\frac{\text{SSR}_{(\text{unrestricted})}}{(T-k)} = \frac{0.028927}{104} = 0.000278144$$

Substitution in equation (B4.3) yields to:

$$\text{Thus, } \phi_2 = \frac{(0.029643 - 0.028927)}{[3(0.000278144)]}$$

$$\phi_2 = \frac{0.000716}{0.000834432}$$

$$\phi_2 = 0.858$$

Appendix B5: Testing the Null Hypothesis $a_2 = \gamma = 0$ in the Disposable Income Series Using ϕ_3

While equation (B4.1) is still assumed to be the unrestricted model, estimates from table A7 are however used to formulate the restricted model:

$$\Delta \text{Log_inc}_t = -0.2491 + 0.0195 \text{Log_inc}_{t-1} - 0.1214 \Delta \text{Log_inc}_{t-1} + \varepsilon_t \quad (\text{B5.1})$$

(0.1158) (0.0088) (0.0899)

$$\begin{aligned} SSR_{unrestricted} &= 0.028927 \\ SSR_{restricted} &= 0.032994 \end{aligned}$$

$$\phi_3 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)} \quad (\text{B5.2})$$

$$\phi_3 = \frac{(0.032994 - 0.028927)}{[2(0.000278144)]}$$

$$\phi_3 = \frac{0.004067}{0.000556288}$$

$$\phi_3 = 7.311$$

Appendix B6: Testing the Null Hypothesis $a_0 = \gamma = 0$ in the Disposable Income Series Using ϕ_1

Using estimates from table A7, the unrestricted model is expressed as:

$$\Delta \text{Log_inc}_t = -0.2491 + 0.0195 \text{Log_inc}_{t-1} - 0.1214 \Delta \text{Log_inc}_{t-1} + \varepsilon_t, \quad (\text{B6.1})$$

(0.1158) (0.0088) (0.0899)

With the estimates from table A8, the restricted model is assumed to be:

$$\Delta \text{Log_Inc}_t = -0.2070 \Delta \text{Log_Inc}_{t-1} + \varepsilon_t \quad (\text{B6.2})$$

(0.0973)

$$\begin{aligned} SSR_{unrestricted} &= 0.032994 \\ SSR_{restricted} &= 0.029643 \end{aligned}$$

With 110 observations and three estimated parameters, the unrestricted model contains 107 degrees of freedom. Since $0.032994/107 = 0.000308355$, the ϕ_1 statistic is calculated as:

$$\phi_1 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)} \quad (\text{B6.3})$$

$$\phi_1 = \frac{(0.029643 - 0.032994)}{[2(0.000308355)]}$$

$$\phi_1 = \frac{-0.003351}{0.00061671}$$

$$\phi_1 = -5.434$$

Appendix B7: Testing the Null Hypothesis $a_0 = a_2 = \gamma = 0$ in the Housing Prices Series Using ϕ_2

Using estimates from *table A11*, the unrestricted model is expressed as:

$$\Delta \text{Log}_{-} \text{HP} = 0.0482 - 0.0042 \text{Log}_{-} \text{HP}_{t-1} + 0.00013t + 0.9258 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t$$

(0.0742) (0.0056) (5.41E-05) (0.0946)

(B7.1)

Using estimates from *table A13*, the restricted model is formulated as:

$$\Delta \text{Log}_{-} \text{HP}_t = 1.0110 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t$$

(0.0985)

(B7.2)

$$\begin{aligned} SSR_{unrestricted} &= 0.023259 \\ SSR_{restricted} &= 0.023881 \end{aligned}$$

$$\phi_2 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)}$$

(B7.3)

With 107 observations and the 4 parameters, the degree of freedom (dof) is:

$$\text{Dof} = T - k = 107 - 4 = 103$$

Thus:

$$\frac{SSR_{(unrestricted)}}{(T - k)} = \frac{0.023259}{103} = 0.000225815$$

Substitution in (B7.3) results to:

Thus:

$$\phi_2 = \frac{(0.023881 - 0.023259)}{[3(0.000225815)]}$$

$$\phi_2 = \frac{0.000622}{0.000677445}$$

$$\phi_2 = 0.918$$

Appendix B8: Testing the Null Hypothesis $a_2 = \gamma = 0$ in the Housing Prices Series
Using ϕ_3

The unrestricted model is still:

$$\Delta \text{Log}_{-} \text{HP} = 0.0482 - 0.0042 \text{Log}_{-} \text{HP}_{t-1} + 0.00013t + 0.9258 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t$$

(0.0742) (0.0056) (5.41E-05) (0.0946)

(B8.1)

While the restricted model formulated using estimates from *table A12* is:

$$\Delta \text{Log}_{-} \text{HP} = 0.0981 + 1.0102 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t$$

(0.0768) (0.0982)

(B8.2)

$$\begin{aligned} SSR_{unrestricted} &= 0.023259 \\ SSR_{restricted} &= 0.023495 \end{aligned}$$

$$\phi_3 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)}$$

(B8.3)

$$\phi_3 = \frac{(0.023495 - 0.023259)}{[2(0.000225815)]}$$

$$\phi_3 = \frac{0.000236}{0.00045163}$$

$$\phi_3 = 0.523$$

Appendix B9: Testing the Null Hypothesis $a_0 = \gamma = 0$ in the Housing Prices Series
Using ϕ_1

Estimates from *table A12* are used to formulate the unrestricted model:

$$\Delta \text{Log}_{-} \text{HP} = 0.0981 - 0.0075 \text{Log}_{-} \text{HP}_{t-1} + 1.0102 \Delta \text{Log}_{-} \text{HP}_{t-1} + \varepsilon_t$$

(0.0768) (0.0059) (0.0982)

(B9.1)

Using the estimates from *table A13*, the restricted model is stated as:

$$\Delta \text{Log}_{-HP} = 1.0102 \Delta \text{Log}_{-HP_{t-1}} + \varepsilon_t \quad (B9.2)$$

(0.0985)

$$\begin{aligned} SSR_{unrestricted} &= 0.023495 \\ SSR_{restricted} &= 0.023881 \end{aligned}$$

$$\phi_1 = \frac{[SSR_{(restricted)} - SSR_{(unrestricted)}] / r}{SSR_{(unrestricted)} / (T - k)} \quad (B9.2)$$

But, with 106 observations and the 3 parameters, the degree of freedom (dof) is:

$$Dof: = T - k = 106 - 3 = 103$$

Since:

$$\frac{SSR_{(unrestricted)}}{(T - k)} = \frac{0.023495}{103} = 0.000228106$$

Therefore

$$\phi_1 = \frac{(0.023881 - 0.023495)}{[2(0.000228106)]}$$

$$\phi_1 = \frac{0.000386}{0.000456212}$$

$$\phi_1 = 0.846$$

Appendix C: Cointegration (Engle-Granger Method)

Table C1: Long-Run Relationship – Step Two of Engle-Granger Unit Root Test

Dependent Variable: Log _Cons

Method: Least Squares
 Date: 02/23/10 Time: 21:12
 Sample: 1980M01 2007M04
 Included observations: 112

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_HP	-0.021500	0.010241	-2.099423	0.0381
LOG_INC	1.177790	0.015386	76.54954	0.0000
C	-2.107363	0.193587	-10.88585	0.0000
R-squared	0.984258	Mean dependent var		13.11985
Adjusted R-squared	0.983970	S.D. dependent var		0.239642
S.E. of regression	0.030341	Akaike info criterion		-4.126188
Sum squared resid	0.100345	Schwarz criterion		-4.053371
Log likelihood	234.0665	Hannan-Quinn criter.		-4.096644
F-statistic	3407.665	Durbin-Watson stat		0.532043
Prob(F-statistic)	0.000000			

Table C2: Unit Root Test - Residuals of Log of Consumption ($\hat{\epsilon}_t$)

Null Hypothesis: LORUNRESID has a unit root

Exogenous: None
 Lag Length: 0 (Automatic based on SIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-8.958699	0.0000
Test critical values:		
1% level	-2.585962	
5% level	-1.943741	
10% level	-1.614818	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(LORUNRESID)
 Method: Least Squares
 Date: 02/23/10 Time: 22:32
 Sample (adjusted): 1980M02 2007M04
 Included observations: 111 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LORUNRESID(-1)	-0.474473	0.052962	-8.958699	0.0000
R-squared	0.418405	Mean dependent var		0.001685
Adjusted R-squared	0.418405	S.D. dependent var		0.021965
S.E. of regression	0.016751	Akaike info criterion		-5.331706

Sum squared resid	0.030867	Schwarz criterion	-5.307296
Log likelihood	296.9097	Hannan-Quinn criter.	-5.321804
Durbin-Watson stat	1.668031		

Table C3: Unit Root Test – Differenced Residuals of Log of Consumption (\hat{e}_t)

Null Hypothesis: D(DLORUNRESID) has a unit root

Exogenous: None

Lag Length: 6 (Automatic based on SIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.076312	0.0000
Test critical values:		
1% level	-2.587607	
5% level	-1.943974	
10% level	-1.614676	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DLORUNRESID,2)

Method: Least Squares

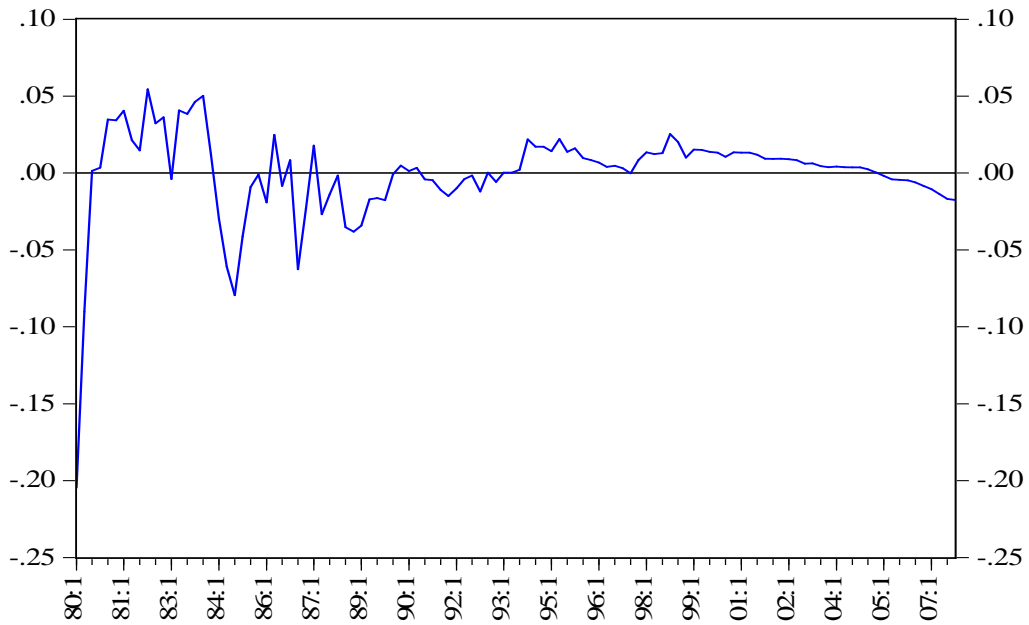
Date: 02/24/10 Time: 01:04

Sample (adjusted): 1982M02 2007M04

Included observations: 103 after adjustments

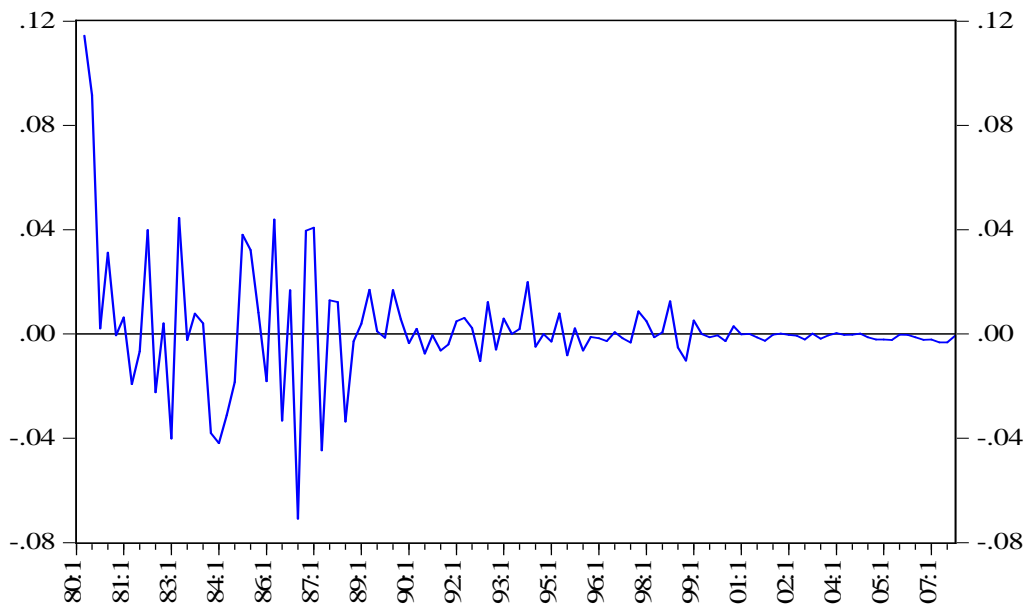
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLORUNRESID(-1))	-5.371781	0.591846	-9.076312	0.0000
D(DLORUNRESID(-1),2)	3.314307	0.537145	6.170227	0.0000
D(DLORUNRESID(-2),2)	2.474747	0.454946	5.439646	0.0000
D(DLORUNRESID(-3),2)	1.774680	0.359130	4.941616	0.0000
D(DLORUNRESID(-4),2)	1.194109	0.260307	4.587303	0.0000
D(DLORUNRESID(-5),2)	0.702350	0.163466	4.296624	0.0000
D(DLORUNRESID(-6),2)	0.240240	0.078708	3.052291	0.0029
R-squared	0.870607	Mean dependent var		-9.71E-05
Adjusted R-squared	0.862520	S.D. dependent var		0.048653
S.E. of regression	0.018040	Akaike info criterion		-5.126927
Sum squared resid	0.031242	Schwarz criterion		-4.947868
Log likelihood	271.0368	Hannan-Quinn criter.		-5.054402
Durbin-Watson stat	2.018266			

Figure C1: Log of Consumption Residuals, 1980:Q1 to 2007: Q4



Source: Own Calculations using Seasonally Adjusted data on Disposable Income and Consumption Expenditure at 2000 Constant Price (in R Millions), Obtained from SARB (2009) and Housing Prices Data obtained from ABSA (2009)

Figure C2: Differenced Log of Consumption Residuals, 1980:Q1 to 2007: Q4



Source: Own Calculations using Seasonally Adjusted data on Disposable Income and Consumption Expenditure at 2000 Constant Price (in R Millions), Obtained from SARB (2009) and Housing Prices Data obtained from ABSA (2009)

Table C4: Error Correction Model or VECM for Differenced Log of Consumption

Vector Error Correction Estimates
 Date: 02/24/10 Time: 22:20
 Sample (adjusted): 1981M02 2005M02
 Included observations: 50 after adjustments
 Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1			
DLOG_CONS(-1)	1.000000			
DLOG_HP(-1)	-0.001757 (0.01694) [-0.10372]			
DLOG_INC(-1)	-1.033248 (0.07899) [-13.0812]			
DLOG_LORUNRESID(-1)	-0.004109 (0.00087) [-4.70638]			
C	-0.001172			
Error Correction:	D(DLOG_CONS)	D(DLOG_HP)	D(DLOG_INC)	D(DLOG_LORUNRESID)
CointEq1	0.045240 (0.29414) [0.15380]	0.044132 (0.77208) [0.05716]	2.480927 (0.47588) [5.21334]	-119.2283 (25.0242) [-4.76453]
D(DLOG_CONS(-1))	-0.453081 (0.22330) [-2.02903]	-0.365048 (0.58613) [-0.62281]	-1.314497 (0.36126) [-3.63860]	43.89679 (18.9971) [2.31071]
D(DLOG_HP(-1))	0.091672 (0.06241) [1.46879]	-0.002152 (0.16383) [-0.01314]	0.037286 (0.10098) [0.36926]	0.197541 (5.30979) [0.03720]
D(DLOG_INC(-1))	-0.032023 (0.21622) [-0.14810]	0.328766 (0.56754) [0.57928]	0.674058 (0.34981) [1.92693]	-39.61400 (18.3948) [-2.15355]
D(DLOG_LORUNRESID(-1))	-0.000625 (0.00218) [-0.28696]	0.007848 (0.00572) [1.37283]	0.004383 (0.00352) [1.24391]	-0.367185 (0.18529) [-1.98164]
C	4.25E-05 (0.00095) [0.04498]	-0.001992 (0.00248) [-0.80270]	0.001199 (0.00153) [0.78374]	-0.169179 (0.08043) [-2.10355]
R-squared	0.275130	0.055678	0.630843	0.527801
Adj. R-squared	0.192758	-0.051631	0.588893	0.474142
Sum sq. resids	0.001946	0.013410	0.005094	14.08674

S.E. equation	0.006651	0.017458	0.010760	0.565821
F-statistic	3.340101	0.518859	15.03807	9.836218
Log likelihood	182.8994	134.6480	158.8444	-39.27720
Akaike AIC	-7.075975	-5.145921	-6.113775	1.811088
Schwarz SC	-6.846532	-4.916478	-5.884332	2.040531
Mean dependent	-8.16E-05	-0.002178	0.001206	-0.169520
S.D. dependent	0.007402	0.017024	0.016782	0.780270
<hr/>				
Determinant resid covariance (dof adj.)		9.23E-14		
Determinant resid covariance		5.53E-14		
Log likelihood		479.3447		
Akaike information criterion		-18.05379		
Schwarz criterion		-16.98305		

Table C5: Unit Root Test for the Estimated Error Term $e_{cons(t-1)}$ from the Long-Run Equilibrium Relationship

Null Hypothesis: D(DLOG_LORUNRESID) has a unit root

Exogenous: None

Lag Length: 0 (Automatic based on SIC, MAXLAG=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.53045	0.0000
Test critical values:		
1% level	-2.612033	
5% level	-1.947520	
10% level	-1.612650	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DLOG_LORUNRESID,2)

Method: Least Squares

Date: 03/02/10 Time: 19:51

Sample (adjusted): 1981M02 2005M02

Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLOG_LORUNRESID(-1))	-1.344811	0.127707	-10.53045	0.0000
R-squared	0.690598	Mean dependent var		-0.129961
Adjusted R-squared	0.690598	S.D. dependent var		1.339924
S.E. of regression	0.745318	Akaike info criterion		2.269785
Sum squared resid	27.21944	Schwarz criterion		2.308026
Log likelihood	-55.74464	Hannan-Quinn criter.		2.284348
Durbin-Watson stat	1.961244			

Appendix D: Vector Autoregression (VAR) Result Estimates

Vector Autoregression Estimates

Date: 02/21/10 Time: 00:13

Sample (adjusted): 1981M03 2007M04

Included observations: 106 after adjustments

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

	LOG_CONS	LOG_HP	LOG_INC
LOG_CONS(-1)	1.081183 (0.11561) [9.35216]	0.085256 (0.19913) [0.42815]	0.323967 (0.18079) [1.79199]
LOG_CONS(-2)	0.094111 (0.16235) [0.57968]	0.106183 (0.27964) [0.37972]	0.287214 (0.25388) [1.13129]
LOG_CONS(-3)	0.104234 (0.15907) [0.65528]	-0.228965 (0.27398) [-0.83569]	0.375828 (0.24875) [1.51087]
LOG_CONS(-4)	-0.178797 (0.14590) [-1.22544]	-0.251359 (0.25131) [-1.00020]	-0.311373 (0.22816) [-1.36470]
LOG_CONS(-5)	-0.239135 (0.13866) [-1.72466]	0.262785 (0.23883) [1.10032]	-0.518096 (0.21683) [-2.38942]
LOG_CONS(-6)	0.154691 (0.09754) [1.58599]	0.106581 (0.16800) [0.63442]	0.184128 (0.15253) [1.20719]
LOG_HP(-1)	0.154277 (0.05989) [2.57615]	1.930896 (0.10315) [18.7192]	-0.007424 (0.09365) [-0.07927]
LOG_HP(-2)	-0.066576 (0.12967) [-0.51345]	-1.270484 (0.22334) [-5.68859]	0.081571 (0.20277) [0.40228]
LOG_HP(-3)	-0.228128 (0.14385) [-1.58592]	0.692289 (0.24776) [2.79414]	-0.152949 (0.22495) [-0.67994]
LOG_HP(-4)	0.161457 (0.14551) [1.10959]	-0.750633 (0.25063) [-2.99498]	0.005102 (0.22755) [0.02242]
LOG_HP(-5)	-0.066826 (0.13408) [-0.49842]	0.619903 (0.23094) [2.68431]	0.075509 (0.20967) [0.36014]
LOG_HP(-6)	0.051297 (0.06627)	-0.229610 (0.11414)	0.013143 (0.10363)

	[0.77407]	[-2.01158]	[0.12682]
LOG_INC(-1)	-0.186268 (0.07494) [-2.48572]	0.001064 (0.12907) [0.00824]	0.309325 (0.11718) [2.63967]
LOG_INC(-2)	0.176587 (0.08188) [2.15663]	0.006887 (0.14103) [0.04883]	0.283799 (0.12804) [2.21641]
LOG_INC(-3)	-0.060746 (0.08286) [-0.73310]	0.075850 (0.14272) [0.53145]	-0.038692 (0.12958) [-0.29860]
LOG_INC(-4)	-0.032348 (0.08052) [-0.40172]	-0.107982 (0.13870) [-0.77855]	0.011884 (0.12592) [0.09438]
LOG_INC(-5)	0.158480 (0.07825) [2.02525]	-0.146030 (0.13478) [-1.08344]	0.107525 (0.12237) [0.87869]
LOG_INC(-6)	-0.068404 (0.05363) [-1.27554]	0.099633 (0.09237) [1.07864]	-0.064919 (0.08386) [-0.77411]
C	-0.112442 (0.14003) [-0.80299]	-0.024086 (0.24119) [-0.09987]	0.472267 (0.21898) [2.15672]
R-squared	0.998743	0.997988	0.995876
Adj. R-squared	0.998483	0.997571	0.995023
Sum sq. resids	0.007013	0.020805	0.017149
S.E. equation	0.008978	0.015464	0.014040
F-statistic	3839.533	2396.910	1167.192
Log likelihood	359.6360	302.0001	312.2423
Akaike AIC	-6.427095	-5.339625	-5.532873
Schwarz SC	-5.949686	-4.862216	-5.055464
Mean dependent	13.13981	13.13976	13.18367
S.D. dependent	0.230483	0.313784	0.199009
Determinant resid covariance (dof adj.)		3.09E-12	
Determinant resid covariance		1.71E-12	
Log likelihood		984.8344	
Akaike information criterion		-17.50631	
Schwarz criterion		-16.07408	

Appendix E: Determination of the number of cointegrating Vectors (Cointegration Test Result Estimates)

Cointegration Analysis:

Date: 02/20/10 Time: 16:49
 Sample (adjusted): 1980M04 2007M04
 Included observations: 109 after adjustments
 Trend assumption: Linear deterministic trend (restricted)
 Series: LOG_CONS LOG_HP LOG_INC
 Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.211489	37.71491	42.91525	0.1504
At most 1	0.078099	11.81556	25.87211	0.8246
At most 2	0.026718	2.951921	12.51798	0.8822

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.211489	25.89935	25.82321	0.0489
At most 1	0.078099	8.863638	19.38704	0.7384
At most 2	0.026718	2.951921	12.51798	0.8822

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b*S11*b=I):

LOG_CONS	LOG_HP	LOG_INC	@TREND(80M02)
-64.01215	-1.030051	65.57456	0.044652
38.35070	-4.205405	-6.497540	-0.251198
28.21627	-6.845778	0.689761	-0.183586

Unrestricted Adjustment Coefficients (alpha):

D(LOG_CONS)	-0.000803	-0.001793	-0.001062
D(LOG_HP)	-0.000815	-0.003207	0.001743
D(LOG_INC)	-0.006878	-0.000741	-0.000669

1 Cointegrating Equation(s): Log likelihood 978.0248

Normalized cointegrating coefficients (standard error in parentheses)

LOG_CONS	LOG_HP	LOG_INC	@TREND(80M02)
1.000000	0.016091	-1.024408	-0.000698
	(0.02182)	(0.12326)	(0.00074)

Adjustment coefficients (standard error in parentheses)

D(LOG_CONS)	0.051419
	(0.05901)
D(LOG_HP)	0.052196
	(0.10029)
D(LOG_INC)	0.440261
	(0.09011)

2 Cointegrating Equation(s): Log likelihood 982.4566

Normalized cointegrating coefficients (standard error in parentheses)

LOG_CONS	LOG_HP	LOG_INC	@TREND(80M02)
1.000000	0.000000	-0.914999	-0.001446
		(0.05933)	(0.00036)
0.000000	1.000000	-6.799182	0.046541
		(1.55429)	(0.00951)

Adjustment coefficients (standard error in parentheses)

D(LOG_CONS)	-0.017347	0.008368
	(0.06748)	(0.00392)
D(LOG_HP)	-0.070781	0.014325
	(0.11446)	(0.00664)
D(LOG_INC)	0.411829	0.010202
	(0.10490)	(0.00609)

Appendix F: Vector Error Correction Model Result Estimates

Vector Error Correction Estimates

Date: 05/04/10 Time: 16:37

Sample (adjusted): 1980M04 2007M04

Included observations: 109 after adjustments

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

Cointegrating Eq:	CointEq1		
LOG_CONS(-1)	1.000000		
LOG_HP(-1)	0.016091		
	(0.02182)		
	[0.73733]		
LOG_INC(-1)	-1.024408		
	(0.12326)		
	[-8.31119]		
@TREND(80M01)	-0.000698		
	(0.00074)		
	[-0.94760]		
C	0.195580		

Error Correction:	D(LOG_CONS)	D(LOG_HP)	D(LOG_INC)
CointEq1	0.051419	0.052196	0.440261
	(0.05901)	(0.10029)	(0.09011)
	[0.87142]	[0.52047]	[4.88578]
D(LOG_CONS(-1))	0.019406	0.068656	0.042365
	(0.10685)	(0.18161)	(0.16318)
	[0.18162]	[0.37805]	[0.25962]
D(LOG_CONS(-2))	0.048647	0.152328	0.046300
	(0.09549)	(0.16229)	(0.14583)
	[0.50945]	[0.93860]	[0.31751]
D(LOG_HP(-1))	0.184316	0.906822	0.002086
	(0.05776)	(0.09817)	(0.08821)
	[3.19089]	[9.23682]	[0.02365]
D(LOG_HP(-2))	-0.040448	-0.135798	-0.036629
	(0.06303)	(0.10713)	(0.09626)
	[-0.64169]	[-1.26758]	[-0.38052]
D(LOG_INC(-1))	-0.096813	-0.012197	-0.165112
	(0.05930)	(0.10078)	(0.09055)
	[-1.63270]	[-0.12103]	[-1.82336]
D(LOG_INC(-2))	0.068613	-0.070698	0.121466
	(0.05273)	(0.08962)	(0.08053)
	[1.30120]	[-0.78885]	[1.50836]

C	0.006902 (0.00142) [4.85472]	-0.000381 (0.00242) [-0.15760]	0.007037 (0.00217) [3.24125]
R-squared	0.284280	0.725263	0.329484
Adj. R-squared	0.234676	0.706222	0.283013
Sum sq. resids	0.009354	0.027022	0.021816
S.E. equation	0.009624	0.016357	0.014697
F-statistic	5.730960	38.08913	7.090034
Log likelihood	355.6334	297.8202	309.4825
Akaike AIC	-6.378594	-5.317801	-5.531790
Schwarz SC	-6.181064	-5.120271	-5.334260
Mean dependent	0.008142	0.005882	0.007168
S.D. dependent	0.011001	0.030178	0.017357
Determinant resid covariance (dof adj.)		4.06E-12	
Determinant resid covariance		3.23E-12	
Log likelihood		978.0248	
Akaike information criterion		-17.43165	
Schwarz criterion		-16.74029	