The Stock Market, the Housing Market and Consumption

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Xin Shen

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Abstract

There is a long history of examining the relationship between consumption and wealth. The recent subprime mortgage crisis in the US and the European sovereign debt crisis associated with the remarkable fluctuations in both stock and housing markets have brought new concerns over the response of consumer spending to asset price shocks. This thesis re-investigates the relationship between consumption, income, financial and housing wealth: specifically, the wealth effect on consumption based on both time-series data in an examination of the US and panel data in an examination of OECD countries. It is argued that nonlinear estimation might provide a better explanation of fluctuations in the relationship between consumption and wealth, given the nature of the studied variables and the complexity of economic systems. The econometric methods employed include the Markov regime-switching approach, the quantile autoregressive distributed-lag framework, panel unit root and cointegration tests, and a panel vector autoregressive procedure. In terms of the US market, only weak evidence of a linear cointegrating relationship is found between consumption, income and wealth. It suggests that the consumption-wealth relation is better characterised in regime-specific terms. Furthermore, the transition probabilities between regimes are time-varying and driven by monetary indicators such as interest rates. In addition, different speeds of adjustment across the range of quantiles are identified in the long-run relationship between consumption, income and wealth. Wealth effects are found to be larger in lower quantiles. The findings imply that asymmetric monetary policies should be responsible for the movement in asset

prices in analysing future inflation and aggregate demand due to the sensitivity of financial and housing wealth effects in different economic states.

In OECD studies, cointegration evidence is only observed in market-based countries, not in bank-based economies. Moreover, the wealth effects are found to be larger in market-based than in bank-based countries. In addition, since a positive wealth effect caused by an increase in capital value of housing might be partly offset by a negative price effect caused by an increase in the cost of housing services, the 'net housing wealth effect' actually is found to be slightly smaller than the stock market wealth effect in OECD countries. However, due to the significant boom in real estate markets since the 1990s, the housing wealth effect has clearly exceeded the share market wealth effect over the past decade. The results show that asset wealth has asymmetric effects on consumption, with stronger and more persistent effects from positive asset wealth shocks.

Note on Publications

Conference papers have been published from this thesis as follows.

Shen, X., Holmes, M.J., & Lim, S. (2011) *Financial wealth, housing wealth and consumption: A regime-switching perspective*. 15th Annual Waikato Management School Student Research Conference, Waikato, New Zealand. (Best paper award)

Shen, X., Holmes, M.J., & Lim, S. (2013) *Wealth effect and consumption: a panel VAR approach*. 42nd Australia Conference of Economists, Perth, Australia.

Shen, X., Holmes, M.J., & Lim, S. (2014) *Wealth effects on consumption: Evidence from quantile cointegration in the autoregressive distributed-lag framework*. 24th New Zealand Econometric Study Group Meeting, Waikato, New Zealand.

Shen, X., Holmes, M.J., & Lim, S. (2014) *Wealth effect on consumption revisited: Does having a market- or bank-based system matter*? International Conference on "Trends in Multidisciplinary Business and Economic Research", Bangkok, Thailand.

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CHAPTER 1: INTRODUCTION

1.1 Origins of this Study

Consumption is commonly viewed as the most important component of aggregate demand, since in most developed countries, consumption accounts for about two thirds of GDP. Furthermore, household utility and welfare are also largely determined by consumption. Therefore, it is not surprising that a considerable amount of research effort from macroeconomists has concentrated on the study of consumption (Attanasio, 1999). In modern macroeconomics, consumption is normally regarded as part of a dynamic decision problem. For example, consumption decisions can be also treated as savings decisions with respect to capital accumulation and investment. As a result, understanding consumption is central to macroeconomics.

The role of consumption in general economic theory first started to receive attention with the introduction of John Maynard Keynes' *General Theory of Employment, Interest and Money* in 1936. Keynes wrote that '*… the propensity to consume is a fairly stable function so that, as a rule, the amount of aggregate consumption mainly depends on aggregate income…*' In other words, Keynes assumed tacitly that households were liquidity constrained and that current real private consumption is mainly determined by current real disposable income. Within his theory, Keynes also specified the economic effects of consumer expenditure and household responses to economic policy changes. Since then, numerous theoretical developments have been made based on Keynes' theory. The most famous examples include Friedman's *Permanent Income Theory* (1957),

and Ando and Modigliani's *Life Cycle Theory* (1963), where the level of consumption depends on households' "permanent income," such as the current and expected future labour income, as well as their stock of wealth. Given expected permanent income, consumers are expected to spend evenly over their lives, i.e. borrowing in their early working lives, saving during their middle working lives, and dis-saving in their retirement lives (Boone and Girouard, 2002). An unexpected increase in financial/housing wealth should lead households to revise their consumption plan. For instance, households will spread the wealth gain over the remainder of their lives, consuming a bit more or saving a bit less. Until recently, most of the research assumed that aggregate consumption is a function of current real disposable incomes, and this explanation is actually consistent with Keynes' absolute income hypothesis.

However, as criticized by Deaton (1992) and Muellbauer and Lattimore (1995), such an explanation is inadequate, because it omits flow and balance sheet effects regarding personal saving and wealth, which have become more important with the liberalization of financial systems. These flow and balance sheet effects also indicate the absence of the impact of asset prices on consumption in the traditional income-based equations. Indeed, household consumption is affected not only by income but also by other factors such as wealth, especially in terms of financial wealth and housing wealth. While changes in income affect consumption in the long-run, influences from changes in private wealth on consumer spending dominate the short and intermediate terms. In order to forecast future macroeconomic performance, policymakers have paid more attention to changes in the components of household wealth and the signals these changes provide.

In general, when stock prices or property prices increase, the wealth of shareholders or homeowners will rise. If household wealth increases permanently, the household can spend the wealth, give it to other people or institutions, or leave it as a bequest to heirs. Therefore, consumer spending will increase at some point due to the increase in wealth. Normally, we refer to the rise in consumption due to increases in share prices as the stock market wealth effect, and call the rise in consumption based on increase in housing prices the housing wealth effect.

The wealth effect can work through different channels. Firstly, realized capital gains may have a direct impact on consumption. Unrealized capital gains can also affect both current and future consumption through expectations of higher future income and wealth or through the reduction of liquidity constraints. Moreover, consumer expenditure may also be affected by increases in the value of stock options due to rising stock prices.

Secondly, changes in share prices may affect consumption even in households that do not own stock because they affect consumer confidence or the uncertainty that consumers perceive about future economic conditions (Poterba, 2000). Carroll et al. (1994) and Bram and Ludvigson (1998) show that improvements in consumer sentiment stimulate consumption in the short run in the US. Nahuis (2000) also finds similar evidence in eight European countries. Otoo (1999) and Ludwig and Slok (2001) identify that there is a contemporaneous correlation between changes in stock prices and consumer sentiment, and also that an increase in stock prices boosts consumer confidence.

Finally, households' consumption might increase through the precautionary saving effect. In terms of uncertainty about future income and asset values,

consumers might choose to hold a buffer stock of wealth to reduce the downward effect on spending due to negative income shocks. An increase in households' wealth implies an increase in the value of their buffer stock. Consequently, it helps to relax the need for precautionary saving, which in turn allows households to increase consumption without consuming their buffer stock of wealth.

The main channels for asset price effects on consumption are shown in Figure 1.1.

Figure 1.1: Channels for Asset Price Effects on Consumption
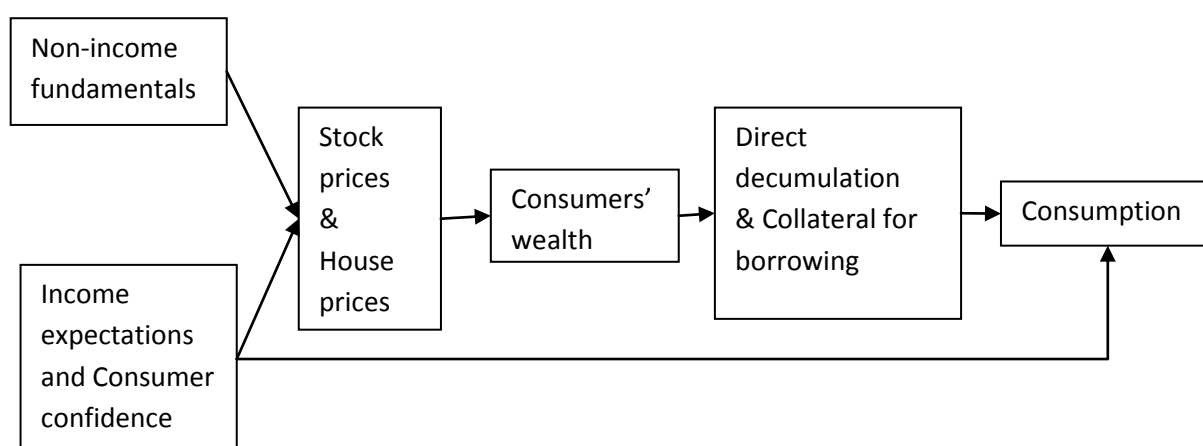
1.2 Background

The second half of the 1990s saw substantial changes in the wealth of US households, primarily owing to a dramatic increase in stock values. The annual return to equity rose to average 26.3% from 1996 to 1999, compared to an average of only 5.9% during the first half of the 1990s in the US. The effect of wealth generated through the stock market on consumer expenditure at that time was more widespread than it may have been several decades ago because of the popularity of the stock markets and more people being willing to participate in this market, whether through direct purchase of stocks or investment in mutual

funds. According to Poterba (2000) this increase accounted for more than 60% of the wealth creation in the US during that period. It is a worthwhile exercise to evaluate the impact of such a major rise in the stock markets on the consumer spending patterns of the US. As mentioned by Poterba (2000), rising share prices are often linked to higher consumer expenditure through the wealth effect. It is then undoubted that the inflation of stock prices would raise consumer spending pressures. There are a few studies which have looked at the impact of equity values on aggregate consumer spending. Ludvigson and Steindel (1999) find that movements in the stock market do appear to affect today's consumption growth, but not tomorrow's. Dynan and Maki (2001) show that households who own stocks react to stock price changes with changes in consumption in the same direction within a couple of years, while the consumption growth of households that do not hold securities has little correlation with movements in stock prices.

It is thus well accepted that a prolonged downturn in stock prices could depress consumer expenditure and result in a recession. Actually, the US stock market experienced a big drop of almost one-third in 2000-2001, shortly after the 1990s bull market that ran up by 450 percent. The US stock market collapse destroyed more than $8 trillion in paper wealth during that time and was arguably a cause of the 2001 recession. Some other developed countries, such as the Organisation of Economic Cooperation and Development (OECD) countries, also suffered roughly a 27% decline in share prices. However, the stock market decline during the beginning of 2000 because of the dot-com bubble burst did not depress consumer spending as expected. Benjamin et al. (2004) and Greenspan (2005) explain that the small impact of dropping stock prices on expenditure was mainly due to an offsetting effect from real estate wealth. During the same time period,

the housing price in the US grew by over 8% a year. Similar growth rates were also recorded in the euro area. In fact, during the early 2000s recession among some developed countries, house prices disconnected from the business cycle. From the *Survey of Consumer Finances*, in 1998 and 2001 more than two-thirds of the US households were homeowners, while only half owned stocks, bonds or mutual funds. Furthermore, the holding of financial assets was concentrated in pension and retirement accounts. Therefore, the marginal propensity to consume (MPC) from housing wealth was higher than from financial wealth. In the case of share market collapses, consumers use their housing equity to finance spending, hence stabilizing the economy. Mortgage market innovations and low interest rates further boosted housing demand and mortgage equity withdrawal pushed consumer spending in these countries. Household debt also reached a historical high in these nations. Lax lending standards and opaque securitisation as well as low long-term interest rates due to the global trade imbalances and rising saving rates all helped to extend the boom. From 2000-2005, property prices doubled in many metropolitan areas in the US. In addition, house prices in the euro area also increased by approximately 50% between 2000 and 2007.

Therefore, it seems that the growth of housing prices contributes to the growth of consumer spending. Actually, a range of evidence shows that the cycles of house price and consumption growth are closely synchronized. Catte et al. (2004) identified that the correlation between house prices and consumption growth had been 0.6 for OECD nations over the past 30 years.

The recent global financial crisis, and the resulting downturn in both the stock market and the housing market, has led to renewed concerns over the role asset

prices may play in impacts on consumption. This financial crisis was caused by the collapse of the subprime mortgage market in some US states since the end of 2006, and it has plunged the world economy into the worst economic recession since the Great Depression. Compared to the financial crisis in the early 2000s, the recent crisis has not only caused a drop in the stock market but has also had a severe negative impact on real estate markets. For example, in addition to the US, the property market in the euro area, which had been overheating, also suffered during this world crisis. During the period 2007-2009, stock values in both the US and the euro area dropped by more than 30%. The fall of nominal prices was bigger than the drop in 1932, at the worst point of the Great Depression. Moreover, at the same time, the housing value in the US declined by around 15%, and European property value also dropped by 8%. In fact, the growth rate of house prices in the euro area started to decline in 2005. The annual growth rates of house prices decreased from about 8% in 2005 to around 4% in 2007. It is obvious that the bursting bubble in the housing market could cause the value of household wealth to decline. According to the 2004 Survey of Consumer Finances, primary and other residential property constituted nearly 39% of the total assets in the portfolios of US families (Bucks et al. 2006). As a result, a drop in property prices could have a significant negative impact on consumer expenditure.

Nevertheless, recently, consumer expenditure did not drop significantly because of the downturn in the housing market and the stock market, despite the expectation that consumer spending should move in line with stock and housing wealth. In fact, the annual expenditure of US households only dropped by 0.6% from 2007-2010. This raises the question: is there a linear or non-linear relationship between asset price and consumption both in terms of the long-run

and the short-run? Are there any potential asymmetric issues in how wealth changes affect consumption? Do changes in house values only affect household consumption in bull markets but not in bear markets? In fact, given the nature of the variables and the complexity of economic systems, it is likely that the relationship between wealth and consumption may be exhibited in different ways, depending on the state of the economy and also on the evolution of wealth. In other words, the relationship between wealth and consumption might be nonlinear and also time-varying.

All of the above facts point to the need to re-investigate the role that stock markets and housing markets can play in determining aggregate consumer spending behaviour in the US and other major developed countries. The next section addresses the research question and the fundamental objective of this research.

1.3 Research Question and Objective

Given the background of this study, there seems to be an urgent need and opportunity to critically understand the dynamic interactions among financial and housing wealth and consumer spending in the US. The study, in a panel of OECD countries, will be conducted to compare results with the robustness of the evidence in the US. To achieve this objective, the study will consider the following questions:

(a) How do changes of stock and housing prices affect personal consumption both in the long-run and the short-run?

(b) Do financial and housing wealth effects on consumption change over time?

(c) Are there any nonlinear/asymmetric responses in consumer expenditure due to the dynamic behaviour of the stock and housing markets, e.g. during different regimes such as bull markets and bear markets?

(d) If so, what can be said about the nature of any non-linearities present?

(e) To what extent have these non-linearities changed during the recent turbulent years?

(f) Is the relationship between household wealth and consumption time-varying?

(g) Is the financial wealth effect larger or smaller than the housing wealth effect?

(h) With regards to wealth effect on consumption, does having a market- or bank-based system[1] matter?

1.4 Data and Research Methods

There are two datasets employed in this study. One is time-series data in the context of the US. The other one is panel data with respect to 14 OECD countries. The time-series data includes non-durable consumption, labour income, financial and housing wealth. The panel data considers total consumption, disposable income, stock and housing price indices. The consumption and income data as well as the household wealth are expressed in real, per capita terms on a seasonally-adjusted basis. All the data are in log forms where the time-series data covers the period from 1952Q1 to 2010Q2, and the panel data covers the period from 1975Q1 to 2011Q2 with quarterly frequency.

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[1] A market-based economy is one in which decisions on investment and the allocation of producer goods are mainly made through markets. Examples include the US and the UK. On the other hand, a bank-based economy concentrates on the role of banks. That is, companies borrow heavily from banks, whose refinancing needs are in turn covered by the central bank. Banks in this system are expected to help regulate the economy. Representatives include Germany and Japan.

In terms of time-series data, both Markov-switching and quantile autoregressive distributed lag (QARDL) approaches will be used to investigate the nonlinear/asymmetric relationship between consumption and wealth. With regards to panel data, second generation unit root and cointegration tests as well as the panel vector autoregressive (panel VAR) model will be employed to examine the wealth effect on consumption.

Full details of data and methodologies are discussed in Chapter 3.

1.5 Contribution of this Study

This thesis will contribute in a number of ways to the body of knowledge in this field. The major areas of contribution are:

- Given the nature of the estimated variables and the complexity of economic systems, it is likely that the dynamics of wealth and consumption adjust in different ways, depending on the state of the economy. In other words, the studied consumption-wealth relationship might behave differently during different time periods due to structural changes. This research employs a Markov-switching model to examine the relationship between consumption, income, and wealth in the US both in the long-run and the short-run, while the Markov switching model can characterize such differences by using Markov chains to change the estimated parameters as an underlying state variable changes.

- In contrast to the conventional Markov-switching model that relies on fixed transition probabilities of switching between regimes, this thesis

concentrates on time-varying transition probabilities. Time-varying transition probabilities do not restrict the transition probabilities to being constant over time. That is, the probability of switching from one regime to the other can depend on the behaviour of underlying economic fundamentals.

- While most existing empirical studies use a linear approach to examine the relationship between wealth and consumption (see Mehra, 2001; Lettau and Ludvigson, 2001&2004; Kishor, 2007; Case et al., 2005&2011), studies which consider nonlinearities are quite scarce, and those limited nonlinear studies have only focused on the dynamics of asymmetric wealth shocks. In fact, it is also important to understand the heterogeneity in consumption behaviour which is fundamental to grasping the impacts of wealth shocks, and the effectiveness of tax and other policies that can impact on wealth. This study uses the quantile autoregressive distributed lag (QARDL) model proposed by Cho et al. (2012) to re-investigate the non-linear relationship between consumption, income and wealth in the US. Instead of relying on a single measure of conditional central tendency, like the conventional cointegration methods, the QARDL approach enables us to explore wealth effects on consumption with quantile-varying (consumption-varying) cointegrating coefficients.

- Considering the estimated sample period in this research is quite long, it is prudent to allow for time-varying patterns in the wealth and consumption relationship. This study employs a robust rolling estimation based on the QARDL model to check wealth effects on consumption over time. In

particular, the study will focus on the 2001-2010 period to measure the impacts from the most recent financial turmoil and subsequent economic downturn.

- A large number of papers have studied the wealth effect on consumption, partly also distinguishing between financial and housing wealth. However, most of these studies emphasise the US and UK; few studies on the effect of financial and in particular of housing wealth on consumer expenditure have been done in the international context. Moreover, most multi-country studies on the wealth effect do not cover the time period of the current financial crisis. The principal reason is the lack of up-to-date data on financial and housing wealth at the international level. This study will use an improved international dataset to estimate the wealth effect on consumption. The international data set is more comprehensive and can exploit a wider spectrum of geographic variation. Furthermore, this thesis uses data at quarterly frequency, to obtain more precise estimates of the magnitude of the wealth effects on consumption.

- Due to the data deficiencies on housing wealth (different studies tend to construct real estate wealth in different ways), evidence of a housing wealth effect on consumption is very scarce and inconclusive. This research will utilize the housing price dataset from the Federal Reserve Bank of Dallas to detect the housing wealth effect. Compared to other housing price databases such as the Bank for International Settlements (BIS) or OECD, this dataset selects the most similar sources from different countries and documents their differences to clarify the extent to which

international sources can be made comparable for empirical research purposes (Mack and Martinez-Garcia, 2011).

- Besides the new dataset with measures of financial and housing wealth from several countries, the multi-country measurement in this thesis also makes several contributions.

  ➤ First, as this study examines the wealth effect for various groups of countries over time, second generation panel unit root and cointegration techniques will be employed to estimate the relevant wealth effect. Panel data can provide higher test power than time-series data that raise the likelihood of rejecting the null hypothesis of non-cointegration, because the panel data set is larger, which can help to avoid Type II error. Panel data techniques are also much more flexible and allow us to distinguish between long-run and short-run relationships of the data.

  ➤ Secondly, the second generation panel data approaches can better address the cross-sectional dependence issue. It is crucial to control for cross-sectional dependence in panel data, because variables like consumption and wealth are expected to be cross-sectionally correlated due to the regional and macroeconomic linkages, such as common global financial shocks (the 2000-2001 dotcom bubble burst and the 2007-2008 subprime mortgage crisis), shared global institutions (OECD, WTO, and IMF), and local spillover effects between regions or nations (Liddle and Lung, 2013). Without considering the issue of cross-sectional dependence, standard

estimation methods may produce inconsistent parameter estimates and incorrect inferences (Kapetanios et al., 2011).

➢ Thirdly, the debate between market-based and bank-based financial systems has been the focus of substantial recent attention in the empirical literature, especially after the global financial crisis in the late 2000s. However, most of these theoretical and empirical discussions on the difference between market- and bank-based systems have focused on the linkage between financial systems and economic growth, which is not directly relevant to the wealth effect on consumption. This research, on the other hand, will examine the wealth effect differences between market-based and bank-based economies to contribute to this debate.

➢ Fourthly, most of the existing literature at the international level has concentrated on the comparison between financial and housing wealth effects. However, the empirical results are inconclusive. On the one hand, some studies show that the real estate wealth effect is substantially larger than the financial wealth effect (see Case et al., 2005&2011; Carroll et al., 2006; Ciarlone, 2011); while on the other hand, some evidence indicates that the financial wealth effect should be stronger (e.g. Ludwig and Slok, 2004; De Bonis and Silvestrini, 2009; Skudelny, 2009; Slacalek, 2009). Since no consensus has been reached on the comparison between stock and real estate wealth effects in previous literature, this study will

revisit this issue and provide new evidence from a set of OECD countries using the most recent available data.

➢ Fifth, most of the previous multi-country studies rely on a single-equation framework. However, Lettau and Ludvigson (2001, 2004) point out that unless consumer spending (not income or wealth) does all the adjustment in response to a shock, it is important to take into account all the variables in the system. Hence, system estimation is necessary. This thesis will employ a panel-data vector autoregressive (Panel VAR) approach based on a methodology advocated by Love and Zicchino (2006) to estimate the relationship between wealth and consumption systematically. Indeed, the VAR model has the advantage of explicitly allowing for feedback effects from consumption to wealth or income, something that the single-equation approach cannot address. The VAR approach can also illustrate how the responses of consumption and wealth vary according to the nature of the shocks on them.

➢ Sixth, potential asymmetric wealth effects on consumption in terms of positive and negative wealth shocks will also be examined based on the panel VAR model. Understanding asymmetric responses can provide valuable insights into theoretical arguments (e.g. based on 'sticky' consumption). A deeper knowledge of asymmetric responses can also be useful for policy analysis if consumption and

asset prices behave differently during different phases of the business cycle.

1.6 Thesis Outline

The overall outline as well as the organisational pattern of this thesis is discussed in this section. The thesis comprises eight chapters and each of the chapters is introduced as follows.

Chapter 1: Introduction explores the origins of the study, research background and problem, research question, objective of the research, brief review of the data and methods of the study, and the major contributions of the study.

Chapter 2: The literature review introduces the theoretical framework as well as the empirical evidence for the relationship between wealth and consumption. Both time-series and panel data evidence are provided. In particular, while most of the previous literature has heavily examined the total wealth or stock market wealth effect on consumer spending, this chapter will emphasize the existing evidence of housing wealth effect on consumption, which is comparatively scarce. In addition, this chapter will also briefly introduce the literature based on micro/household-level data, though the main focus of this thesis is in the context of macro data.

Chapter 3 introduces, in detail, the time-series and panel data set employed in this research. Each variable is specified along with the reasoning behind it. Moreover, both theoretical and econometrical models are introduced. In particular, both time-series and panel data econometric approaches are presented.

Chapters 4 and 5 examine the relationship between wealth and consumption based on the time-series data for the US, while Chapters 6 and 7 estimate the wealth effect on consumption based on the panel data of 14 OECD countries.

Specifically, Chapter 4 argues that nonlinear estimation, in particular regime-switching adjustment, may provide a better explanation of fluctuations in the relationship between consumption, labour income, financial and housing wealth in the US. It has been shown that marginal propensity to consume (MPC) out of housing and financial wealth could be estimated more accurately under regime shifts. That is, a dollar increase in housing wealth increases consumer spending by 10 cents during housing boom periods, and only increases consumption by 8 cents during normal conditions. On the other hand, an additional dollar of financial wealth raises consumer expenditures by 4 cents and 5 cents in the respective regimes. Therefore, the housing wealth effect is larger than the financial wealth effect in both regimes and even bigger during a housing boom state. Moreover, the estimation of the Markov switching-vector error correction model (MS-VECM) suggests that short-term deviations in the consumption-wealth relationship could predict either consumption growth or financial and housing asset returns which depend on corresponding regimes. This chapter also finds that the transition probabilities between regimes are time-varying and driven by monetary indicators, such as short- and long-term interest rates, and the term structure of the interest rates. In particular, monetary policy changes may exhibit asymmetric impacts on the role of the consumption-wealth channel.

In contrast to Chapter 4, which focuses on the dynamics of asymmetric wealth shocks, Chapter 5 considers the importance of heterogeneity in consumption

behaviour, which is fundamental to grasping the impacts of wealth shocks, and the effectiveness of tax and other policies that can impact on wealth. A novel approach is applied in this chapter, where an autoregressive distributed-lag model (ARDL) is embedded within a quantile framework. Whereas conventional cointegration tests fail to detect long-run relationships between consumption and wealth, this chapter finds that there actually exists a long-run cointegrating relationship between consumption, income, and wealth that is characterised by different speeds of adjustment across the range of quantiles. Further analysis shows that there is strong evidence of location asymmetries between lower and medium-to-higher quantiles for most of the estimated parameters, where wealth effects on consumption are larger in the lower quantiles. There is also a time-varying pattern for the relationship between consumption and wealth in the US.

Chapter 6 examines the wealth effect on consumption in 14 OECD countries and two sub-groups of countries with different financial systems by employing an advanced four-stage approach. After accounting for cross-sectional dependence, this chapter finds that stock prices in bank-based markets might exhibit mean reversion. Moreover, weak cointegration evidence for consumption, income and wealth is observed in market-based economies but not in bank-based economies. Chapter 6 also shows that the housing wealth effect is larger than the financial wealth effect. Contributing to the market-based versus bank-based financial systems debate, Chapter 6 identifies that wealth has a stronger impact on consumption in market-based nations than in bank-based economies. As a result, policy makers should still prevent a recurrence of the bubble-like increases followed by crashes in both equity and housing prices that have been the case over recent years, because the decline of capital markets has more severe adverse

impacts on households' expenditure in market-based economies than in bank-based nations. For example, the recent global financial crisis has hurt the financial and housing markets more severely in market-based nations such as the United States, whereas in bank-based countries like Germany it has had less influence.

Since Chapter 6 finds that the stock prices in bank-based markets might show mean reversion, and there is also no cointegration evidence observed for bank-based economies, multi-country wealth effect estimation based on level data ($I(1)$) might be biased. Chapter 7 employs a panel-data vector autoregressive (Panel VAR) approach to investigate the wealth effect on consumption in OECD countries. The panel VAR model is able to estimate the wealth effect on consumption regardless of the presence of a cointegrating relationship, due to the use of stationary series ($I(0)$) for all the variables in the equations. Moreover, compared with the single-equation method used in many previous cross-country studies that relied on the cointegrating relationship between consumption, income and wealth to determine the wealth effect on consumption, the panel VAR relies on system estimation, which has the advantage of explicitly allowing for feedback effects from consumption to wealth or income, something that the single-equation approach cannot address. The VAR approach can also illustrate how the responses of consumption and wealth vary according to the nature of the shocks on them.

Chapter 7 estimates the evolution of asset wealth effects over time. Despite the stock market wealth effect being generally larger than the housing wealth effect, the housing wealth effect has outweighed the share market wealth effect in the last decade. Chapter 7 further finds that asset wealth has asymmetric effects on consumption, with stronger and more persistent effects from positive asset wealth

shocks. The results of Chapter 7 have important monetary policy implications for both stock and real estate markets, and offer timely insights into the desirability of current proposals to reduce house price volatility, such as through macro prudential regulations.

Finally, Chapter 8 provides the summary and implications of the thesis, and points out its contributions and limitations. To consolidate the answer to the research question and objective, this chapter synthesises the overall findings of the relationship between consumption, income, financial and housing wealth, followed by policy implications for researchers and policymakers as well as caveats. Several avenues for future research are also suggested.

CHAPTER 2: LITERATURE REVIEW

2.1 Theoretical Framework

The basic ideas and key theoretical links between wealth and consumption can be analysed in the framework of the permanent income hypothesis (Friedman, 1957) or the life-cycle model of household spending behaviour (Ando and Modigliani, 1963). In this framework, the level of consumption depends on households' current and expected future income stream as well as their stock of wealth. In detail, a typical consumer will accumulate and deplete his/her wealth to keep his/her spending more or less steady. In terms of predictable changes in wealth, the model shows that wealth could vary substantially over the consumer's lifetime but his/her consumption will stay relatively constant. In the case of unexpected changes in wealth, the household will spread out the benefit or deficit from the unexpected gain or loss in wealth by raising or cutting current consumption by a fraction of the value of the change in wealth and keep the new level of consumption stable over time. Therefore, the framework suggests that predictable changes in wealth should not cause changes in planned consumer expenditure, but unexpected changes might influence the plan.

Researchers have extended the basic model in order to capture a more realistic interpretation of the process by which consumers make their spending decisions. For instance, they have restricted the ability of households to borrow as much as they would like against higher future incomes. They also allowed the possibility that households may save some money as a precaution against future unpredictable events or leave the money to other individuals, charities, or the

government after death. All these extensions have helped to explain some deviations from the underlying life-cycle theory. Specifically, it is then possible to measure the response of consumption even in terms of predictable changes in wealth or income, and also determine the variables that could predict future changes in wealth or income.

However, consumption does not behave the same way for all types of wealth. Catte et al. (2004) have argued that the MPC out of financial and housing wealth could differ due to a number of factors, which can work in opposite directions. Firstly, unlike financial assets, housing is both an asset and a consumption item. The effect of higher house prices on wealth is partly or fully offset by the higher cost of present and future housing services consumed. As an example, following a house price increase, homeowners may feel wealthier through both a realized wealth effect (home equity withdrawal or selling the house) and an unrealized wealth effect (higher discounted value of wealth). However, the increase in house prices also implies a rise in the value of housing services, which works in the opposite direction with respect to both realized and unrealized wealth effects. For instance, for homeowners who intend to increase their consumption of housing services (e.g. moving into a more expensive home), or renters who want to rent a house, the net housing wealth effect is negative. It is therefore the different categories of households as well as the relative size of their consumption responses to changes in housing wealth that determine the sign and size of the aggregate housing wealth effect on consumer spending.

Secondly, housing wealth can facilitate access to credit for liquidity-constrained households, which may not have access to uncollateralized consumer credit or

may find it prohibitively expensive. Homeowners with lower wealth are more likely to be liquidity-constrained than wealthier homeowners. Therefore, if mortgage markets allow homeowners to borrow easily against home equity, a change in aggregate housing wealth may have a larger effect on consumer spending than an equivalent change in financial wealth.

Thirdly, housing assets are treated as less liquid than financial assets, and some people may develop "mental accounts" that view changes in the value of financial wealth as more appropriate to use for current consumption and changes in housing wealth as long-term savings. Therefore, households are more reluctant to sell their house and are thus less likely to transform any house price increase into liquid assets ready for consumption. Moreover, it is relatively costly and time-consuming to convert increases in housing wealth into money. For example, transaction costs are much higher on housing assets than on financial assets in many countries. Therefore, consumption is likely to respond to a house price shock only after the accumulated price movement has become so large that it exceeds the costs associated with adjusting the housing stock.

Fourthly, unlike a rise in stock price which can reflect an increase in the economy's expected productive potentials and future income prospects, higher house prices may simply mirror scarcity owing to a higher demand, with no change in either the quantity or the quality of the services housing can provide to the overall economy (Ciarlone, 2011). However, even if there is no change in the aggregate wealth, housing price changes still would affect the consumption decisions of different groups of people, such as current homeowners and potential house buyers.

Finally, housing prices are less volatile than equity prices in most countries. This has made households regard changes in housing values as being more persistent, and any change in households' housing wealth will have a relatively large impact on the households' expected lifetime resources. Therefore, households might be willing to modify their consumption more rapidly following a change in house prices (Lettau and Ludvigson, 2004).

In summary, whether the financial wealth effect should be larger or lower than the housing wealth effect is ambiguous on theoretical grounds. Therefore, it is crucial to distinguish financial and housing wealth effects on consumption.

2.2 Empirical Research

Empirical analyses of the wealth effect place emphasis on the question of whether – and if so, to what extent – movements in wealth impact consumer spending. The purpose of these analyses is to estimate the MPC out of wealth. That is, how many cents will households spend or save due to a one dollar increase or decrease in the households' wealth.

Generally speaking, the literature of wealth effect on consumption can be divided into two groups, one dealing with aggregate data and the other relying on household-level data. This chapter however primarily concentrates on the literature with regard to the macro/aggregate data.

2.2.1 Aggregate Data

2.2.1.1 Total Wealth Effect and Financial Wealth Effect

2.2.1.1.1 The US Evidences

Most studies of how wealth affects consumption are based on aggregate data and use cointegration techniques. Until recently, an extensive empirical literature has focused on the total wealth or stock market wealth effect on consumer spending in context of the US market. This is not only because the US market provides a more comprehensive and detailed dataset than other countries, but also because US households hold large amounts of their wealth in stocks: thus gains and losses in the stock market are vital in explaining changes in households' wealth (Ludvigson and Steindel, 1999). Mankiw and Zeldes (1991) also show that the consumption of stockholders is more volatile and more strongly correlated with stock market returns than that of non-stockholders.

Numerous empirical studies on the relationship between wealth and consumption have found evidence of a positive and significant long-run relationship between them. As early as the 1970s, Modigliani (1971) calculated the MPC from accumulated wealth to be 0.05, meaning that a dollar increase in aggregate wealth leads to an increase in aggregate consumption of 5 cents. Recent follow-up studies all show that the MPC in the US is in the range of 0.03 to 0.07 (see Brayton and Tinsley, 1996; Campbell et al., 1997; Ludvigson and Steindel, 1999; Mehra, 2001; Davis and Palumbo, 2001; Lettau and Ludvigson, 2001&2004), which is consistent with the early academic work of Modigliani (1971). Nevertheless, some studies argue that the wealth effect, especially the stock wealth effect, is relatively

modest for various reasons. Poterba and Samwick (1995) show that changes in the patterns of stocks' property do not have a significant impact on the relationship between stock price fluctuations and consumer spending. Caporale and Williams (1997) state that the MPC in the US is small, but the processes of financial liberalization or deregulation have strengthened the wealth effect. Poterba (2000) suggests that bequests' motives and precautionary savings behaviour also may lead to a modest wealth effect. Starr-McCluer (2002) points out that stockholders may not spend realized capital gains but rather save them for retirement due to rising concerns regarding trend inversions in stock prices. Bulmash (2002) finds that consumers do not respond immediately to a change in stock market: rather, they wait at first and thereafter gradually accelerate their consumption only after they are convinced that the gain is permanent. He shows that for instance, over 40% of the growth in consumption in 1999 was attributable to gains in the stock market in previous years. Moreover, Benjamin et al. (2004) estimate the financial wealth effect on consumption in the US and find that an additional dollar of financial wealth only increases consumer expenditure by 2 cents in the current year. They note that consumption is so limited from financial wealth in the US because households' financial wealth is concentrated in restricted accounts such as pension accounts and insurances that are hard to withdraw from.

In addition, Ludvigson and Steindel (1999) and Lettau and Ludvigson (2001, 2004) estimate the impact of temporary fluctuations in the growth rate of wealth on future consumption growth by using a vector error correction approach. They find that permanent changes in wealth do affect consumption, but most changes in wealth are transitory and are uncorrelated with consumption. In particular, subsequent to an equilibrium-distorting shock, only wealth, not income or

consumption, exhibits error correction behaviour that adjusts to restore the long-run equilibrium. It also implies that conventional estimates of the MPC out of wealth, based on parameters of the shared trends in wealth, income and consumption which only specify the relation between consumption and permanent changes in wealth, may overstate the wealth effect on consumption, especially in the case of most movements in wealth which are transitory but not a trend. Kishor (2007) also shows that a dollar increase in financial wealth only increases consumption by 3 cents because transitory shocks constitute half of the movements in financial wealth if consumption only responds to permanent movements. Similar evidence has recently been found by Sousa (2010) who shows that financial wealth shocks only produce transitory effects.

Almost all the wealth effect studies mentioned above are based on cointegration models that require a stable long-run relationship between wealth, income and consumption. Carroll et al. (2006) present a new method for determining the wealth effect that exploits the sluggishness of consumption growth. This approach does not require the existence of a stable cointegrating vector when refer to time-series specification. Furthermore, this method is more robust to changes in underlying parameters (including expected income growth, taxes, productivity growth, financial structure and regulation, interest rates, social insurance or demographics). In fact, Rudd and Whelan (2006) do not find any cointegrating vector for the US. Muellbauer (2008) and Barrell and Davis (2007) also confirm the fact that the estimation of wealth effects might be biased by omitted variables.

Alexandre et al. (2007) argue that the commonly used equation for the estimation of wealth effect on consumption (e.g. Lettau and Ludvigson, 2001) might be

unsuitable because the wealth effect will be indeterminate based on the usual assumptions. They show that a Markov-switching model may be more suitable to measure the wealth effect, which confirms the evidence of indeterminacy in usual consumption equations and finds two regimes related to different estimates of the wealth effect. Gabriel et al. (2008) further study the short-run trivariate relationship between consumption, income and wealth by utilizing a Markov-switching vector error-correction model. Again, they find the wealth effect can differ across regimes, and these regimes are related to the fluctuations of financial markets. In addition, they show that short-term deviations in the trivariate relationship will predict either asset returns or consumption growth, depending on the state of the economy.

2.2.1.1.2 The International Evidences

Estimates of the strength of the wealth effect in other countries are limited, in large part because wealth data for other countries often are not available for a sufficiently long time series for estimation.

Carruth and Henley (1990) was one of the first to identify the importance of the wealth effect as a determinant of consumption based on an ECM approach for the UK market. Recently, Fernandez-Corugedo et al. (2003, 2007) identify the long-run MPC out of total wealth in the UK is 0.05, which is similar to the US, by investigating the short-run dynamics and long-run relationship of and between non-durable consumption, labour income, wealth and the relative price of durable goods. They also find that adjustments take place in wealth and not through income or consumption. In other words, variation in income and consumption is

only related to permanent shocks. Specifically, at least 30% of fluctuations in non-human wealth are transitory, decoupled from permanent consumption. Moreover, their results imply that the consumption cointegrating residual may predict asset returns.

Wealth effect research in Australia has been mainly conducted by Tan and Voss (2003), Fisher and Voss (2004), Tang (2006), and Fisher et al. (2010). Tan and Voss (2003) find a steady-state relationship between non-durables consumption, labour income and aggregate household wealth for the period 1988-1999. They also show that changes in both non-financial and financial assets have significant but different short-run and long-run effects in dynamic consumption models. Following Lettau and Ludvigson (2001), Fisher and Voss (2004) show that private dissaving can predict real stock returns and the risk premia on stocks over short and intermediate horizons in Australia. Nevertheless, it cannot predict consumption growth at any growth horizon, which is consistent with the permanent income hypothesis.

Tang (2006) shows that a permanent one dollar rise in financial wealth leads to only a two cent increase in consumption, which is much smaller than the housing wealth effect. Fisher et al. (2010) examine the response of non-housing consumption to permanent and transitory changes in financial and non-financial wealth in Australia since the mid-1970s by following the Lettau and Ludvigson (2004) cointegration model. They show that household consumption will respond to transitory rises in wealth and labour income. In general, these studies all find similar results to the US and UK evidence showing that there exists a long-run

steady relationship between consumption, income and wealth. In particular, the financial wealth effect on consumption is modest.

In Canada, using a vector error-correction model in which permanent and transitory shocks are identified using the restrictions implied by cointegration proposed by King et al. (1991) and Gonzalo and Granger (1995), Pichette and Tremblay (2003) find that the MPC out of stock market wealth is small and insignificant, at less than a cent. However, Abizadeh and Ng (2009) show a positive and significant stock market wealth effect on consumption based on the dynamic ordinary least squares (DOLS) method.

To the best of my knowledge, to date, few studies have been done for economies in continental Europe. One reason for this could be that wealth data are not readily available for most continental European countries. By using a unique new dataset of German household wealth, Hamburg et al. (2008) find the MPC out of wealth in Germany is around 0.05, which is in line with most studies in the US. Furthermore, they also identify that consumption does not exhibit error correction behaviour. Nevertheless, they find some important differential evidence compared with the studies in Anglo-Saxon economies[2]. They show that subsequent to an equilibrium-distorting shock, it is income, and not wealth, that adjusts to restore the long-run equilibrium. Compared with the evidence in the US, the transitory component in asset wealth is quite small in Germany.

The reason why the transitory component in wealth is relatively small in Germany is probably due to the structural differences in the financial and pension systems.

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[2] As opposed to Continental economies, Anglo-Saxon economies represent the countries with low levels of regulation and taxes, fewer services from the public sector, overall ease of doing business and low barriers to free trade, such as the US, the UK, Canada, Australia, and New Zealand.

That is, stock market wealth accounts for a much smaller share of household net wealth in Germany than in the Anglo-Saxon economies. Therefore, temporary fluctuations in stock markets only have small impacts on German private household net wealth.

Germany's financial system is one of the main representatives of the continental European type of financial system, where private stock ownership is much less widespread than in the Anglo-Saxon economies and households generally hold large shares of their wealth in the form of relatively illiquid assets such as housing. The results of Hamburg et al. (2008) suggest that these differences imply a different transmission mechanism from financial markets to the real economy and in particular in a different role of asset price fluctuations in consumption.

Chen (2006) finds strong evidence that the long-run movements of consumption, income and financial wealth are tied together in Sweden, and the MPC out of financial wealth is found to be 0.05, which is within the international average. Fenz and Fessler (2008) find that a one unit increase in Austrian wealth is associated with an MPC of 0.05. Furthermore, they show that a decrease in wealth has a relatively minor effect on private consumption and economic growth in Austria. In contrast, in France, Chauvin and Damette (2010) identify that an increase (decrease) in total wealth of one euro would only lead to an increase (decrease) of 1 cent in total consumption. In the context of elasticity, they find that an increase (decrease) of 10% in wealth would also imply a relatively small impact of 0.8 to 1.1% on consumption, depending on the concept of consumption considered. Their results imply that the wealth effects in France are smaller than in the US or UK but close to what is observed in Italy.

Apart from individual country studies, recently there have also been a few multi-country studies on the wealth effect, which mainly focus on international economic organizations such as the OECD, G7, and EU. Based on a time-series econometric model, Boone and Girouard (2002) investigated G7 countries (excluding Germany) for a sample period covering the 70s, 80s and 90s in terms of wealth effect on consumption. Their estimates of the MPC out of financial wealth show a large variation: from 8-12 cents for Canada, France, Italy and Japan, to 4 cents for the US and UK. Bertaut (2002) also examines individual countries and presents similar evidence to Boone and Girouard (2002). Another time-series G7 study by Byrne and Davis (2003), however, finds relatively lower MPC out of financial wealth for Canada, France, Italy and Japan. Moreover, they show that illiquid financial wealth tends to be a more important long-run determinant of consumption than liquid financial wealth. Most recently, McMillan (2013) investigated the relationship between consumption growth and stock market for the G7 economies based on panel data approaches. He tests whether consumption growth is affected by stock returns and dividend yield. The results confirm a significant relationship between the dividend yield and consumption growth, such that a fall in the yield is associated with higher future consumption. McMillan (2013) concludes that when stock prices deviate from their fundamental path this has an effect on future consumption. His findings have important policy implications with respect to the share market bubbles.

Edison and Slok (2002) measure the impact from changes in 'new' and 'old' economy stock valuations on consumption for 7 OECD countries by using reduced form VAR under the time-series econometric framework. They identify that the impact from changes in old economy stock valuations on consumption is

larger in countries with market-based financial systems (the US, UK and Canada) than in countries with bank-based financial systems (continental Europe). Furthermore, the impact from changes in new economy valuations on consumption is roughly the same for these two groups. Ludwig and Slok (2004) examine the implications of the structure of the financial system for the transmission of changes in asset prices to consumption in 16 OECD countries using a panel data approach. They find that the responsiveness of consumption to changes in stock prices is higher for countries with market-based systems (Australia, Canada, Ireland, Netherland, Sweden, UK and US) than nations with bank-based financial systems (Finland, France, Germany, Italy, Japan, Norway and Spain).

Labhard et al. (2005) employ structural vector autoregressions (VARs) to estimate the wealth effect on consumption for 11 OECD countries individually. Structural VARs are better than single-equation studies (Bertaut, 2002; Ludwig and Slok, 2004) that explicitly allow for feedback effects from consumption to wealth. The results from Labhard et al. (2005) show a large cross-country dispersion. Specifically, the MPCs out of total wealth for the US and Canada as well as most euro-area countries lie in the range 0.01 to 0.05. However, in terms of MPC out of financial wealth, values in the US and Canada are much larger than those for most European nations.

The most recent study on OECD countries is that of De Bonis and Silvestrini (2012) who rely on pooled mean group (PMG) estimation. In contrast to the previous literature, they exploit European quarterly harmonized data on household financial assets and liabilities, which have been taken from the flow of funds.

Moreover, they not only estimate the total financial wealth effect on consumption, but also consider the impact of a subset of those financial assets, such as quoted shares, mutual funds, and insurance technical reserves, which are more linked to the Stock Exchange. They find that both net financial and housing wealth have a positive effect on consumer spending. In particular, the effect of net financial assets is stronger than that of real estate assets.

Dreger and Reimers (2006) employ the panel cointegration test developed by Pedroni (1999, 2004) to examine the wealth effect on consumption in 12 European Union countries. They find a long-run relationship between consumption and disposable income in the EU. Moreover, the MPC out of financial wealth is determined to be in the range of 3-5%, which is in line with recent aggregate data results. Dreger and Reimers (2011) further investigate wealth effects on consumption in a panel of 15 industrialized countries in terms of common and idiosyncratic effects. They show that consumption, income and wealth are cointegrated in their common components. At the idiosyncratic level, a long-run equilibrium is detected between consumption and income. The income elasticity in the idiosyncratic relationship is found to be significantly less than unity. Therefore, the presence of wealth effects in consumption equations arises from the international integration of asset markets and points to the relevance of risk sharing activities of agents.

Skudelny (2009) estimates the wealth effect in the euro area by using two macro-datasets. One is for the aggregate euro area for the period 1980-2006, and the other relates to the individual euro area countries from 1995-2006 by using panel data techniques. The results from the euro area aggregate data show the MPC out

of financial wealth is between 2.4 and 3.6 cents, while the panel data estimation is quite low (0.6 to 1.1 cents), meaning that only 0.6 to 1.1 cents will be spent on consumption due to one euro increase in financial wealth.

Wealth effect studies in emerging markets are rather scarce. Funke (2004) finds a small but statistically significant stock market wealth effect in a panel of 16 emerging markets. A 10% drop/rise in stock markets is associated with a 0.2-0.4% decrease/increase in private consumption. Peltonen et al. (2009) apply a panel generalized method of moments (GMM) model to estimate the magnitude of stock market wealth effects on consumption in a panel of 14 emerging economies. They find a statistically significant and large wealth effect on consumption, and consumption reacts more strongly to negative than to positive shocks in financial wealth. Furthermore, stock market wealth effects are found to be smaller for Latin American countries.

2.2.1.1.3 The Nonlinear Evidences

Besides the numerous empirical evidences of the positive and significant/modest long-run relationship between total wealth/stock wealth and consumer expenditure, there are also a few studies on the asymmetric behaviour of wealth effects on consumption, though such studies are quite rare.

Studies on the relationship between wealth and consumption asymmetry in the US have mainly been conducted by Apergis and Miller (2005a, 2005b, 2006). Apergis and Miller (2005a) use a threshold adjustment model to examine whether stock market wealth affects real consumption asymmetrically in the US. They find that

a rise in stock market wealth generates a larger increase in consumption than a corresponding decrease in consumption from a similar decline in stock market wealth. Such asymmetric behaviour of consumption implies that policy makers should respond more quickly to rising stock market wealth for the purpose of preventing asset "bubbles," while they should pay less attention to drops in stock market wealth. Apergis and Miller (2005b) provide further evidence showing that besides stock market assets, household net assets and financial assets including stock market assets also exert an asymmetric wealth effect on consumer spending. Apergis and Miller (2006) identify that stock market value asymmetrically affects real per capita consumption during the short-run adjustment process, by using cointegration and error correction methodology. They also find that bad news will produce a stronger effect than good news. In addition, Stevans (2004) shows that households' consumption growth will be altered to quickly eliminate the gap between actual and target spending when the value of equities held by households is larger than the threshold, e.g. during a bull market. Conversely, during a bear market (the value of equities is less than the threshold), the disparity between actual and target spending will be eliminated relatively slowly. Gabriel et al. (2008) estimate the consumption-wealth ratio by employing a Markov-switching vector error-correction model and find that when changes in wealth are transitory, short-term deviations in the consumption-wealth ratio can forecast asset returns, while when changes in wealth are permanent, such short-term deviations will predict consumption growth.

Recently, using a testing procedure advocated by Bierens (1997a, 1997b, 2000) applied to the US data, Holmes and Shen (2012) find evidence that consumption, income and wealth are in fact stationary around a nonlinear deterministic trend

and are co-trended insofar as they share a common nonlinear deterministic trend. This can be seen in the context of cointegration-based studies that have often found against the existence of a long-run relationship (Benjamin et al., 2004, Rudd and Whelan, 2006, and Carroll et al., 2006). Furthermore, Holmes and Shen (2013) explore the connection between the average propensity to consume (APC) and wealth to income ratio (WY) in the US. They find evidence of a long-run relationship characterised by threshold error correction. It is the APC that responds to long-run disequilibrium where the speed of adjustment is asymmetric insofar as being most likely fastest in regimes characterised by a high APC and low WY.

In the context of international research on asymmetric wealth effect, Shirvani and Wilbrate (2000) investigate the asymmetric stock wealth effect on consumption in the US, Japan and Germany, and find that consumption responds more strongly to stock price declines than to increases. DeJuan et al. (2006) test the permanent-income hypothesis in 11 West-German states and only find weak evidence to support this hypothesis. Specifically, for each individual state and for Germany as a whole, the response of consumption to income innovations is found to be asymmetric, that is, it is much stronger for negative than positive income innovations. A recent study by DeJuan et al. (2010) examines the permanent-income hypothesis using Canadian provincial-level data. Again, consumption's response to income innovations is found to be much weaker than that predicted by permanent income hypothesis (PIH). In particular, negative income innovations are stronger than positive income innovations. In addition, Ibrahim and Habibullah (2010) analyse the asymmetric impacts of real stock prices on aggregate consumption for Malaysia using an asymmetric cointegration and error

correction modelling. They show that in the long-run, there is a positive relationship between aggregate consumption–income ratio and stock price–income ratio. Nevertheless, in the short-run, the consumption–income ratio will adjust to restore the long-run equilibrium only when it is above its long-run value.

2.2.1.2 Housing Wealth Effect

Very recently, the effect of house prices on consumption has come under the spotlight. One of the key factors affecting the linkage between housing wealth and consumer spending is financial liberalisation. Financial market innovation helps to increase the availability of credit for given creditor characteristics, e.g. the level of indebtedness of the creditor. There are several channels by which financial market innovation can affect consumption expenditure (De Veirman and Dunstan, 2008). Firstly, financial liberalisation might encourage consumption through the collateral effect. That is, under financial innovation, there will be an increase in the size of loans relative to household wealth. As a result, a household's marginal borrowing capacity will improve if house prices increase. Secondly, the increase in loan supply due to financial market innovation tends to reduce the fraction of liquidity-constrained households. The aggregate relationship between wealth and consumption might then be weakened, since the collateral channel only works for credit-constrained households. Thirdly, with the increase in loan-to-value or loan-to-income ratios, households no longer need to save as much as before in order to purchase houses. In other words, households are able to consume more.

However, evidence of the housing wealth effect is still quite scarce, especially for studies based on aggregate data, and the results are also inconclusive. The main

reason that evidence of housing wealth effects is so rare and diverse is the scarcity of data. Due to the limitation on complete datasets for different countries, ways to measure housing wealth are rather varied (based on household sector balance sheet accounts or on sales price indices or on survey data).

Several recent papers have found that the housing wealth effect on consumption might be larger than the financial wealth effect in the US. Benjamin et al. (2004) investigate the real estate wealth effect for the time period from 1952 to 2001 and find that an additional dollar of housing wealth increases consumption by 8 cents, which is higher than the financial wealth effect of only 2 cents. This implies that the decline in the stock market in the US during 2000-2001 had a limited influence on aggregate consumer spending, partly due to an offsetting housing wealth effect. By decomposing wealth according to the liquidity of household assets, Donihue and Avramenko (2005) also find that the significant appreciation in the value of property assets since the stock market collapsed in early 2000 has helped to maintain consumer expenditure. Carroll et al. (2006) employ a new methodology that does not require a stable long-run relationship between wealth, income and consumption, and find that the immediate MPC out of housing wealth is 2 cents but the long-run effect may be up to 9% in the absence of policy interventions, which is larger than the stock market wealth effect. In addition, Kishor (2007) shows that in the long-run, a dollar increase in housing wealth increases consumption by 7 cents, while a corresponding one dollar increase in financial wealth only raises consumer spending by 3 cents. He further explains that the difference between the two wealth effects may be that transitory shocks dominate variation in financial wealth while permanent shocks dominate variation in housing wealth.

In the context of international research on the housing wealth effect, Pichette and Tremblay (2003) find a significant housing wealth effect on consumption compared to weak evidence for a stock market wealth effect in Canada. This suggests that policy makers should put more future inflationary pressures on fluctuations in housing prices than on fluctuations in stock prices. Chen (2006) extends the work by Lettau and Ludvigson (2004) and finds strong evidence of a long-run relationship between housing wealth and consumer expenditure in Sweden. Furthermore, he also shows that short-run variations in the Swedish housing market are largely dissociated from consumption. Fenz and Fessler (2009) also identify significant housing wealth effect on consumption for Austria, and Nastansky and Strohe (2010) find the same for Germany.

Housing wealth studies in Australia find similar results as in the US. Tang (2006) shows that the MPC out of housing wealth is 0.06 in Australia, which is three times the effect of financial wealth. It suggests that a large movement in house prices is potentially more disruptive than a corresponding movement in financial prices. Fisher et al. (2007, 2010) estimate the transitory part of housing wealth, and find that the transitory component of housing wealth is relatively larger than the transitory component of consumption. Moreover, private consumer spending does not respond to transitory fluctuations in either total or housing wealth.

Edelstein and Lum (2004) investigate the housing wealth effect on aggregate consumption in Singapore by focusing on both private and public housing sectors. They find that changes in private house prices have no significant effect on consumer spending, while public housing wealth shows a larger and more persistent effect on consumption. Cheng and Fung (2007) examine the Hong

Kong housing market, and find that a rise in housing price has both a positive wealth effect and a negative price effect on consumption. In particular, the positive wealth effect is caused by an increase in capital income, and the negative wealth effect is caused by an increase in the cost of housing services. It has the policy implication that the government policy of land supply aiming to stimulate the economy should keep a balance between the possible wealth and price effects of the housing market.

Multi-country studies on the housing wealth effect are mainly based on developed countries. Boone and Girouard (2002) find a significant long-run relationship between housing wealth and consumption by examining G7 (excluding Germany). However, estimates of the MPC out of housing wealth show a large variation: from between 0.03 and 0.05 for France, the UK and US, to in excess of 0.1 for Canada and Japan. Bertaut (2002) identifies a positive and significant housing wealth effect for the US and UK but not for Canada. He shows that the consumption responses are similar for both financial and non-financial wealth.

Ludwig and Slok (2004) find a positive relationship between housing wealth and consumption by examining 16 OECD countries, with both bank-based financial systems and market-based financial systems. Catte et al. (2004) show that the estimated long-run MPC out of housing wealth is in the range of 0.05 to 0.08 for Australia, Canada, the Netherlands, UK and US, while it is only 0.01 to 0.02 in Italy, Japan, and Spain and statistically insignificant in France and Germany. Moreover, the former five countries also have a larger housing wealth effect than financial wealth effect. Case et al. (2005) also find a positive and significant relationship between housing wealth and consumption in 14 developed countries.

Moreover, they examine the wealth effect in terms of US states, and identify that the housing wealth effect is stronger than the financial wealth effect at the state level, though there could be some bias from the imputations of data due to insufficient data sources. Dvornak and Kohler (2007) follow the work of Case et al. (2005) and estimate the housing wealth effect based on a panel of Australian states. They show that a one dollar increase in housing market wealth leads to less consumption than the same increase in stock wealth. Nevertheless, as Australian households' housing assets are more than three times that of their stock market assets, the same percentage increase in housing wealth should have an effect on consumption at least as large as that of stock market wealth.

Very recently, Skudelny (2009) examined the housing wealth effect in the euro area by using panel data techniques. He states that the MPC out of nominal housing wealth lies between 0.7 and 0.9 cents per euro, which is lower than that for financial wealth. However, when specifying housing wealth in real terms (taking out of the effect of volatile house prices), the MPC is larger, up to 2.5 cents. Slacalek (2009) followed the methodology introduced by Carroll et al. (2006) to measure the wealth effect in 16 countries. He finds that the effect of housing wealth is smaller than that of financial wealth for most countries, but not for the US and UK. Peltonen et al. (2009) estimate the magnitude of housing wealth effect on consumption in 14 emerging economies. They identify that housing wealth effects have increased for Asian countries in recent years but they are still smaller than in other emerging markets. In particular, housing wealth effects are relatively important in Thailand, Singapore and Hong Kong. In addition, Ciarlone (2011) examines the impact of changes in real and financial wealth on household consumption for a panel of 17 emerging countries in Asia

and Central and Eastern Europe. He shows that both housing and financial wealth positively affect private consumption in the long-run, with the elasticity of housing wealth being larger than that of stock market wealth. Furthermore, there is also a significant short-term adjustment from income, stock prices and house prices on consumer spending. In terms of the wealth effect comparison between Asia and Central and Eastern Europe, the evidence shows that the long-run impact of an increase (decrease) in house price is generally larger in Central and Eastern European countries compared to Asian economies.

Research on the asymmetric behaviour of the housing wealth effect on consumption is quite limited. Donihue and Avramenko (2005) find that in the long-run, housing wealth effects are symmetric in the US. However, consumers behave asymmetrically in the short-run. That is, households adjust more quickly to positive deviations from their consumption targets, while reacting more slowly following negative shocks. Phang (2004) examines the asymmetric behaviour of consumption relative to the change in house prices in Singapore. He shows that anticipated house price increases do not have a positive effect on aggregate consumption, while declines in expected house price growth have a negative effect on consumer spending. Chen et al. (2010) measure the asymmetric effect of house prices on various categories of consumption under constrained and unconstrained regimes using a threshold regression model in Taiwan. They find that the Permanent-Income Hypothesis only holds under an unconstrained regime. Furthermore, durable consumption exhibits a strong asymmetric effect in response to changes in house prices but not for other categories of consumption (e.g. non-durable consumption and total consumption). Peltonen et al. (2009) show that consumption responds more strongly to negative than to positive shocks in

housing wealth in 14 emerging countries. In addition, most recently, Marquez et al. (2013) examine wealth effects in the UK by taking into account the credit conditions of financial markets. Based on the Enders and Siklos (2001) M-TAR model, they show that there is a wealth effect on consumption and that the consumption discrepancies resulting from an unanticipated positive change in housing wealth are eliminated whereas those resulting from a negative change are not. On the other hand, when changes in financial wealth are considered, consumption only responds to negative unanticipated changes in such wealth.

2.2.2 Household Data

The household-level evidence of the wealth effect is relatively recent and is intended to measure the household behaviour underlying the relationship between wealth and consumption. Three main hypotheses for the co-movement between wealth and consumption have been normally tested by micro-data in the literature. Firstly, if there is no causal relationship between wealth and consumption, then the decrease of asset prices should be treated as a symptom of future downturn for expenditure rather than a cause. Secondly, a change in asset prices may lead to different effects depending on whether such change causes adjustment in the expectations of future economic conditions. Finally, acceptance of the collateral channel hypothesis implies that there will be heterogeneous responses in consumer spending to changes in asset prices due to the heterogeneity of household portfolios.

In practice, it is also important to distinguish between the impact of housing wealth and stock market wealth on consumption as consumption may be

differently affected by the form in which wealth is held. For example, the extent to which people view their currently-measured wealth as temporary or uncertain may differ between real estate wealth and stock market wealth. People may be less aware of the short-run changes in housing wealth because they do not get regular updates on its value. In contrast, stock market wealth can be measured daily through the internet or newspapers. The exogenous changes in housing wealth might also have different impacts on consumption from changes in stock wealth, especially the consumption behaviour of young consumers and older homeowners. Increased house values would lead younger renters to save more now to purchase a house in the future. Such increased savings by younger renters could be offset by the increased consumption of current homeowners. In addition, housing could be regarded as both a consumption good and an investment good.

A few studies have estimated the direct wealth effect on consumption in the context of the US markets. Skinner (1989) examines real estate wealth effects and finds a significant but minor wealth effect on consumption. Parker (1999) concentrates on a broader wealth spectrum and also identifies a significant relationship between wealth and consumer spending. In particular, the MPC out of wealth is estimated to be 0.04. However, as identification is based on cross-sectional variation in levels, Parker's findings only show information about the long-run and cannot assess a direct wealth effect occurring in the short-run. Moreover, unobservable variables such as differences in risk aversion or discount rates may vary systematically across the wealth distribution and contaminate the estimation of MPC. Dynan and Maki (2001) overcome the shortage of cross-sectional identification by using data in first difference. They focus on the effect of changes in equity wealth on consumption, and they find that the MPC out of

equity wealth is in the range of 0.05 to 0.15. Maki and Palumbo (2001) also find a strong direct wealth effect on US household consumption during the 1990s. In particular, the households who gained most from exceptional stock market performance are also the same households whose savings fell during the same time. And the households who only obtained modest gains from the stock market kept the same saving rate. Juster et al. (2006) show that the MPC out of equity wealth (0.17) is higher than that from other assets such as real estate. Morris (2007) allows responses to housing gains to vary by age in her work and identifies an MPC out of capital gains of -0.15 for young households, between 0.01 and 0.05 for the middle-aged and of 0.13 for the over-fifties.

In terms of international studies based on micro-economic data, Bover (2005) examines the wealth effect based on micro data from the Spanish Survey of Household Finances (EFF). This study differs from others in that it reflects the different wealth distribution across different regions. The results show the MPC out of real estate wealth to be around 0.015 versus insignificant financial wealth effects. Grant and Peltonen (2008) find similar evidence in Italy, based on data from the Survey of Italian Household Income and Wealth (SHIW), indicating that there is a strong housing wealth effect (0.05 to 0.08) but a weaker financial wealth effect (0.005). Paiella (2007), who also uses SHIW data, finds the MPC out of total wealth is 0.04 which is smaller than in the US. The reason may be partly due to Italian households' smaller holdings of stock and financial wealth in general.

Attanasio et al. (2005) investigate the relationship between UK house prices and consumption. They find strong evidence supporting the common causality hypothesis and show that a 1% increase in house prices leads to a 0.04% - 0.21%

increase in consumption depending on the age group. However, Campbell and Cocco (2007) who employ reduced-form regression, find that the wealth effect from the UK house prices to consumption operates to a large extent through an easing of borrowing constraints. Their estimate of the consumption response is 1.2% which is much higher than Attanasio et al.'s (2005).

Sierminska and Takhtamanova (2007) examine the differences in wealth effects from different types of wealth and across age groups in multiple countries: Canada, Italy and Finland. They find a stronger housing wealth effect compared to financial wealth effect and also substantial differences in the size of the effects between countries.

Nonetheless, evidence on the household-level underpinnings of wealth effects is still limited, which partly reflects the lack of good data to explore the question. My thesis will only focus on the study of aggregate data. I treat the estimates on aggregate data as complementary to micro-level studies. In particular, both time-series and panel data as well as the associated econometric approaches will be employed to contribute new evidence to the existing literature. The following chapter will introduce the relevant data and methodology used in this thesis in detail.

CHAPTER 3: DATA AND METHODOLOGY

3.1 Data

3.1.1 Time-series Data

The time-series dataset consists of real per capita household consumption, labour income, financial wealth and housing wealth for the US during the period 1952Q1-2010Q2. All the data are quarterly, seasonally adjusted, per capita variables, measured in 2005 dollars.

In order to be consistent with the previous time-series wealth effect studies in the US market, the construction of the US data in this thesis follows Lettau and Ludvigson (2001, 2004). That is, consumption is measured as personal consumption expenditures on nondurable goods and services. The reason is that the standard consumption theory concerns the intertemporal optimization of utility derived from the service flow of consumption, but the service flows from durable goods are uneven over a lifetime and are difficult to measure. Observable current expenditures on durable goods are regarded as replacements and additions to the capital stock, rather than a service flow from the existing stock. Thus, they are not valid to indicate the service flows of durable goods consumed in each period. As a result, durable goods are normally excluded from the consumption model. The consumption data for this study has been taken from the national income and product accounts of the Bureau of Economic Analysis.

Labour income is used to represent unobservable human wealth. Labour income can be interpreted as the annuity value of human wealth or the dividend on human capital. After tax labour income is defined as Wages and Salaries + Transfer

Payments + Other labour income − personal contributions for social insurance − taxes. Taxes are defined as [Wages and Salaries / (Wages and Salaries + Proprietor's income + rental income + personal dividends + personal income)] times personal tax and non-tax payments. This source is from the Bureau of Economic Analysis.

Financial wealth is defined as total financial assets − (households' liabilities − home mortgages). The data source is the Flow of Funds Account of the Federal Reserve Board.

Housing wealth is homeowners' net equity in real estate after adjusting for home mortgages. The data source is the Flow of Funds Account of the Federal Reserve Board.

Figure 3.1 plots the log form of the real per capita non-durable consumption, labour income, financial and housing wealth for the US market from 1952Q1 to 2010Q2. In Figure 3.1 there appear to be upward trends for all the variables in the US market. In particular, as expected, it can be clearly seen that both consumption and income are steadier than the financial and housing wealth series over the study period, which is consistent with the theoretical prediction from the permanent income hypothesis (Friedman, 1957) and the life-cycle model of household consumption behaviour (Ando and Modigliani, 1963). One notable feature of the graph is that since 1993, consumption growth has been remarkably strong and has outweighed labour income, though household spending was adversely affected by the recent financial crisis in 2008. Another clear implication of this graph is the large increase in housing wealth since the late 1990s which is generated from the massive boom in the real estate market, while the financial

market had suffered a severe downturn during the similar period due to the 2000-2001 dotcom bubble burst. However, both financial and housing wealth have been significantly shocked by the recent subprime mortgage crisis, where property wealth experienced a larger fall than financial wealth.

Figure 3.1: Consumption, Income, Financial and Housing Wealth data for the US Market
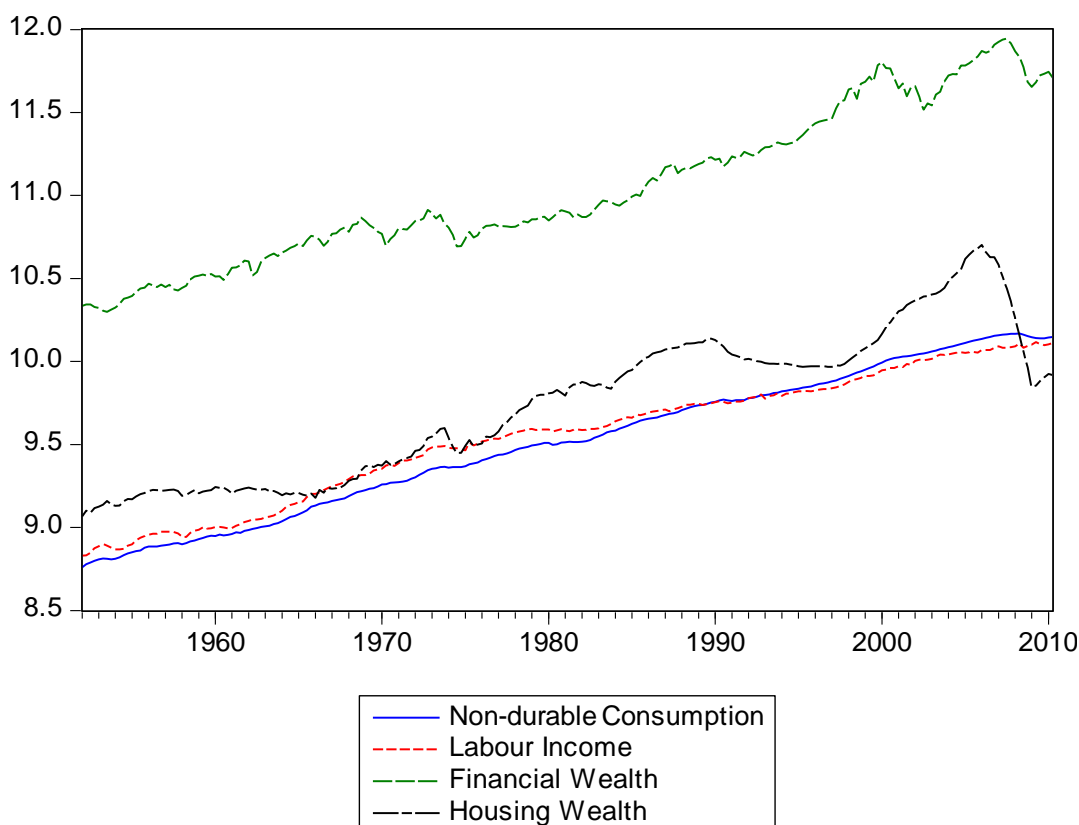
In addition, in terms of the driving factors for transition probabilities of switching between consumption regimes, the short-term interest rate used is the yield on 3-month US Treasury bills, and the long-term rate used is the maturity rate on 10-year Treasuries. The term structure of the interest rate is constructed by taking the difference between the long rate and the short rate. All the interest rate data are sourced from the Federal Reserve Bank of St. Louis.

3.1.2 Panel Data

The panel dataset is based on data for a balanced panel of 14 OECD countries. These countries are Australia, Canada, the Netherlands, Sweden, Switzerland, the UK, the US, Belgium, Denmark, France, Finland, Germany, Italy and Spain. Due to the broad coverage of this study, there are some data limitations. First, the panel data estimation uses total consumption instead of non-durable consumption, since the measure of non-durable consumption is not available for most of the OECD countries. However, according to Mehra (2001), as total consumption is the variable of interest when examining the consumption-wealth channel, a collapse in the share market is more likely to result in a postponement of durable consumption decision, while a decline in non-durable consumption may be of minor importance (Romer, 1990). Moreover, durable consumption goods are among the major entities on which resources raised by mortgage refinancing are spent (Brady et al., 2000). Second, this study uses total disposable income rather than labour income due to data availability. However, the use of disposable income is also suggested by several economic theories (e.g. Campbell and Mankiw, 1991; Attanasio, 1999).

Third, consistent measures of financial and housing wealth are not available on a broad basis for the sample of OECD countries, so they have been proxied by stock price and house price indices. For example, considering the relatively long time-span of the estimated period, consistent measures of asset wealth required for a balanced panel are only available in a limited number of cases such as the US, the UK and Australia. However, price series are readily available across countries, and are reported at the desired frequencies. Nevertheless, there are also some

drawbacks for the use of real value of stock and real estate. For instance, some stocks can be owned by foreign investors or not even listed, so the value of stocks may not reflect actual household wealth. ECB (2009) has also suggested the use of price data rather than value data. Furthermore, in regards to the estimation of the dual impacts of housing price on consumption, wealth data would not be able to fully reflect both the positive capital value effect and the negative housing service effect, because the housing wealth data ignores the effect on non-homeowners. In addition, Lustig and Van Nieuwerburgh (2005) show that there may be measurement error problems in a cross section of countries if housing values are involved. In fact, most of the previous empirical panel-data wealth effect studies have adopted this strategy of using price indices instead of real values (Ludwig and Slok, 2004; Dreger and Reimers, 2006 & 2011; Ciarlone, 2011). Therefore, to be consistent with earlier studies and be more easily comparable, asset price index data is also used in this thesis.

Both consumption and income data are expressed in real, per capita terms on a seasonally-adjusted basis. All the data are in log forms that cover the period from 1975Q1 to 2011Q2 with quarterly frequency. Data on consumption, income and stock price indices have been collected from Datastream. The house price indices data follow Mack and Martinez-Garcia (2011) who constructed them based on a variety of national and international data sources. These house price data are available from the Federal Reserve Bank of Dallas.

Figures 3.2-3.5 plot the log of real per capita total consumption and disposable income, as well as the stock and housing price indices for 14 OECD nations. It can be seen that the OECD findings are similar to those from the US market. That

is, the studied variables show upward trends for most of the OECD countries, and the consumption and income series vary considerably less than the stock and housing price indices. Furthermore, consumption and income in most of the OECD economies had slightly dropped due to the 2008 global financial tsunami.

In terms of stock and housing price indices, while the equity markets in OECD countries were quite volatile between the late 1990s and early 2000s, real estate markets on the other hand experienced substantial booms since the late 1990s, with the exception of Germany and Switzerland. Moreover, most of the OECD countries also experienced downturns in their asset markets in response to the 2008 crisis. However, many of them have picked up since then.

Figure 3.2: Total Consumption in 14 OECD Countries
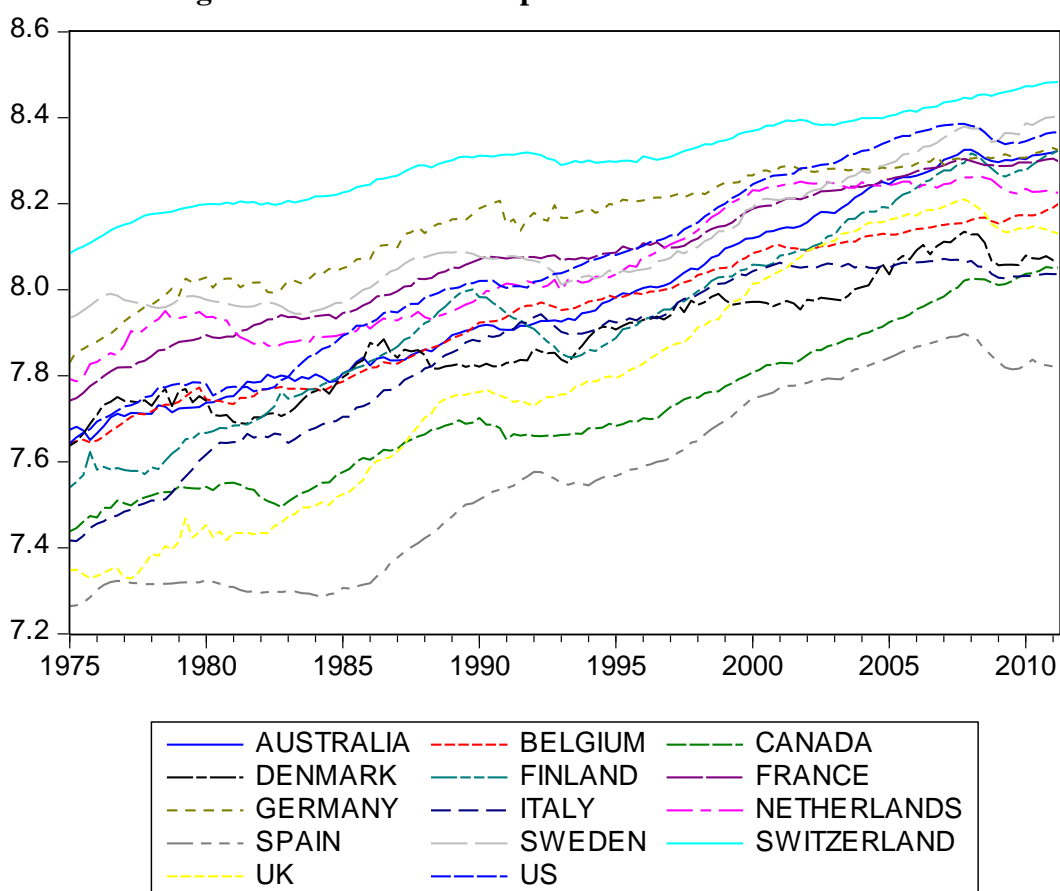
Figure 3.3: Disposable Income in 14 OECD Countries

AUSTRALIA	BELGIUM	CANADA
DENMARK	FINLAND	FRANCE
GERMANY	ITALY	NETHERLANDS
SPAIN	SWEDEN	SWITZERLAND
UK	US	
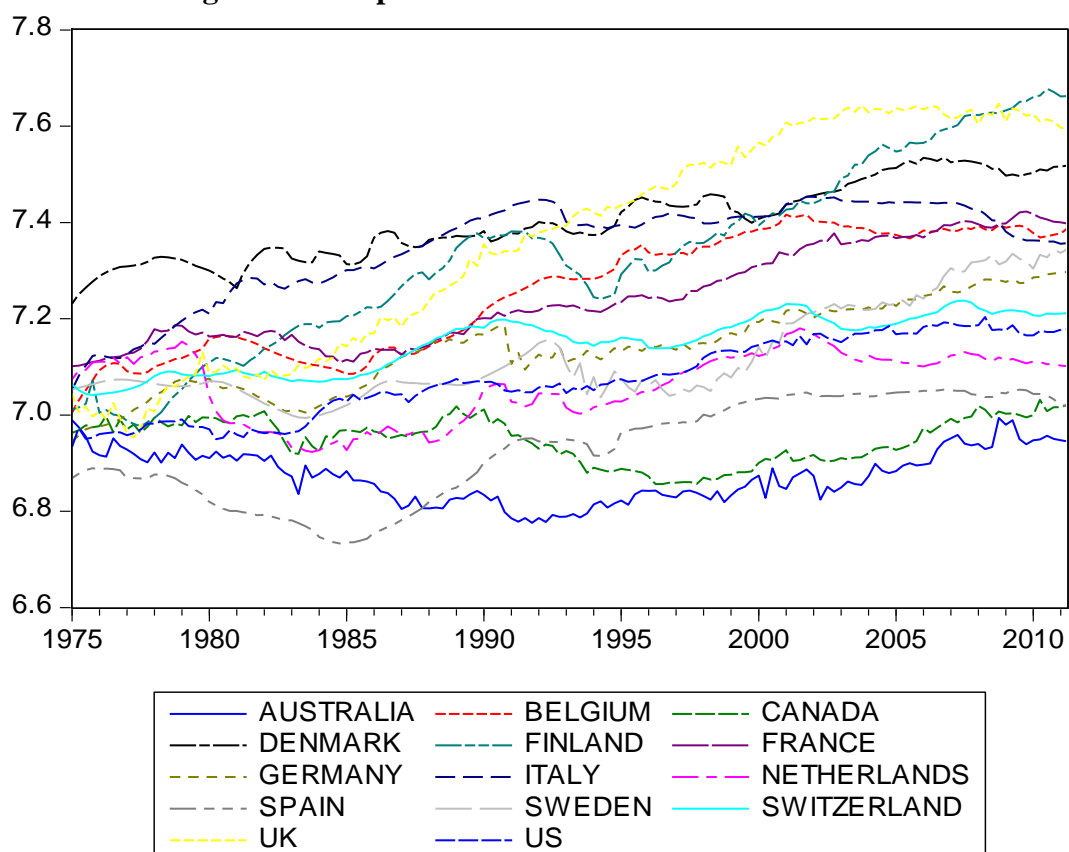
Figure 3.4: Stock Price Indices in 14 OECD Countries

AUSTRALIA	BELGIUM	CANADA
DENMARK	FINLAND	FRANCE
GERMANY	ITALY	NETHERLANDS
SPAIN	SWEDEN	SWITZERLAND
UK	US	
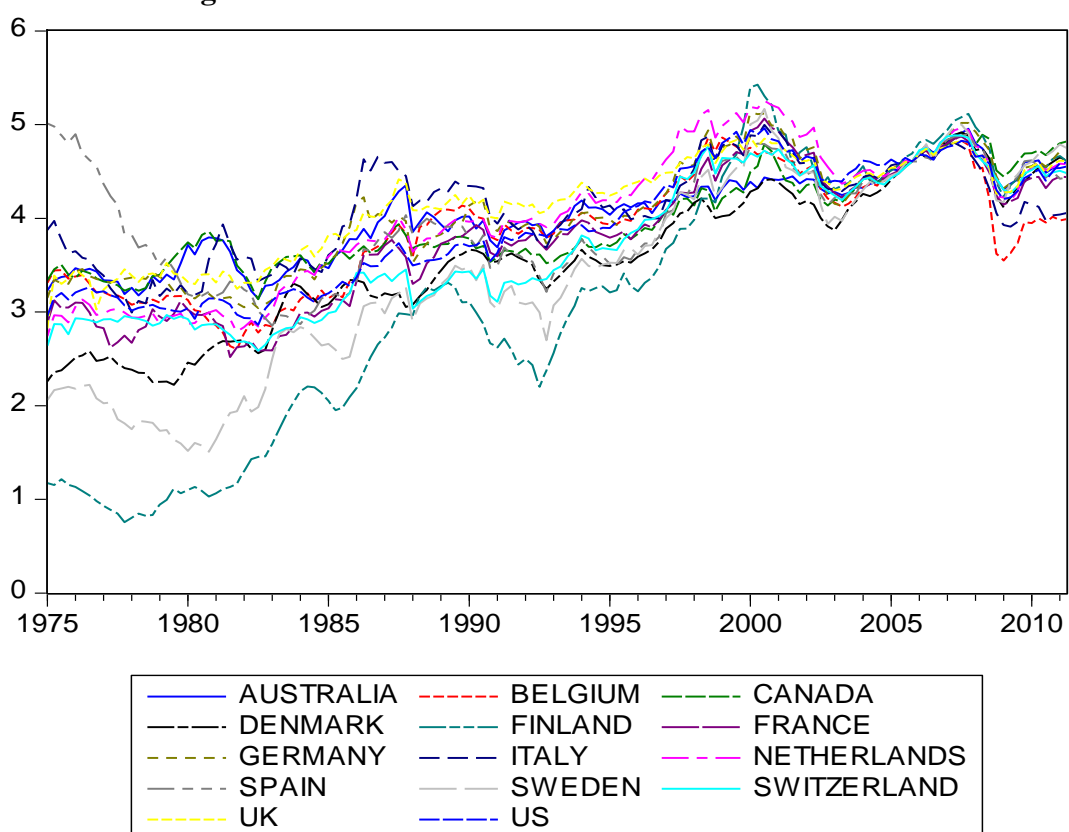
Figure 3.5: House Price Indices in 14 OECD Countries

Legend: AUSTRALIA, BELGIUM, CANADA, DENMARK, FINLAND, FRANCE, GERMANY, ITALY, NETHERLANDS, SPAIN, SWEDEN, SWITZERLAND, UK, US
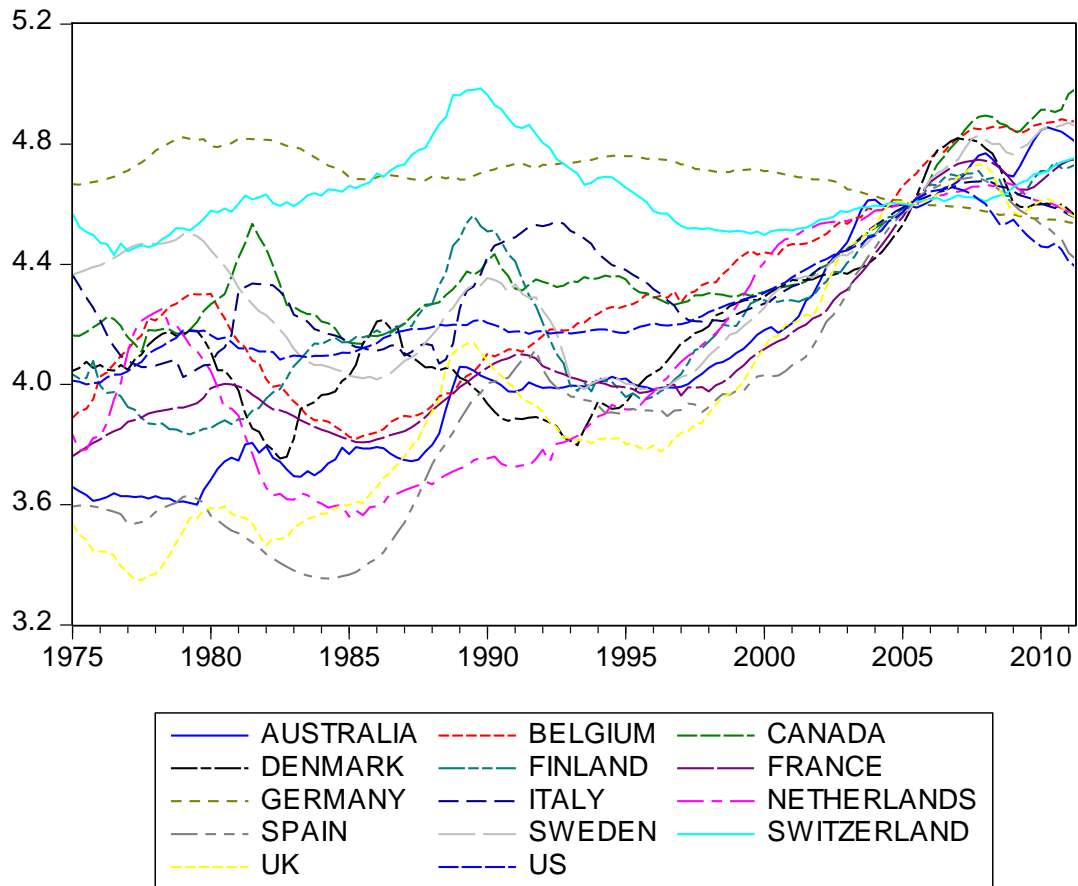
3.2 Methodology

A time-series econometric approach that distinguishes between short-run and long-run links between wealth, income and consumption based on aggregate data will be employed in this thesis.

3.2.1 Basic Time-series Model:

According to Ludvigson and Steindel (1999), normally, logarithmic approximation of aggregate consumption function is used for time-series studies of wealth effects as the aggregate data of consumption, income and wealth are

closer to linear in logs than linear in levels. The basic form of the long-run relationship between consumption, income and wealth can be shown as:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 f_t + \alpha_3 h_t + \varepsilon_t \tag{3.1}$$

where c_t is log per capita planned consumption, y_t represents log per capita income, f_t and h_t denote log per capita financial and housing wealth respectively and ε_t is the residual capturing the effects of unexpected shocks to expenditure. α_1, α_2 and α_3 represent the coefficients for income, financial and housing wealth respectively that give the effect on consumption of permanent changes.

If the variables in the equation are non-stationary and cointegrated, then the error term of Equation 3.1 is stationary and the parameters of interest can be estimated by OLS estimates. In other words, these variables should be $I(1)$ which contain one unit root. According to the Granger representation theorem, any long-run cointegrating relationship can be expressed as an equilibrium correction model describing the short-run dynamics. Normally, a vector error-correction model is used to determine which variables adjust to restore the long-run equilibrium, and the time taken by the adjustment process. Such an error-correction equation can be expressed as:

$$\Delta x_t = b_0 + b_1 u_{t-1} + B(L)\Delta x_{t-1} + v_t \tag{3.2}$$

where Δx_t is the vector of log differences ($\Delta c_t \Delta y_t \Delta w_t$), u_{t-1} denotes the error correction term, which is the estimated lagged residual obtained from Equation 3.1, B(L) is a finite-order distributed lag operator, and b_1 measures the speed of adjustment back to equilibrium; that is, it determines the proportion of the last

period's deviation from long-run equilibrium that the variable (consumption, income or wealth) responds to. A negative statistically significant b_{1c} would indicate that current period expenditure moves to correct an error from the last period.

However, given the nature of the variables, it is likely that these adjustments occur in different ways, depending on the state of economy and on the phase of the stock and housing markets. Therefore, the possibility of nonlinear adjustment in the relationship between consumption and wealth will be further investigated.

3.2.2 Nonlinear Testing by Markov-switching Model:

This study will follow the multi-step approach suggested by Psaradakis et al. (2004) to detect nonlinear error-correction. In the first step, the long-run cointegration relationship between wealth and consumption will be checked by unit root and cointegration tests. Once cointegration between the variables is discovered, a second step follows, focusing on the potential nonlinear characteristics of the system. This task will be carried out by employing nonlinearity tests designed to examine linear adjustment against nonlinear adjustment alternatives, such as Markov switching (Hansen, 1992) and likelihood ratio tests. If any evidence of nonlinearity is found, then a third step is applied. That is, a Markov switching model should be fitted to either the equilibrium error or to the error-correction representation. A Markov switching model could characterize nonlinear adjustment by utilizing Markov chains to create a model that will change its parameters as an underlying state variable changes. Movement

of the state variable between regimes is governed by a Markov process. The Markov process is one in which a random variable is only dependent on its value in the previous period. As noted by Lettau and Ludvigson (2001, 2004), in the case where wealth does most of the adjustment towards equilibrium, a single-equation ECM with consumption as the dependent variable would be mis-specified. Hence, it is important to analyse the whole system where a Markov-switching vector error-correction model should be then employed.

Camacho (2005) finds that if the equilibrium errors z_t of a generic cointegrated system for the $m \times 1$ vector x_t follow a MS-(V) AR,

$$z_t = c_{st} + A_{st}(L)z_{t-1} + \theta_{st}\varepsilon_t \tag{3.3}$$

where c_{st} is the vector of Markov switching intercepts, $A_{st}(L) = (A_{st}^1 + ... + A_{st}^p L^{p-1})$ and $\varepsilon_t | s_t \sim N(0, V_\varepsilon)$, then there is a corresponding MS-VECM representation

$$\Delta x_t = \mu_{st} + \Gamma_{st} z_{t-1} + \Pi_{st}(L)\Delta x_{t-1} + \sigma_{st} u_t \tag{3.4}$$

where Π_i 's are $m \times m$ coefficient matrices, μ_{st} is a vector of intercepts, $u_t | s_t \sim N(0, V_u)$ and Γ_{st} is a regime-dependent long-run impact matrix. In fact, the nonlinear dynamics of the equilibrium errors z_t may lead to a switching adjustment matrix Γ and to short-run dynamics of the endogenous variables (given by Π) that vary across regimes. Several possibilities may arise, including one where cointegration switches on and off, for instance. The system may be estimated by a multi-equation version of the Hamilton filter and estimates of the adjustment coefficients obtained.

3.2.3 Nonlinear Testing by Quantile ARDL Model:

This thesis also employs a quantile version of the autoregressive distributed-lag model (QARDL) to investigate non-linear wealth effects on consumption. As an extension to the conventional least squares method, Koenker and Bassett (1978) introduce the quantile regression that can estimate any percentage point of the distribution of a dependent variable conditional on the regressors. In other words, the calculation of a single value (the conditional mean) is replaced by the computation of a whole set of numbers (the conditional quantiles) which are able to give a more comprehensive picture of the entire conditional distribution of dependent variables and the underlying interrelations without imposing global distributional assumptions on the errors. The rationale of using quantile regression in this thesis is that the distribution of consumption level can be characterised by several quantiles which might be associated with extreme levels of income or asset wealth.

In the context of the ARDL procedure, Pesaran and Shin (1998) first generalise the ARDL model to cointegration and develop an asymptotic theory for estimating and making inferences on cointegrated time series data. Pesaran et al. (2001) extend the ARDL method and develop a pragmatic procedure testing for the existence of a stable long-run relationship, showing that it is a valid procedure irrespective of whether the underlying variables are either $I(1)$, mutually cointegrated, or $I(0)$ processes. The ARDL techniques have been used to solve a wide range of economic issues. Despite the panel data version of the ARDL approach having been employed in several multi-country studies to examine the wealth effect on consumption (see Ludwig and Slok, 2004; Labhard et al., 2005,

Ciarlone, 2011), this study is the first such attempt in the time-series literature, especially for the US market.

If the long-run linear relationship between consumption, income, financial and housing wealth can be written as:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 f_t + \alpha_3 h_t + \varepsilon_t \tag{3.5}$$

where α_2 and α_3 denote the long-run elasticity of consumption with respect to financial wealth and housing wealth due to the log form on the variables, a QARDL representation of Equation 3.5 can be formulated as follows:

$$\Delta c_t = \delta_0(\tau) + \sum_{i=1}^{k} \delta_{1i}(\tau)\Delta c_{t-i} + \sum_{i=0}^{k} \delta_{2i}(\tau)\Delta y_{t-i} + \sum_{i=0}^{k} \delta_{3i}(\tau)\Delta f_{t-i} + \sum_{i=0}^{k} \delta_{4i}(\tau)\Delta h_{t-i}$$

$$+ \pi(\tau)(c_{t-1} - \beta_1(\tau)y_{t-1} - \beta_2(\tau)f_{t-1} - \beta_3(\tau)h_{t-1}) + u_t(\tau) \tag{3.6}$$

where $\tau \in (0,1)$ is a quantile index, and k is lag order. The study uses the set of τ = {0.1, 0.2, …, 0.9}. Equation 3.6 is more general than its least squared-based counterparts, since it is less restrictive as the slope coefficients can vary by quantiles. Hence, the model can be utilized to estimate a potentially thick-tailed distribution of consumption.

3.2.4 Second Generation Panel Data Techniques:

The panel unit root and cointegration approach is another important method being used to estimate the relationship between income, wealth and consumption based on panel data. Panel data have advantages in correction of omitted variable bias and error-in-variable bias. When panel data are available we can control for

omitted variables which remain fixed across time by using fixed effects on entities. Also, omitted variables that remain fixed over entities but change over time can be controlled by time fixed effects. A panel data approach also can strongly reject the null rather than by using a time-series approach.

This research employs a four-stage procedure to examine this long-run equilibrium relationship for a sample of 14 OECD countries. First, the cross section dependence (CD) test developed by Pesaran (2004) is used to determine whether dependence is present in the panel data. If the panel members are correlated to each other, then it is necessary to apply the panel unit root and cointegration tests that can address cross-sectional dependence issues to investigate the long-run relationship. Second, the Pesaran (2007) (CIPS) panel unit root test that is robust to the existence of cross-section dependence in a panel is used to ascertain the order of integration of the variables. Moreover, the Im et al. (2003) (IPS) test will also be implemented for the purpose of comparison. Third, the conventional Pedroni (1999, 2004) panel cointegration procedure is applied to test the long-run cointegrating relationship. A Westerlund (2007) test which can better handle the issue of cross-sectional dependence will be employed as a robustness check. Fourth, the panel dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) approaches suggested by Pedroni (2001) are used to estimate the wealth effects.

3.2.5 Panel-data Vector Autoregressive (panel VAR) Model:

While second generation panel unit root and cointegration tests focus on the long-run cointegrating relationship between consumption, income and wealth, the panel

VAR approach examines short-term dynamics by modelling the endogenous behaviour between them, as well as determining economically interpretable disturbances.

The panel VAR approach inherits advantages from the traditional VAR model that treats all the variables in the system as endogenous. In fact, Lettau and Ludvigson (2004) show that both consumption and wealth are endogenous, and the conventional method which implicitly treats wealth as an exogenous variable may be biased, since wealth also responds to underlying exogenous shocks. Moreover, the panel VAR procedure also has an advantage from the panel-data framework that allows for unobserved individual heterogeneity for all the variables by introducing fixed effects which enhance the consistency of the estimation. This panel VAR model can be specified as follows:

$$X_{t,i} = \alpha_i + \Theta(L)X_{t,i} + F_i + D_{t,c} + \varepsilon_{t,i} \tag{3.7}$$

where $\Theta(L)$ is the lag operator and $X_{t,i}$ represents a vector of four endogenous variables (TC, DIN, SP, HP) or a vector of six variables (TC, DIN, SPP, SPN, HPP, HPN). Subscripts t and i refer to time and country. F_i denotes the fixed effect and $D_{t,c}$ is the country-specific time dummy. $\varepsilon_{t,i}$ represents the vector of residuals. In addition, the Schwarz information criterion (SIC) is used to select the optimal autoregressive order. In terms of the variables studied in this study, TC and DIN are the changes in household total consumption and disposable income. SP and HP indicate the decomposed wealth effects from the growth rate of stock and housing, respectively. In order to distinguish between positive and negative asset price shocks to capture potential asymmetric wealth effect on consumption,

positive and negative values of stock and house price changes are calculated to denote positive and negative wealth shocks, where SPP and SPN represent the positive and negative stock market shocks respectively, and HPP and HPN are the positive and negative housing market shocks. Specifically, following Simo-Kengne et al. (2012), two dummy variables $d_{t,i}^{p}$ and $d_{t,i}^{n}$ are used to calculate the positive and negative asset market shocks. $d_{t,i}^{p}$ is set to be equal to one for the positive values of asset price changes and equal to zero for negative values. Conversely, $d_{t,i}^{n}$ is equal to one for the negative values of asset price changes and equal to zero for positive values. Therefore, SPP is computed as $d_{t,i}^{p} \times$SP and SPN as $d_{t,i}^{n} \times$SP, and similarly for HPP and HPN.

CHAPTER 4: FINANCIAL WEALTH, HOUSING WEALTH AND CONSUMPTION: A REGIME-SWITCHING PERSPECTIVE

4.1 Introduction

Economists have traditionally employed life-cycle models to identify macroeconomic channels of impact arising from changes in wealth (Campbell et al., 1997; Mehra, 2001; Davis and Palumbo, 2001; Lettau and Ludvigson, 2001&2004; Kishor, 2007; and Fisher et al., 2010). Nevertheless, as the traditional life-cycle models of consumption imply that wealth effects should be symmetric, it might be difficult for policymakers to examine recent wealth effects on consumption by using the traditional life-cycle approach. In fact, due to the natural volatility of the asset market, asset wealth might exhibit different impacts on consumption, depending on the state of the economy (Gabriel et al., 2008). Several studies document the existence of different regimes in asset markets; see Schaller and Van Norden (1997), Bansal et al. (2010), and Nneji et al. (2013), for example. Therefore, the ability of the traditional life-cycle method to reflect the importance of wealth cycles and their influence on the economy might be questionable. In addition, it has been suggested that monetary policy responds to movements in asset prices. For example, the rise in households' wealth from a rise in asset prices might result in an increase in consumption. This increase in consumption could push consumer prices and then warrant a restrictive monetary policy. However, if consumption responds asymmetrically to equal but opposite movements in wealth then (how) should the monetary policy still respond to the

change in asset prices through the wealth effect channel? In order to throw more light on this issue it is necessary to estimate the wealth effect more accurately using an appropriate econometric model.

Alexandre et al. (2007) argue that the traditional model used in the estimation of the wealth effect on consumption might be inappropriate because the wealth effect is unstable. In particular, when financial wealth volatility increases, the estimate of the wealth effect should decrease. In other words, the estimation of wealth effect should rely on the state of the economy and, specifically, on the phase of the stock market. Alexandre et al. (2007) use a Markov-switching model to estimate the traditional long-run consumption equation and accept the indeterminacy hypothesis. As a result, they conclude that nonlinear estimation might be better to explain the movements of asset prices.

Gabriel et al. (2008) further study the short-run trivariate relationship between consumption, income and wealth using a Markov-switching vector error-correction model. Again, they find the wealth effect could differ across regimes, and these regimes are related to the fluctuations in financial markets. In addition, they show that short-term deviations in the trivariate relationship will predict either asset returns or consumption growth, depending on the state of the economy.

This chapter follows Alexandre et al. (2007) and Gabriel et al. (2008) in using a Markov-switching model to examine the relationship between consumption, income, and wealth. A Markov-switching model is preferable to a single-regime model in that it allows us investigate the consumption-wealth relation in different states due to economic fluctuations. However, the investigation of this chapter departs from the approach taken by these studies in a number of important ways.

First, rather than only including total asset wealth in the model, this chapter further decomposes the total wealth into financial and housing wealth to detect the relative importance of these different forms of wealth on consumption. There is considerable value added in analysing financial and housing wealth effects separately. More than two-thirds of households are homeowners in the US, while only half own stocks, bonds or mutual funds (Cooper and Dynan, 2013). Homeowners not only benefit from the rise in house values which make them feel wealthier, but also obtain a service from houses by living in them. In addition, financial and housing assets have different degrees of liquidity and facilities. For instance, housing wealth is more illiquid than financial wealth, and housing can also be used as collateral in a loan. As a result, households might react differently to capital gains depending on whether they are generated by increasing share prices or by rising property prices. To the best of my knowledge, there has not been any published work on separate financial and housing wealth effects on consumption in terms of a regime-specific approach. Also, few studies have estimated non-linearity in housing wealth effects. One key reason is that the real estate market had not experienced such a significant downturn before the subprime mortgage crisis. Therefore, compared to Alexandre et al. (2007) and Gabriel et al. (2008)'s study period which ends by 2003, this chapter will extend the time period to 2010, covering the recent financial tsunami. The extended study period can better capture the trend and cyclical behaviour of the financial and housing markets.

The second contribution of this chapter in comparison to the work of Alexandre et al. (2007) and Gabriel et al. (2008) is that the Markov-switching model is based on time-varying rather than fixed transition probabilities of switching between

regimes. In contrast to fixed transition probabilities, time-varying transition probabilities do not restrict the transition probabilities to being constant over time. That is, the probability of switching from one regime to the other can depend on the behaviour of underlying economic fundamentals. In particular, it is important to identify which macroeconomic factors significantly affect the probability of a regime shift. This study considers whether monetary indicators such as short- and long-term interest rates as well as the term structure of interest rates are the driving factors. Several studies (Ling and Naranjo, 1999; Bernanke and Kuttner, 2005; and Nneji et al. 2013) have referred to the importance of monetary indicators in explaining the development of asset markets on the grounds that these variables are the macroeconomic series that are assumed to contain information about future economic conditions and capture the state of investment opportunities. Furthermore, some other studies (Ludvigson et al., 2002; MacDonald et al., 2011; and Navarro and Frutos, 2012) also show that monetary policy shocks have a significant impact on the consumption-wealth channel. That is, monetary policy changes can affect consumer spending through movement in asset prices and thereby household wealth. Therefore, this chapter examines the role of the consumption-decomposed wealth channel within the framework of regime-switching in explaining the effects of monetary policy changes.

The empirical evidence in this chapter shows that Markov-switching estimation is preferred to the conventional single-regime estimation. In particular, the housing wealth effect is determined to be larger than the financial wealth effect in both regimes, and such wealth effect difference is higher in State 0 than in State 1, which is consistent with the behaviours of financial and housing market during the past decade. Moreover, estimation of a Markov-switching vector error-correction

model (MS-VECM) suggests that the mechanism through which deviations from the long-run equilibrium are eliminated depends on the state of the economy. Specifically, consumption, financial wealth and housing wealth are all identified as exhibiting error correction during particular regimes. Therefore, short-run deviations in the relationship between consumption, labour income, financial and housing wealth could help forecast either consumption growth or asset returns, depending on the state of the economy. Finally, it is shown that predetermined variables (short-term interest rate, long-term interest rate, and term structure) can help us understand shifts between the two regimes through their influence on the transition probabilities. In particular, monetary tightening could increase the probability of staying in the regime with a larger financial wealth effect, while monetary loosening would raise the probability of remaining in the state with a stronger housing wealth effect.

The structure of this chapter is as follows. Section 4.2 briefly reviews the traditional linear consumption model and points out why a nonlinear framework may provide a better description of the relationship between consumption, income and wealth. Section 4.3 discusses the data choices and presents the main techniques used in this chapter to examine the relationship between consumption, income and the components of wealth both in the long-term and short-term. Section 4.4 shows the results of the estimation on wealth effect in terms of both linear and non-linear frameworks. Finally, Section 4.5 summarises and concludes.

4.2 Why Linear Estimation of Wealth Effect on Consumption Might Be Indeterminate

Recent studies of wealth effects on consumption have been heavily based on the model presented by Lettau and Ludvigson (2001, 2004). The framework they use to investigate the relationship between consumption, income and wealth is the household budget constraint identity.

Assume Wt is the total wealth at time t, Ct is consumption of non-durable goods and services, and Rw,t is the rate of return on aggregate wealth, then the budget constraint can be shown as:

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t)$$ (4.1)

To identify the implications of the budget constraint above, Campbell and Mankiw (1989) show that, if the consumption-wealth ratio is stationary, the budget constraint may be approximated by taking a first-order Taylor expansion of the equation. They derive an expression for the consumption-wealth ratio in logs by solving the difference equation for log wealth forward, imposing a transversality condition and assuming households have rational expectations, resulting in:

$$c_t - w_t = E_t \sum_{i=1}^{\infty} \rho_w^i (r_{w,t+i} - \Delta c_{t+i})$$ (4.2)

where r=log(1+R), Δc_{t+i} is the rate of growth of consumption between time t and t+i, $\rho_w = (W - C)/W$ is the steady state ratio of investment to consumption which

will be positive but less than one. Lower case letters in Equation 4.2 denote the variables in natural logarithms.

Equation 4.2 states that if there is a deviation from the long-run ratio of wealth and consumption, then either wealth or consumption should adjust to restore the long-run equilibrium. In other words, such deviation should either forecast rate of return on wealth or rate of growth in consumption. Nevertheless, log aggregate wealth w in Equation 4.2 contains human wealth which is unobservable, so the estimation of Equation 4.2 is not feasible. Lettau and Ludvigson (2001) mitigate this issue by assuming permanent human wealth is proportional to current labour income. They assume $l_t = \alpha + y_t + z_t$, where l_t is log of human wealth, α is a constant, y_t is log of labour income and z_t is a mean zero stationary random variable.

As total wealth is equal to the sum of physical wealth and human wealth:

$$W_t = A_t + L_t \qquad (4.3)$$

where A_t is physical wealth and L_t is human wealth. If we split the physical wealth into financial wealth F_t and housing wealth H_t, then Equation 4.3 can be re-written as:

$$W_t = F_t + H_t + L_t \qquad (4.4)$$

The log-linear approximation of Equation 4.4 then can be expressed as:

$$w_t \approx \omega_f f_t + \omega_h h_t + (1 - \omega_f - \omega_h) l_t \qquad (4.5)$$

where lower case letters are logs of variables: f_t is the log of financial wealth, h_t is the log of housing wealth, and l_t represents the log of human wealth. ω_f and

ω_h denote the steady state shares of financial and housing wealth in total wealth, respectively, and $(1 - \omega_f - \omega_h)$ is the steady state share of human wealth. The return to aggregate wealth can be decomposed as:

$$(1 + R_{w,t}) = \omega_f (1 + R_{f,t}) + \omega_h (1 + R_{h,t}) + (1 - \omega_f - \omega_h)(1 + R_{l,t}) \tag{4.6}$$

where $R_{w,t}$, $R_{f,t}$, $R_{h,t}$, and $R_{l,t}$ are the returns to aggregate wealth, financial wealth, housing wealth and human wealth, respectively. Assuming r=log(1+R), then substituting for w_t and $r_{w,t+i}$ in Equation 4.2, we find:

$$c_t - \omega_f f_t - \omega_h h_t - (1 - \omega_f - \omega_h) l_t$$

$$= E_t \sum_{i=1}^{\infty} \rho_w^i [\omega_f r_{f,t+i} + \omega_h r_{h,t+i} + (1 - \omega_f - \omega_h) r_{l,t+i} - \Delta c_{t+i}]$$

$$\tag{4.7}$$

To remove the unobservable human wealth l_t on the left-hand side, we can substitute the log of labour income y_t into Equation 4.7, which yields:

$$c_t - \omega_f f_t - \omega_h h_t - (1 - \omega_f - \omega_h) y_t$$

$$= E_t \sum_{i=1}^{\infty} \rho_w^i [\omega_f r_{f,t+i} + \omega_h r_{h,t+i} + (1 - \omega_f - \omega_h) r_{l,t+i} - \Delta c_{t+i}] + (1 - \omega_f - \omega_h) z_t$$

$$\tag{4.8}$$

As all the terms on the right-hand side of Equation 4.8 are presumed stationary, then the linear combination of consumption, financial wealth, housing wealth and labour income is stationary. In other words, they are cointegrated.

However, as noted by Lettau and Ludvigson (2001, p. 823) their estimates of the long-run aggregate consumption function are consistent with a Cobb-Douglas production function. Alexandre et al., (2007) then argue that if this is the case, then either the long-run aggregate consumption function cannot represent a cointegrating relation, or the wealth effect on consumption is indeterminate. In fact, a few studies have failed to find a long-run cointegration relationship between consumption, wealth and income (Benjamin et al., 2004, Rudd and Whelan, 2006, and Carroll et al., 2006). Holmes and Shen (2012) argue that consumption, income and wealth are in fact stationary around a nonlinear deterministic trend and are co-trended insofar as they share a common nonlinear deterministic trend. With regard to the second possibility that the wealth effect on consumption might be indeterminate, Alexandre et al., (2007) employ a standard macro model to find theoretical evidence that the wealth effect is unstable. They also use a Markov-switching model to confirm the regime switching behaviour of the asset market and accept the hypothesis on the indeterminacy of the wealth effect.

Alexandre et al. (2007) assume that consumption can be written as C=O-X, where O is the aggregate output and X is the use of output other than consumption. The aggregate output can be expressed in the Cobb-Douglas function:

$$O_t = K_t^\alpha L_t^{1-\alpha} \tag{4.9}$$

where K stands for capital and L represents labour. Then the return to capital is $Rt = \alpha Ot$ and the labour income is $Yt = (1-\alpha)Ot$.

In order to link between asset markets and consumption, the return to capital *Rt* can also be presented as *Rt=DtKt*, where *Dt* is the dividend per unit of capital and *Kt* is the capital. According to the standard macroeconomic asset-pricing model suggested by Ljungqvist and Sargent (2004), the current price of an asset is the expected discount sum of future dividends:

$$P_t = E_t[m_{t+1}(P_{t+1} + D_{t+1})] \tag{4.10}$$

where P_t represents the asset price and m_t stands for the stochastic discount factor. The relationship between asset price and dividend then can be shown as:

$$P = \frac{m}{1-m} D \tag{4.11}$$

Assume asset wealth is *A = (P+D) K*, where the total asset wealth is the product of asset price (including dividend) and volume. Along with the Cobb-Douglas function (*R=αO*):

$$A = (P + D)K = \frac{D}{1-m} K = \frac{\alpha}{1-m} O \tag{4.12}$$

With an arbitrary θ, total asset wealth can be decomposed into non-human wealth and labour income *Y= (1-α) O*, then consumption can be expressed as:

$$C = O - X = \theta \frac{1-m}{\alpha} A + (1-\theta)\frac{1}{1-\alpha} Y - X \tag{4.13}$$

To be consistent with the traditional consumption model that does not include X, which is the other component of output besides consumption, X is assumed to be equal to 0. Then the new consumption equation is:

$$C = \theta \frac{1-m}{\alpha} A + (1-\theta) \frac{1}{1-\alpha} Y \qquad (4.14)$$

It can be seen from Equation 4.14 that the wealth effect is indeterminate because θ is arbitrary. In terms of the log form of Equation 4.14, we have:

$$c = \rho_a a + \rho_y y \qquad (4.15)$$

where the coefficients are:

$$\rho_a = \frac{\theta(1-m)\alpha^{-1}A}{C} = \theta \frac{O}{C} = \theta \qquad (4.16)$$

$$\rho_y = \frac{(1-\theta)(1-\alpha)^{-1}Y}{C} = (1-\theta)\frac{O}{C} = 1-\theta \qquad (4.17)$$

Again it indicates that the wealth effect is indeterminate. Besides that, the asset market itself is unstable due to the volatility of asset prices. Driffill and Sola (1998) and Guidolin and Timmerman (2005) find evidence of the existence of different regimes in financial markets. Alexandre et al. (2007) confirm that the financial market is well characterised by regime switching, and they use a Markov-switching model to investigate the relationship between consumption and wealth. Gabriel et al. (2008) further find that a Markov-switching vector error-correction model might be better to describe short-term deviations in the consumption-wealth ratio due to fluctuations in the asset market. Recently, Brady and Stimel (2011) show that there also exist structural breaks in housing wealth and that the housing wealth effect gets larger over time.

In summary, all the above results and evidence indicate that a nonlinear framework might offer a better estimation of the evolution of consumption and

wealth than the conventional linear model. In particular, a Markov-switching model has been suggested to better characterise the instability of the wealth effect.

4.3 Data and Methodology

4.3.1 Data

The main dataset of this chapter consists of the data from the US market, as introduced in Chapter 3.

In addition, short-term and long-term interest rates as well as term structures will be used as the driving factors for transition probabilities.

4.3.2 Methodology

In this section, both linear and nonlinear econometric techniques for the estimation of wealth effects will be introduced. The linear estimations are based on cointegration models, and the nonlinear estimations mainly rely on a Markov regime-switching model.

4.3.2.1 Linear Approach

Based on the framework suggested by Lettau and Ludvigson (2001, 2004), the long-run linear consumption equation can be written as:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 f_t + \alpha_3 h_t + \varepsilon_t \tag{4.18}$$

where c_t is consumption on nondurable goods and services, y_t is labour income, and f_t and h_t represent financial wealth and housing wealth respectively. All the variables are in logs. α_2 and α_3 denote the long-run elasticity of consumption

with respect to financial wealth and housing wealth due to the log form of the variables. These elasticities can be converted to MPC out of financial wealth and housing wealth by multiplying respective consumption-wealth ratios.

The Engle-Granger and Johansen approach will be used to test cointegration and the number of cointegrating vectors. There are two steps involved in the Engle-Granger test. Firstly, a regression is conducted on Equation 4.18, and the residual of Equation 4.18 is saved. Secondly, the unit root test is used to check whether the residual from Equation 4.18 has one unit root or not:

$$\Delta \hat{\varepsilon}_t = \varphi \hat{\varepsilon}_{t-1} + \eta_t \tag{4.19}$$

The null is H_0: $\varphi = 0$. Rejection of the null will imply that the residual is stationary, which means that a long-run equilibrium relationship exists among consumption, labour income, financial wealth and housing wealth.

Johansen's test determines the number of cointegrating vectors as the rank of Γ in:

$$\Delta z_t = \alpha_z + \Gamma z_{t-1} + \sum_{i=1}^{m} \gamma_m \Delta z_{t-m} + \varepsilon_{zt} \tag{4.20}$$

where z = (c, y, f, h) is the variable vector for consumption, labour income, financial wealth, and housing wealth. Both the trace test and the maximum eigenvalue test will be employed to check the hypothesis on the rank of Γ. Assuming r is the rank of Γ, the null hypothesis of a trace test is that the number of cointegrating vectors is less than or equal to r, as against the alternative of more than r. On the other hand, the null hypothesis of the maximum eigenvalue test is that the number of cointegrating vectors is r, against the alternative of r + 1.

A vector error-correction model (VECM) associated with the cointegrated model is normally used to measure the short-run dynamics between consumption, income, financial wealth and housing wealth:

$$\Delta x_t = \Gamma_0 + \Gamma(L)\Delta x_t + \alpha \eta_{t-1} + u_t \qquad (4.21)$$

where $x_t = (c_t, y_t, f_t, h_t)'$, $\Gamma 0$ is the vector of intercepts, $\Gamma(L)$ represents a polynomial in the lag operator reflecting the short-run dynamics of the system, $\alpha = (\alpha_c, \alpha_y, \alpha_f, \alpha_h)'$ stands for the corresponding speed of correction for consumption, income, financial wealth and housing wealth, η_{t-1} is the disequilibrium error from the last period, and u_t denotes the vector of stationary random variables. The VECM is a four-equation system because there are four variables in the consumption model.

4.3.2.2 Nonlinear Approach

A Markov regime-switching model and Markov switching vector error-correction model will be used to investigate the nonlinear relationship between consumption, income, financial wealth and housing wealth both in the long-run and short-run. Moreover, time-varying transition probabilities will be further estimated to identify underlying factors that drive one regime to switch to the other.

It is believed that time series data might behave differently during different time periods due to structural changes. A Markov switching model could characterize such differences by using Markov chains to change the estimated parameters as an underlying state variable changes. Movements of the state variable between

regimes are governed by a Markov process. The Markov process is one in which a random variable is only dependent on its value in the previous period.

This chapter uses a two-regime Markov switching model following Hamilton (1989, 1990):

$$c_t = \mu_{s_t} + \alpha_{s_t} y_t + \beta_{s_t} f_t + \delta_{s_t} h_t + e_t \tag{4.22}$$

where c_t, y_t, f_t and h_t represent log of consumption, labour income, financial wealth and housing wealth respectively, and $e_t \sim N(0, \sigma_{s_t}^2)$; S_t is the state variable that takes the value 0 or 1 depending on whether the estimated variables are in Regime 0 or Regime 1. For example, $S_t = 0$ or 1, and:

$$\mu_{s_t} = \mu_0(1 - S_t) + \mu_1 S_t \tag{4.23}$$

$$\alpha_{s_t} = \alpha_0(1 - S_t) + \alpha_1 S_t \tag{4.24}$$

$$\beta_{s_t} = \beta_0(1 - S_t) + \beta_1 S_t \tag{4.25}$$

$$\delta_{s_t} = \delta_0(1 - S_t) + \delta_1 S_t \tag{4.26}$$

$$\sigma_{s_t}^2 = \sigma_0^2(1 - S_t) + \sigma_1^2 S_t \tag{4.27}$$

The probabilities that a variable will stay in Regime 0 or 1 at time t given that it was in that regime at time t-1 can be shown as:

$$\Pr[S_t = 0 | S_{t-1} = 0] = p = \Phi(\gamma_0) \tag{4.28}$$

$$\Pr[S_t = 1 | S_{t-1} = 1] = q = \Phi(\gamma_1) \tag{4.29}$$

where $\Phi(.)$ is the cumulative normal distribution function ensuring that the transition probabilities lie between 0 and 1; p and q denote the fixed transition probability of being in Regime 0 or 1, given that the systems were in Regime 0 or 1 during the previous period. Therefore, the probability of switching from Regime 0 to Regime 1 in period t is (1-p), and the probability of switching from Regime 1 to Regime 0 is (1-q). Moreover, the expected durations of the regimes at t can be calculated as 1/(1-p) and 1/(1-q) respectively.

In regards to the time-varying transition probabilities, Equation 4.28 and 4.29 can be extended as:

$$\Pr[S_t = 0 | S_{t-1} = 0, \Omega_{t-1}, \Omega_{t-2}, \cdots] = p_t = \Phi(\gamma_0 + \sum_{i=1}^{m} \vartheta_i \Omega_{t-i}) \tag{4.30}$$

$$\Pr[S_t = 1 | S_{t-1} = 1, \Omega_{t-1}, \Omega_{t-2}, \cdots] = q_t = \Phi(\gamma_1 + \sum_{i=1}^{n} \kappa_i \Omega_{t-i}) \tag{4.31}$$

where Ω is the predetermined variable driving the transition probabilities, and the parameters ϑ_i and κ_i measure the impact effects of Ω on the probabilities that the estimated variables will persist in the same regime.

In order to investigate the adjustments of both consumption and wealth towards equilibrium in the short-term under the regime-switching framework, a Markov-switching vector error-correction model will be employed. In contrast to linear VECM that only allows single speed adjustment, MS-VECM can provide different speeds of correction in different regimes. Following Krolzig (1998), Camacho (2005) and Gabriel et al. (2008), the MS-VECM is specified as:

$$\Delta x_t = \mu_{s_t} + \Pi_{s_t}(L)\Delta x_t + \alpha_{s_t} \eta_{t-1} + u_t \tag{4.32}$$

where $x_t = (c_t, y_t, f_t, h_t)'$, μ_{s_t} is the state-dependent vector of intercepts, Π_{s_t} stands for the coefficient matrices that characterize the short-run dynamics of the endogenous variables that vary across regimes, α_{s_t} represents the regime-dependent long-run adjustment matrix, η_{t-1} is the disequilibrium error from the last period, and $u_t \sim N(0, \sigma_{s_t}^2)$.

4.4 Results

4.4.1 Existence of a Long-term Relationship

Based on Lettau and Ludvigson's (2001, 2004) linear framework, in order to have a meaningful long-run relationship between consumption, labour income, financial wealth and housing wealth, all these variables should be non-stationary. In other words, they all need to be $I(1)$. An augmented Dickey-Fuller (ADF) unit root test with the null hypothesis of a unit root is used to check the stationarity of the variables. In addition, a Phillips-Perron (PP) unit root test is employed to confirm the results from the ADF test. The PP test has the same null hypothesis as the ADF test, but there is an automatic correction for the DF procedure to allow for autocorrelated residuals in the PP approach.

Table 4.1 & 4.2 display the results from the ADF and PP tests. Both of the results show that all four variables are $I(1)$ under the 1% significance level, whether or not they include a time trend. In other words, all the variables exhibit unit roots in levels, but they are stationary after the first difference. Therefore, they are all valid for the further cointegration test.

Table 4.1: Tests for Orders of Integration (ADF)

ADF	H0: I(1) H1: I(0)		H0: I(2) H1: I(1)		Results from ADF test
	ADF(no trend) t-statistics	ADF(with trend) t-statistics	ADF(no trend) t-statistics	ADF(with trend) t-statistics	
c_t	-0.760	-2.134	-5.882***	-5.904***	**I(1)**
y_t	-1.852	-1.181	-14.948***	-15.111***	**I(1)**
f_t	-0.705	-2.126	-13.333***	-13.306***	**I(1)**
h_t	-1.597	-2.588	-5.566***	-5.620***	**I(1)**

, * indicate rejection of the null of non-stationarity at the 5% and 1% significance level, respectively
Critical value for ADF test (no trend): -3.48 at 1% significance level, -2.88 at 5% level, -2.58 at 10% level
Critical value for ADF test (with trend): -4.03 at 1% significance level, -3.44 at 5% level, -3.15 at 10% level

Table 4.2: Tests for Orders of Integration (PP)

PP	H0: I(1) H1: I(0)		H0: I(2) H1: I(1)		Results from PP test
	PP(no trend) t-statistics	PP(with trend) t-statistics	PP(no trend) t-statistics	PP(with trend) t-statistics	
c_t	-1.320	-1.352	-10.143***	-10.101***	**I(1)**
y_t	-1.789	-1.255	-14.980***	-15.134***	**I(1)**
f_t	-0.744	-2.491	-13.329***	-13.302***	**I(1)**
h_t	-1.514	-1.567	-7.999***	-8.043***	**I(1)**

, * indicate rejection of the null of non-stationarity at the 5% and 1% significance level, respectively
Critical value for PP test (no trend): -3.46 at 1% significance level, -2.87 at 5% level, -2.57 at 10% level
Critical value for PP test (with trend): -4.00 at 1% significance level, -3.43 at 5% level, -3.14 at 10% level

The Engle-Granger and Johansen cointegration test is used to identify the existence of cointegrating relationship between consumption, labour income, financial wealth and housing wealth. To determine the optimal lag length for the cointegration approach, Akaike and Schwarz information criteria (AIC and SIC) are applied. Both AIC and SIC show that the optimal lag length should be 1, which is consistent with previous studies on the US market based on a similar framework, such as Lettau and Ludvigson (2001, 2004) and Kishor (2007). Table 4.3 presents

results from the Engle-Granger and Johansen test. The Engle-Granger method cannot reject the null hypothesis of a unit root in the residual at the 10% level. Therefore, the Engle-Granger test shows that there is no cointegrating relationship between consumption, labour income, financial wealth and housing wealth. In the Johansen approach, however, both the trace statistic and the maximum eigenvalue statistic indicate that the null of no cointegration against the alternative of one cointegrating vector can be rejected under the 5% level. In other words, Johansen results provide evidence of one cointegrating relationship among consumption, labour income, financial wealth and housing wealth. In sum, the evidence for the existence of the hypothesized long-run relationship is identified, though the evidence is relatively weak.

Table 4.3: Cointegration Tests

Engle-Granger cointegration Test				
H0: No cointegration				
Test statistics	Critical values			
-3.118	-4.72	1%		
	-4.15	5%		
	-3.85	10%		
Johansen Cointegration Test (lag=1)				
H0: Rank	Trace	Trace 5%	L-Max	L-Max 5%
0	**68.57****	47.71	**43.26****	27.58
1	25.31	29.8	18.35	21.13
2	6.97	15.41	5.13	14.26
3	1.83	3.84	1.83	3.84

The number of lags in the Johansen tests refers to the VAR specification.
**denotes significance at 5% level. Both AIC and SIC indicate the optimal lag length is 1.

4.4.2 Estimates of the Long-term Relationship

Following from the evidence for the presence of a long-run relationship among the estimated variables, the long-term relationship is then estimated. The cointegrating

vector is estimated by Stock-Watson dynamic ordinary least squares (DOLS) with Newey-West heteroscedastic autocorrelation consistent (HAC) standard errors, because the estimates might be biased if just OLS is used. Specifically, according to Stock and Watson (1993), the OLS estimator has a non-normal distribution, and inferences based on its *t*-statistics could be misleading whether or not those *t*-statistics are computed using HAC standard errors. Moreover, there is a significant degree of serial correlation in the residuals under OLS estimation, and such serial correlation can be corrected by the asymptotic distribution of the DOLS estimator. Referring to Equation 4.18, Table 4.4 shows the DOLS estimates of the long-run relationship between consumption, labour income, financial wealth and housing wealth, and 14 leads and 14 lags are chosen by AIC for the estimation. It shows that all the coefficients are statistically significant at the 1% level. In particular, the coefficient of labour income is 0.657. It is plausible that this coefficient is the largest estimate of the long-run parameter, since human wealth accounts for most of aggregate wealth. The coefficient of financial wealth is nearly twice as large as the corresponding coefficient for housing wealth. In other words, the long-run elasticity of consumption with respect to financial wealth is twice as large as the elasticity in housing wealth. These elasticities can be converted into MPC out of corresponding wealth by using the respective consumption-wealth ratios. As financial wealth is almost four times the size of housing wealth, the MPC out of financial wealth is calculated to be 5 cents, while the MPC out of housing wealth is 11 cents. Therefore, an additional dollar of financial wealth increases consumption by 5 cents, as compared with 11 cents for real estate wealth. The results are consistent with previous empirical evidence that the housing wealth effect is larger than the financial wealth effect.

Table 4.4: DOLS Estimates of Cointegrating Vector

Coefficient	Value	Std. error	P-value
α_1	0.657***	0.0149	0.000
α_2	0.228***	0.0088	0.000
α_3	0.135***	0.0160	0.000

Standard errors are Newey-West HAC errors
Differenced explanatory variables are from t-14 to t+14
*** *indicates significance at the 1 percent level*
Log-likelihood value is 562.6

4.4.3 Estimates of the Short-term VECM

In order to investigate how the equilibrium implied by the identified long-run relationship gets restored, a vector error correction model (VECM) associated with the cointegrated model will be estimated. According to the Engle-Granger representation theorem, every long-run cointegrating relationship has an error correction representation. Table 4.5 provides the VECM estimation results based on Equation 4.21, and both AIC and SIC imply the optimal lag length to be 1. It indicates that the VECM results are consistent with Lettau and Ludvigson's (2004) findings that it is wealth that adjusts to restore the long-run equilibrium, but not consumption or income. For example, although the error correction coefficient for consumption is correctly signed as negative, it is insignificant. In particular, only financial wealth has a significant error correction coefficient which is correctly signed as positive: this is not so for housing wealth. Therefore, financial wealth growth exhibits error correction behaviour and has predictability in the long-run.

In the context of interactions between the growth rates of the variables, consumption and housing wealth are predictable in the short-run by their own lagged growth rates. Consumption can also be predicted by the lagged financial

wealth growth rate but not by the growth rate of housing wealth. Moreover, the growth rate of housing wealth is the only variable that can also be predicted by the other three lagged growth rates. Lastly, there are significant positive impacts of housing wealth on financial wealth in the subsequent period, and vice versa.

Table 4.5: Linear VECM Estimation

	Equation			
	Δc_t	Δy_t	Δf_t	Δh_t
Δc_{t-1}	0.271***	0.618***	0.128	0.696**
	(4.049)	(4.355)	(0.275)	(2.074)
Δy_{t-1}	0.040	-0.124	-0.183	-0.365**
	(1.170)	(-1.719)	(-0.771)	(-2.134)
Δf_{t-1}	0.033***	0.026	0.103	0.113**
	(3.368)	(1.258)	(1.510)	(2.282)
Δh_{t-1}	0.021	-0.006	0.229***	0.588***
	(1.843)	(-0.256)	(2.864)	(10.15)
$\alpha\eta_{t-1}$	-0.025	0.036	0.260***	0.114
	(-1.861)	(1.266)	(2.824)	(1.707)

t-statistics are shown in parentheses for the adjustment parameters
*** indicates significance at the 5% level; *** indicates significance at the 1% level.*

4.4.4 Markov-switching Model Estimates in Levels

Several empirical studies have found the existence of regime-switching behaviour in financial and housing markets. With regard to the cointegration equation, Markov-switching model and likelihood ratio tests are conducted to check whether the wealth effect is better characterised by regime-switching or not. The likelihood ratio test is first employed to examine whether Markov-switching estimation of wealth effect with two regimes is preferred to the single-regime OLS estimate. According to Table 4.6, as the log likelihood value for Markov-switching

estimation (677.192) is much bigger than the log likelihood value of DOLS

estimation (562.569), the likelihood ratio statistic of 229.246 distributed as $\chi^2(8)$

on the null rejects the null of linear cointegration specification at the 1%

significance level, which implies that the Markov-switching model is more

suitable to estimate the long-run relationship between consumption, labour income,

financial wealth and housing wealth.

Table 4.6: LR Test for DOLS vs Markov-switching

LL: DOLS	562.569
LL: MS	677.192
LR$_1$	229.246
	(0.000)

LL denotes the log likelihood values.
P-value is shown in parenthesis
LR1 is the likelihood ratio statistic for testing the null of no regime-switching on cointegration
equation against
the alternative of regime-switching on cointegration equation with fixed transition probabilities.

Next, the estimation of the Markov switching model is performed. According to

Equation 4.22, Table 4.7 presents the results of maximum likelihood estimation of

the wealth effect on consumption in terms of regime-specific. It shows that all the

estimated coefficients are statistically significant in both states, and they are

consistent with the linear estimation results that indicate that financial wealth

coefficients are larger than the housing wealth coefficients. Specifically, in State 0,

the coefficient associated with financial wealth is smaller (0.201) than in State 1

(0.232), while the coefficient of housing wealth in State 0 is bigger (0.113) than in

State 1 (0.097). After converting the elasticities into the corresponding MPCs, the

MPCs out of financial wealth are calculated to be 4 cents in Regime 0 and 5 cents

in Regime 1, and the MPCs out of housing wealth are 10 cents in Regime 0 but 8 cents in Regime 1. Therefore, the financial wealth effect in Regime 0 is smaller than in Regime 1, while the housing wealth effect in Regime 0 is larger than in Regime 1. In particular, the difference between financial wealth effect and housing wealth effect in Regime 0 (6 cents) is larger than in Regime 1 (3 cents). All the MPC estimates are within bounds that are provided by theoretical and empirical research.

Table 4.7: Markov-switching Cointegration Estimates

Coefficient	Value	Std. error	P-value
α_0	0.685***	0.0012	0.000
α_1	0.801***	0.0121	0.000
β_0	0.201***	0.0027	0.000
β_1	0.232***	0.0140	0.000
δ_0	0.113***	0.0035	0.000
δ_1	0.097***	0.0053	0.000

*** indicates significance at the 1 percent level

Log-likelihood value is 677.2

The behaviour of financial and housing wealth effects in both regimes is well displayed in Figure 4.1, which plots the inferred probability of the wealth effect on consumption being in Regime 0. It indicates that the time period 1999 to 2008, which is also the dot-com crisis and real estate boom period, has a high probability under Regime 0. It explains why during this period the financial wealth effect is smaller but the housing wealth effect is bigger than in other time periods under Regime 1. Moreover, during this time period, the housing wealth effect is much bigger than the financial wealth effect (6 cents difference), compared with other

time periods under Regime 1 (3 cents difference) such as the period since the recent subprime crisis.

Figure 4.1: Inferred Probabilities of Being in Regime 0 for MS Estimation

Inferred probabilities (FTP) for Regime 0
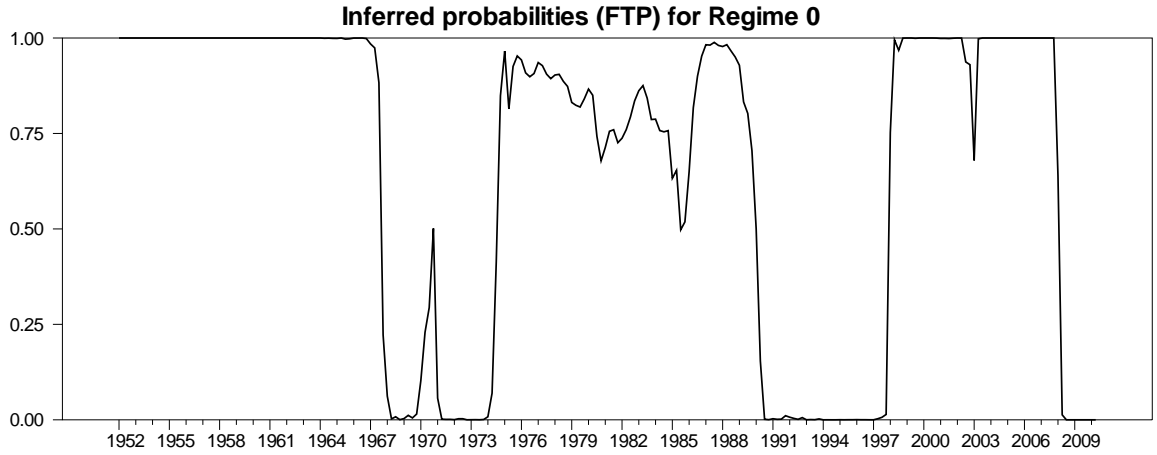
4.4.5 The MS-VECM Estimation

Table 4.8 presents results of the estimation of Equation 4.32, that is, the short-run dynamics between consumption, labour income, financial wealth and housing wealth in terms of regime-switching. This provides new insights over and above the linear VECM model, which does not allow for regime switching. In Regime 0, it is housing wealth, but neither consumption nor financial wealth, that moves to correct for the disequilibrium error, $\eta_{t-1,0}$. In Regime 1, however, both consumption and financial wealth exhibit error correction, though not housing wealth. In other words, either consumption, financial wealth or housing wealth will adjust to restore the long-run equilibrium in only one out of the two regimes. In particular, the speed of error correction for financial wealth in Regime 1 is faster than in the single-regime model (0.681 as opposed to 0.260). Therefore, these findings suggest that short-term deviations in consumption, labour income, financial wealth and housing wealth could forecast either consumption growth or

asset returns (both financial and housing assets), depending on the state of the economy. In addition, in the context of interactions between the growth rates of the variables, changes of financial wealth in Regime 0 and housing wealth in Regime 1 predict future consumption growth, while in a linear VECM model only the growth of financial wealth can forecast the change in consumption. Labour income is predictable by its own lagged growth rate in both of the two regimes, while it cannot be predicted by its own lagged growth rate under a single-regime VECM model.

Table 4.8: MS-VECM Estimation

	Regime 0			
Equation	Δc_t	Δy_t	Δf_t	Δh_t
$\Delta c_{t-1,0}$	0.217***	1.157***	0.030	0.682***
	(3.360)	(6.493)	(0.150)	(3.057)
$\Delta y_{t-1,0}$	0.050	-0.363***	-0.507***	-0.357**
	(1.271)	(-3.592)	(-3.616)	(-2.396)
$\Delta f_{t-1,0}$	0.116***	0.015	0.122	0.080
	(4.701)	(0.383)	(1.536)	(1.336)
$\Delta h_{t-1,0}$	-0.046	-0.031	-0.033	0.127***
	(-1.559)	(-1.132)	(-0.499)	(2.841)
$\eta_{t-1,0}$	-0.039	0.065	0.028	0.137**
	(-1.591)	(1.227)	(0.371)	(2.221)
	Regime 1			
Equation	Δc_t	Δy_t	Δf_t	Δh_t
$\Delta c_{t-1,1}$	0.276***	0.052	1.374**	0.253
	(7.332)	(0.737)	(2.044)	(1.763)
$\Delta y_{t-1,1}$	0.034	0.285***	0.647	-0.251**
	(1.387)	(4.598)	(1.529)	(-2.369)
$\Delta f_{t-1,1}$	0.006	0.030	0.007	0.100***
	(0.833)	(1.697)	(0.053)	(5.168)
$\Delta h_{t-1,1}$	0.040***	0.029	0.378***	1.043***
	(4.973)	(1.137)	(2.882)	(42.865)
$\eta_{t-1,1}$	-0.029**	0.017	0.681***	0.044
	(-2.331)	(0.658)	(3.070)	(1.138)

t-statistics are shown in parentheses for the adjustment parameter.
** indicates significance at the 5% level; *** indicates significance at the 1% level.

A likelihood ratio test based on the two VECMs for the null hypothesis of no regime-switching against the alternative of regime-switching is performed. As shown in Table 4.9, the likelihood ratio statistic of 267.864 distributed as $\chi^2(10)$ on the null rejects the null of single-regime VECM model in favour of the MS-VECM model at the 1% significance level.

Table 4.9: LR Test for VECM vs MS-VECM

LL: VECM	2780.335
LL: MS-VECM	2914.267
LR$_2$	267.864
	(0.000)

LL denotes the log likelihood values. P-value is shown in parenthesis.
LR2 is the likelihood ratio statistic for testing the null of no regime-switching on VECM against the alternative of regime-switching on VECM with fixed transition probabilities.

4.4.6 Time-varying Transition Probability

According to MacDonald et al. (2011), monetary policy changes can affect consumption through the wealth effect channel. Therefore, this section considers if monetary policy indicators such as short- and long-term rate as well as term structure of interest rate (also referred to as the yield curve or interest rate spread) are responsible for switching between Regime 0 and Regime 1 and therefore the relative size and importance of the decomposed wealth effect. These indicators also have been found to have significant contribution to the dynamics of asset markets (Englund and Ioannides, 1997; Bernanke and Kuttner, 2005; Nneji et al., 2013).

Table 4.10, which is based on the estimation of Equation 4.30 and 4.31, provides the time-varying transition probability (TVTP) estimates in terms of the consumption error-correction equation. It shows that $\vartheta_0 > 0$ for changes in the short- and long-term interest rates. This implies that the larger the change in interest rate, the higher the probability remaining in Regime 0, which is characterized by a stronger financial wealth effect over housing wealth effect (insignificant in this regime). Furthermore, $\kappa_0 < 0$ indicates that an upward movement in interest rates will lead to a lower probability of remaining in Regime 1, which is characterized by a larger housing wealth effect in relation to a financial wealth effect (insignificant in this regime) on consumption. Therefore, consumer spending is more likely to respond to a financial wealth shock when there is a rise in interest rates, while consumer spending is more likely to respond to a housing wealth shock if there is a fall in interest rates.

Interest rate shocks can affect consumer spending through the wealth channel in two ways. First, a drop in the interest rate is expected to reduce the cost of mortgages. This would, in turn, lead to an increase in the demand for properties and a subsequent rise in house prices. Lower interest rates might also reduce defaults on mortgages, which could further contribute towards an increase in prices. Higher house prices imply a gain in asset wealth for homeowners, so households can then convert these capital gains from their property into liquid spending power through mortgage equity withdrawal to finance consumption. Second, lower interest rates can also increase the market value of financial assets, because the market price of financial assets rises due to the lower discount rate. The increased financial wealth then encourages consumer expenditure. A rise in

interest rates, on the other hand, would have negative effects on the consumption-wealth channel.

Since the results based on the time-varying transition probability (TVTP) estimates indicate that consumption is more likely to respond to financial wealth shocks when there is a rise in interest rates, bearing in mind that a rise in interest rates will normally lead to negative financial wealth shocks, these imply that consumption responds significantly to negative financial wealth shocks based on positive interest rate shocks with a regime change. In the case of housing wealth effects, consumption is more likely to respond to housing wealth shocks when there is a fall in interest rates. Since the drop in interest rates would normally lead to positive housing wealth shocks, consumption then would respond significantly to positive housing wealth shocks based on negative interest rate shocks with a regime change. With respect to the asymmetric consumption response to a financial wealth shock, one possible explanation is related to market liquidity. In particular, when there is a drop in share prices, market uncertainty increases, making it more difficult for lenders to distinguish 'good' from 'bad' borrowers, and with the enhanced adverse selection problem, credit restrictions would discourage spending. Moreover, with increasing volatility of financial asset prices, households would react in a more intense way to decreases due to loss-aversion behaviour.

In terms of the asymmetric housing wealth effect, one explanation for this behaviour is the development of home equity withdrawal. Households can expand their spending by extracting equity from their homes through housing equity withdrawal when property prices increase. In addition, according to Benito (2007),

consumers are more likely to withdraw home equity if they face less uncertainty about the real estate market. Since the evolution of property prices is historically less volatile than share prices, the indirect housing wealth effect from positive home equity withdrawal can significantly add to the direct housing wealth effect (homeowners can realize a capital gain by selling their higher valued property asset or feel wealthier because of the increased value). As a result, consumption would adjust more to positive housing wealth shocks than to negative shocks. It also partially explains why the fall in house prices since the subprime mortgage crisis has had only a limited adverse effect on consumption.

In sum, these results suggest that monetary loosening may boost consumption mainly through the housing wealth effect, while monetary tightening may dampen consumer spending largely through a negative financial wealth effect. The results are consistent with the findings of Apergis and Miller (2006), Donihue and Avramenko (2007), and Marquez *et al*. (2013) that consumer spending responds asymmetrically to shocks from household wealth movements.

Similar to interest rates, the yield curve has also been used to predict future economic conditions. In fact, Estrella and Hardouvelis (1991) find that the term structure has extra predictive power beyond that contained in the short-term interest rate. With regard to the term structure of interest rate as the driving factor, it is found that $\vartheta_0 < 0$ and $\kappa_0 > 0$ which indicates that an increase in the term structure will lead to a larger probability of staying in Regime 1, but a smaller probability of remaining in Regime 0. Since the earlier findings concerning short- and long-term interest rates show that a negative interest rate shock will increase the probability staying in Regime 1 but reduce the probability of remaining in

Regime 0, the evidence concerning the term structure is consistent because a positive term spread shock accompanies a negative short-term interest rate shock. This means that the central bank decreases the policy rate when it anticipates economic tightening in the future, or when it believes that private agents anticipate future tightening (Cheng and Jin, 2013). The reduced policy rate will stimulate the real estate market directly. Furthermore, the lower policy rate is also a signal for the following reduction in long-term rates such as mortgage rates, which could additionally boost the housing wealth effect. Finally, likelihood ratio tests indicate that the time-varying transition probabilities model dominates the fixed transition probabilities model.

Table 4.10: Time-varying Transition Probability

	Regime 0		
	Ω: Change of short-term interest	Ω: Change of long-term interest rate	Ω Change of term structure
$\Delta c_{t-1,0}$	-0.156	-0.186	-0.176
	(-1.652)	(-1.909)	(-1.823)
$\Delta y_{t-1,0}$	0.538***	0.571***	0.535***
	(7.504)	(7.101)	(7.314)
$\Delta f_{t-1,0}$	0.070***	0.090***	0.067***
	(2.810)	(2.670)	(2.732)
$\Delta h_{t-1,0}$	-0.066	-0.066	-0.060
	(-1.590)	(-1.382)	(-1.349)
$\eta_{t-1,0}$	-0.050	-0.067	-0.048
	(-1.169)	(-1.621)	(-1.120)
γ_0 (P00)	3.139***	1.712***	3.388***
	(5.392)	(3.459)	(5.138)
ϑ_0 (P01)	298.904***	352.688**	-474.216***
	(2.907)	(2.030)	(-2.832)
	Regime 1		
	Ω: Change of short-term interest	Ω: Change of long-term interest rate	Ω Change of term structure
$\Delta c_{t-1,1}$	0.254***	0.254***	0.266***
	(7.710)	(7.871)	(8.004)
$\Delta y_{t-1,1}$	-0.033	-0.035	-0.034
	(-1.554)	(-1.617)	(-1.625)
$\Delta f_{t-1,1}$	0.015	0.014	0.016
	(1.821)	(1.644)	(1.866)
$\Delta h_{t-1,1}$	0.040***	0.041***	0.040***
	(4.463)	(4.489)	(4.359)
$\eta_{t-1,1}$	-0.023**	-0.022**	-0.023**
	(-2.156)	(-2.010)	(-2.195)
γ_1 (P10)	4.401***	2.956***	4.047***
	(7.530)	(6.831)	(7.452)
κ_0 (P11)	-281.554***	-177.628**	274.213***
	(-3.176)	(-2.119)	(2.762)
LL	945.810	942.594	942.970
LR$_3$	12.996***	6.565**	7.316**
	(0.002)	(0.038)	(0.026)

t-statistics are shown in parentheses for the adjustment parameter.
*** indicates significance at the 5% level; *** indicates significance at the 1% level.*

Figures 4.2, 4.3, and 4.4 further plot the probabilities of switching from Regime 0 to Regime 1 during the entire study period, which is $(1 - p_t)$, for the three driving variables, respectively. It is reasonable to emphasize that monetary policy surprises are responsible for only a small portion of the overall variability of asset prices (Bernanke and Kuttner, 2005). In fact, all these transition probabilities are mostly moderate and below 0.5, but there are still some sharp upward spikes during the structural break dates, such as the 2000s dotcom bubble burst and the recent subprime mortgage crisis. For example, changes in term structure and interest rates are clearly shown to drive the switching from Regime 0 to Regime 1 in 2001 and 2008, which would be associated with stronger housing wealth effects that resulted from the monetary stimulus after the crisis.

Figure 4.2: Probability of Switching from Regime 0 to Regime 1 by Term Structure

Probability of switching from Regime 0 to Regime 1
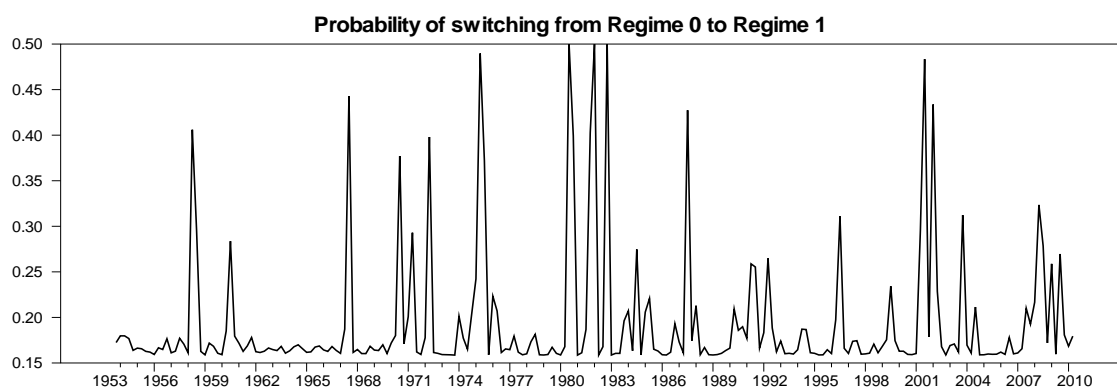
Figure 4.3: Probability of Switching from Regime 0 to Regime 1 by Short-term Interest Rate

Probability of switching from Regime 0 to Regime 1
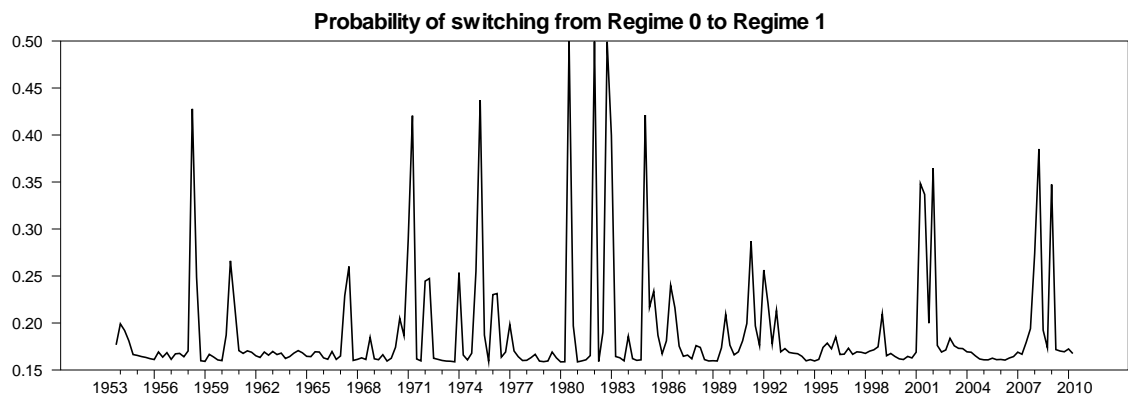
Figure 4.4: Probability of Switching from Regime 0 to Regime 1 by Long-term Interest Rate

Probability of switching from Regime 0 to Regime 1
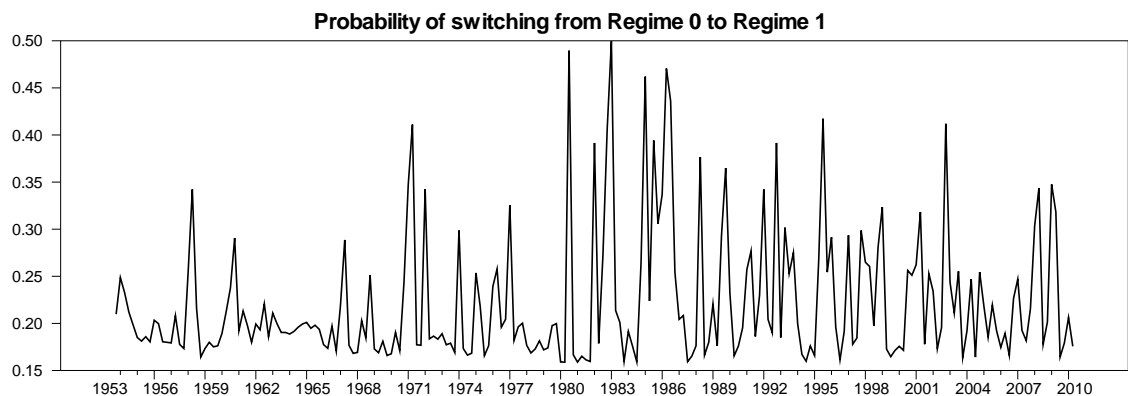
4.5 Conclusion

The relationship between asset prices and consumer spending is one of the most popular study issues in economics. The influence of housing prices on consumption first received attention following the late 1990s financial crisis. That is, the limited impact of falling stock prices on consumer expenditures is explained as the contemporary offsetting effect from the upsurge in house prices. Now the

recent subprime mortgage crisis and the real estate market downturn have renewed concerns about the implications of asset market fluctuations for consumer spending. Based on the latest quarterly US data, this chapter investigated the relationship between consumption, income, financial wealth and housing wealth both in the long-run and short-run within the framework of regime-switching.

All the regime-switching frameworks are found to be preferable to conventional single-regime models. The MPC out of financial wealth is estimated to be 4 cents in Regime 0 and 5 cents in Regime 1, while the MPCs out of housing wealth are found to be 10 cents in Regime 0 and 8 cents in Regime 1. In other words, the housing wealth effect is stronger than the financial wealth effect in both regimes, and the difference between those two effects is even larger in Regime 0, which has applied in the time period covering the recent housing market boom. The MPC estimates are consistent with the theoretical and empirical bounds on the MPC from aggregate wealth.

This chapter also finds that consumption as well as financial and housing wealth exhibit error correction during their own particular states. Therefore, estimation of the system suggests that short-term derivations in the consumption-wealth ratio will predict either consumption growth or asset returns, depending on the state of the economy. It further shows that TVTP outperforms fixed transition probability (FTP) where monetary policy indicators such as interest rate and term structure significantly drive the transition probabilities. In particular, monetary tightening might result in a relatively stronger negative financial wealth shock, while monetary loosening could lead to a relatively larger positive housing wealth effect on consumption.

The findings of this chapter have important policy implications. Asymmetric monetary policies should be responsible for movement in asset prices in analysing future inflation and aggregate demand due to the sensitivity of financial and housing wealth effects in different economic states. In particular, asymmetry in the consumption-wealth channel suggests the central bank needs to recognize the fact that monetary loosening might over-boost the real estate market with excessive credit growth in the mortgage sectors, which could lead to a higher potential housing price bubble. On the other hand, monetary tightening could dampen the financial market more, which in turn discourages household consumption, especially for consumers who have heavy shares of their wealth in stocks, bonds and mutual funds. As a result, it is crucial to re-assess monetary policy especially during periods of uneven development between financial and real estate markets.

CHAPTER 5: WEALTH EFFECTS ON CONSUMPTION: EVIDENCE FROM QUANTILE COINTEGRATION IN THE AUTOREGRESSIVE DISTRIBUTED-LAG FRAMEWORK

5.1 Introduction

As introduced in Chapter 4, most existing empirical studies use a linear cointegration approach to detect the long-run relationship between consumption and wealth (see Mehra, 2001; Lettau and Ludvigson, 2001&2004; Kishor, 2007; Case et al., 2005&2012). However, some studies fail to find such long-run cointegrating relationships (see Benjamin et al., 2004; Rudd and Whelan, 2006; Carroll et al., 2006). Chapter 4 also finds only weak evidence of a linear-based cointegrating relationship between consumption and wealth. Indeed, given the nature of the studied variables and the complexity of economic systems, it is possible that the relationship between consumption and wealth will vary over time and behave in nonlinear ways. Without considering nonlinearity, conventional cointegration methods may not be able to detect significant evidence of cointegration.

Empirically, very limited research focuses on nonlinear wealth effects on consumer spending. By employing the Enders and Siklos (2001) threshold model, Stevans (2004), Apergis and Miller (2006), and Marquez et al. (2013) find evidence of asymmetric effects of stock and housing wealth on consumption. Moreover, Chapter 4, in agreement with Alexandre et al. (2007) and Gabriel et al.

(2008) highlights the importance of regime switching in the consumption-wealth relationship using various Markov-switching models. Holmes and Shen (2012 & 2013) identify a nonlinear connection between the APC and the WY ratio.

This chapter employs the QARDL model proposed by Cho et al. (2012) to re-investigate the non-linear relationship between consumption, income and wealth. While previous non-linear studies, including that in Chapter 4, have focused on the dynamics of asymmetric wealth shocks, it is also important to understand the heterogeneity in consumption behaviour which is fundamental to grasping the impacts of wealth shocks, and the effectiveness of tax and other policies that can impact on wealth. For instance, with regard to different levels of consumer spending growth, household consumption may respond differently even to the same wealth shock. Instead of relying on a single measure of conditional central tendency like the conventional cointegration methods, the QARDL approach enables us to explore wealth effects on consumption with quantile-varying (consumption-varying) cointegrating coefficients. In other words, the QARDL method is able to give a comprehensive picture of the entire conditional distribution of consumption without imposing global distributional assumptions on the errors.

To further consider the time-varying patterns of the relationship between consumption and wealth, this chapter employs a robust rolling estimation based on the QARDL model to check wealth effects on consumption over time. In particular, this study will focus on the 2001-2010 period to measure the impacts from the most recent financial turmoil and subsequent economic downturn. Several questions need to be addressed here. Is the relationship governed by non-

linearities? If so, what can be said about the nature of any non-linearities present? To what extent have these non-linearities changed during the recent turbulent years?

Empirical examinations provide interesting findings regarding wealth effects on consumption. First, the full sample estimation shows a strong evidence of location asymmetries between lower and medium-to-higher quantiles for both long-run and short-term relationships. For example, the speed of adjustment of consumption towards long-run equilibrium following a wealth shock exhibits a downward trend in which the speed of error correction is lower at higher quantiles than the speed at lower quantiles. Second, while the quantile estimates of the financial wealth effect decrease as quantiles increase, reduction of the housing wealth effect is quite limited in higher quantiles compared with lower quantiles. Third, the rolling quantile estimation reveals that there is a strong time-varying pattern for the relationship between consumption and wealth. In particular, the financial wealth effect displays a downward time-varying pattern, especially after the shock of the 2007-2008 subprime mortgage crisis. However, the housing wealth effect has become significantly higher in recent periods.

This chapter is structured as follows. The next section briefly describes several theoretical aspects of the non-linear behaviour of consumption and wealth. Section 5.3 introduces the QARDL procedure. Section 5.4 describes the dataset and provides the empirical results. Section 5.5 concludes the chapter.

5.2 Consumption Heterogeneity

While most of the literature focuses on the linear relationship between consumption and wealth, the non-linear evidence is rather scarce. In fact, given the nature of the studied variables and the complexity of economic systems, it is possible that the relationship between consumption and wealth will vary over time and behave in nonlinear ways.

Several reasons may explain the nonlinear behaviour of consumption and wealth. First, as most studies find a positive and constant long-run relationship between consumption and wealth, Alexandre et al. (2007) argue that conventional linear estimation of wealth effect on consumption is indeterminate, since asset wealth displays more volatility than consumption or income. Therefore, estimates of the wealth effect may change between different regimes of the economy. Gabriel et al. (2008) further show that regime-switching adjustment may provide a better explanation of fluctuations in the consumption-wealth ratio, and the dynamics of the relationship between different regimes are related to the behaviour of financial markets.

Second, the wealth effect has also evolved over time due to financial innovation. For instance, since the 1980s, technological advances and institutional developments have reduced credit constraints, increasing availability and lowering the cost of borrowing, which has allowed more households to own financial assets. On the other hand, the housing wealth effect has also increased through the development of 'home equity withdrawal.'

Finally, with the shock of asset prices, household consumption may also respond in nonlinear (or asymmetric) manners. According to the prospect theory (Kahneman and Tversky, 1979), people tend to overweight losses in comparison to comparable gains and engage in risk-averse behaviour with respect to gains and risk-acceptant behaviour with respect to losses. Moreover, habit persistence theory (Sundaresan, 1989) indicates that consumption is 'sticky' during periods of fluctuating equity prices, where consumer utility depends on consumption history.

Consequently, without considering nonlinearity/asymmetry, conventional cointegration methods may not be able to detect significant evidence of cointegration, and it is more appropriate to estimate wealth effects on consumption based on a nonlinear framework.

Empirically, studies of the non-linear relationship between wealth and consumption in the US have been mainly conducted by Stevans (2004) and Apergis and Miller (2005a, 2005b, 2006) based on Enders and Siklos's (2001) threshold method as well as work by Alexandre et al. (2007) and Gabriel et al. (2008) based on a Markov switching model.

Nevertheless, no previous study has allowed for quantile-varying in the relationship between consumption and wealth. While most of the previous non-linear wealth effect literature argues that consumption may respond asymmetrically to different shocks of asset wealth, in terms of different levels of consumer spending, household consumption may respond differently even to the same wealth shock. For example, when consumption expenditure is already at a high level, household consumption may adjust less in response to the asset wealth shock compared with the same size shock during a lower consumption level,

because a higher consumption level implies lower future savings, and with higher consumption levels, it is more difficult for households to raise or even sustain their current spending level.

Compared with the nonlinear methods employed in the previous studies, the QARDL approach employed in this chapter has several advantages. First, while there is a debate on whether stock price/wealth is stationary or not (Chaudhuri and Wu, 2003; Lee et al., 2010; Shen and Holmes, 2014&forthcoming), incorrectly including potential stationary stock market wealth series in conventional cointegration models might lead to biased results. However, an ARDL approach does not rely on pre-testing the non-stationarity of the variables.

Second, the most widely-used cointegration test in linear time series modelling, such as Engle and Granger's (1987) approach, is static and delivers only the long-run relationship between integrated series such that the associated short-run dynamics can be recovered through a potentially inefficient two-step approach. In contrast to that, the QARDL approach can simultaneously address the long-run relationship between the studied variables as well as the associated short-run dynamics across a range of quantiles of the conditional distribution of the dependent variable in a fully parametric setting.

Third, further valuable insights can be drawn from a quantile perspective. The QARDL model allows the values of cointegrating coefficients to be affected by the shock received in each period, and hence, they may vary over different innovation quantiles. Specifically, instead of concentrating on the average relationship between consumption, income and wealth through a conditional mean function, the QARDL model examines their long-run relationships in a range of

quantiles of a shock. For instance, the estimate of wealth effects on consumption may vary across different quantiles, and within the framework of QARDL, it is possible to quantify the effects of the magnitudes of a shock on the long-run coefficients. Under the framework of a quantile-varying ARDL, it is possible to detect extreme levels of wealth shocks on consumer spending. Therefore, the QARDL approach can be regarded as a stochastic cointegration model which includes the conventional counterpart as a special case.

Fourth, the QARDL model not only permits one to check whether or not there is a long-run equilibrium relationship between consumption, income and wealth, but also provides detailed insight on which quantiles the cointegrating relationship exists in. Furthermore, instead of assuming the speed of adjustment towards the long-run equilibrium is constant, the QARDL approach allows for differing speeds of adjustment across the quantiles, depending on the size and sign of the shocks.

Finally, since the magnitudes of shocks are determined endogenously by the data under the framework of quantile regression, in the case of potential heavy-tailed behaviour in the disturbance, the QARDL approach can achieve larger efficiency gains compared with the conventional least squared-based counterparts. In other words, the QARDL method may be able to provide more reliable results. Existing regression analyses of the relationship between consumption and wealth typically rely on OLS or least absolute deviations methods and so only estimate the marginal effects of the covariates on the conditional mean (median) function of consumption. Such estimates sidestep the potentially heterogeneous patterns of the influence of the covariates in the conditional distribution.

In short, it is crucial to explore the relationship between consumption and wealth conditional on quantiles in the distribution of consumer spending. Therefore, this chapter will re-examine non-linear wealth effects on consumption from a new perspective of quantile-varying, which can be regarded as a complementary contribution to the existing non-linear wealth effect literature.

5.3 Econometric Modelling

5.3.1 The Theoretical Model

As introduced in Chapter 4, following Lettau and Ludvigson (2001, 2004), the time-series framework for investigating the relationship between consumption, income and wealth is based on the household budget constraint identity.

The long-run linear consumption equation can be written as:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 f_t + \alpha_3 h_t + \varepsilon_t \tag{5.1}$$

where α_2 and α_3 denote the long-run elasticity of consumption with respect to financial wealth and housing wealth due to the log form of the variables.

However, as noted by Lettau and Ludvigson (2001, p. 823), their estimates of the long-run aggregate consumption function are consistent with a Cobb-Douglas production function. Alexandre et al., (2007) argue that if this is the case, either the long-run aggregate consumption function cannot represent a cointegrating relationship, or the wealth effect on consumption is indeterminate. In fact, a few studies have failed to find a long-run cointegration relationship between consumption, income and wealth (Benjamin et al. (2004), Rudd and Whelan

(2006), and Carroll et al., (2006)). Chapter 4 also showed that there is only a weak cointegrating relationship between consumption, income and wealth. With regard to the second possibility, Alexandre et al. (2007) employ a standard macro model to find theoretical evidence that the wealth effect is unstable. Therefore, it is crucial to account for nonlinearity when estimating the long-run relationship between consumption, income and wealth.

5.3.2 Quantile ARDL Modelling

This chapter employs the quantile version of the ARDL model to investigate the non-linear wealth effects on consumption. This section will introduce the quantile ARDL model briefly and further detailed discussion can be seen in Cho et al. (2012).

An ARDL representation of Equation 5.1 can be formulated as follows:

$$\Delta c_t = \lambda_0 + \sum_{i=1}^{m} \lambda_{1i} \Delta c_{t-i} + \sum_{i=0}^{m} \lambda_{2i} \Delta y_{t-i} + \sum_{i=0}^{m} \lambda_{3i} \Delta f_{t-i} + \sum_{i=0}^{m} \lambda_{4i} \Delta h_{t-i}$$

$$+ \lambda_5 c_{t-1} + \lambda_6 y_{t-1} + \lambda_7 f_{t-1} + \lambda_8 h_{t-1} + v_t \tag{5.2}$$

where *m* is lag order. Suppose that v_t is an independent and identically distributed (IID) process with a finite second moment.

Equation 5.2 can be further rewritten into a form following the structure of an error correction model (ECM):

$$\Delta c_t = \delta_0 + \sum_{i=1}^{k} \delta_{1i} \Delta c_{t-i} + \sum_{i=0}^{k} \delta_{2i} \Delta y_{t-i} + \sum_{i=0}^{k} \delta_{3i} \Delta f_{t-i} + \sum_{i=0}^{k} \delta_{4i} \Delta h_{t-i}$$

$$+ \pi(c_{t-1} - \beta_1 y_{t-1} - \beta_2 f_{t-1} - \beta_3 h_{t-1}) + u_t \tag{5.3}$$

where π is the speed of adjustment parameter. β_1, β_2, and β_3 represent long-run coefficients for income, financial wealth, and housing wealth, respectively. Moreover, δ_{1i}, δ_{2i}, δ_{3i}, and δ_{4i} indicate short-run parameters.

To apply the proposed QARDL approach, the quantile counterpart of Equation 5.3 is considered, which is given by:

$$\Delta c_t = \delta_0(\tau) + \sum_{i=1}^{k} \delta_{1i}(\tau)\Delta c_{t-i} + \sum_{i=0}^{k} \delta_{2i}(\tau)\Delta y_{t-i} + \sum_{i=0}^{k} \delta_{3i}(\tau)\Delta f_{t-i} + \sum_{i=0}^{k} \delta_{4i}(\tau)\Delta h_{t-i}$$

$$+ \pi(\tau)(c_{t-1} - \beta_1(\tau)y_{t-1} - \beta_2(\tau)f_{t-1} - \beta_3(\tau)h_{t-1}) + u_t(\tau) \tag{5.4}$$

where $\tau \in (0,1)$ is a quantile index, and k is lag order. This study uses the set of τ = {0.1, 0.2, …, 0.9}. Equation 5.4 is more general than its least squared-based counterparts, since it is less restrictive as the slope coefficients can vary by quantiles. Hence, the model can be used to estimate a potentially thick-tailed distribution of consumption.

In a simple ARDL (2, 2, 2, 0) model, for example, Equation 5.4 can be represented as:

$$\Delta c_t = \delta_0(\tau) + \delta_{11}(\tau)\Delta c_{t-1} + \delta_{20}(\tau)\Delta y_t + \delta_{21}(\tau)\Delta y_{t-1} + \delta_{30}(\tau)\Delta f_t + \delta_{31}(\tau)\Delta f_{t-1}$$

$$+ \delta_{40}(\tau)\Delta h_t + \delta_{41}(\tau)\Delta h_{t-1} + \pi(\tau)(c_{t-1} - \beta_1(\tau)y_{t-1} - \beta_2(\tau)f_{t-1} - \beta_3(\tau)h_{t-1}) + u_t(\tau) \tag{5.5}$$

where $\pi(\tau)$ is the coefficient of the error-correction term. $\beta_1(\tau)$, $\beta_2(\tau)$, and $\beta_3(\tau)$ indicate long-run coefficients for labour income, financial wealth, and

housing wealth, respectively. In addition, $\delta_{11}(\tau)$, $\delta_{20}(\tau)$, $\delta_{21}(\tau)$, $\delta_{30}(\tau)$, $\delta_{31}(\tau)$,

$\delta_{40}(\tau)$ and $\delta_{41}(\tau)$ represent parameters for short-run dynamics.

According to Cho et al., (2012), the QARDL estimators of both the long-run (cointegrating) parameters and the short-run dynamics are shown to follow normal distributions asymptotically. Moreover, any linear joint restrictions on the parameters involving multiple quantiles can be tested using standard Wald statistics.

5.4 Data and Results

5.4.1 Data Description

The dataset of this chapter is the same as the one used in Chapter 4, which is based on US data.

5.4.2 Empirical Results

According to the Engle-Granger cointegration test results in Chapter 4, the null hypothesis of a unit root in the residual cannot be rejected at the 10% level. Therefore, the Engle-Granger test shows that there is no cointegrating relationship between consumption, income, financial wealth and housing wealth. It confirms the hypothesis that the long-run relationship between consumption, income and wealth is indeterminate (Alexandre et al. 2007). In fact, earlier findings by Benjamin et al. (2004), Rudd and Whelan (2006), and Carroll et al. (2006) also imply the absence of a long-run equilibrium relationship between consumption and wealth.

The QARDL model is then estimated to see if a cointegrating relationship exists under the nonlinear framework: to be precise, after allowing quantile-varying. As the first stage of the QARDL procedure, the order of lags on the first-differenced variables from Equation 5.4 need to be confirmed based on information criteria. This study uses a maximum lag order of four, which can be considered to be sufficiently high, given the fact that quarterly data is employed, because Pesaran and Pesaran (1997) suggest that a lag length of one period can be a reasonable choice in the case of annual data. This chapter uses the Akaike Information Criterion (AIC) to select the optimal lag length for each of the variables in the QARDL model given the maximum number of lagged terms set to four, since AIC performs better in the selection of lag length due to its superior power properties. The results of AIC[3] suggest the optimal lag orders to be QARDL (2, 2, 2, 0).

The full sample estimation results of QARDL procedure are reported in Table 5.1, which shows that most of the estimated coefficients are statistically significant across the quantiles. Specifically, in terms of the error-correction parameter (ECM), most of the error-correction terms are significant at the 5% level, except at the 0.1, 0.7 and 0.8 quantiles. Therefore, it can be concluded that a cointegrating relationship indeed exists between consumption, income, financial and housing wealth, but under the condition of particular quantiles.

The long-run coefficients between consumption, income, financial and housing wealth are significant across all of the quantiles, but the size of the coefficients varies across different quantiles. With respect to the short-term dynamics, only income and financial wealth have significant effects on consumption throughout

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[3] There is no qualitatively different result from the optimal lag ordering of QARDL (1, 2, 2, 0) suggested by SIC.

most of the quantiles. Lagged consumption only has significant effects on current consumption at low to medium quantiles, while lagged income, lagged financial wealth and housing wealth only have significant effects on current consumption at higher quantiles.

Table 5.1: QARDL Estimation

Dependent variable = Δc_t

Variable	τ: 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Δc_{t-1}	0.341*	0.323*	0.217*	0.144	0.171*	0.096	0.072	0.085	0.077
	(0.076)	(0.077)	(0.075)	(0.074)	(0.072)	(0.070)	(0.068)	(0.068)	(0.075)
Δy_t	0.140*	0.122*	0.131*	0.145*	0.147*	0.139*	0.134*	0.143*	0.112*
	(0.035)	(0.035)	(0.035)	(0.034)	(0.033)	(0.032)	(0.031)	(0.031)	(0.035)
Δy_{t-1}	0.055	0.017	0.054	0.069	0.060	0.094*	0.115*	0.157*	0.171*
	(0.037)	(0.037)	(0.036)	(0.036)	(0.035)	(0.034)	(0.033)	(0.033)	(0.036)
Δf_t	0.026*	0.036*	0.037*	0.033*	0.027*	0.024*	0.026*	0.017*	0.028*
	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
Δf_{t-1}	0.023*	0.009	0.010	0.013	0.012	0.016	0.024*	0.019	0.021*
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
Δh_t	0.017	0.022	0.024	0.025	0.025*	0.030*	0.033*	0.026*	0.037*
	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.013)
ecm_{t-1}	-0.021	-0.038*	-0.032*	-0.035*	-0.036*	-0.034*	-0.024	-0.019	-0.033*
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
y_{t-1}	0.824*	0.785*	0.747*	0.743*	0.738*	0.692*	0.676*	0.665*	0.707*
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.011)
f_{t-1}	0.343*	0.260*	0.236*	0.199*	0.231*	0.233*	0.238*	0.172*	0.223*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
h_{t-1}	0.006*	0.065*	0.101*	0.117*	0.081*	0.092*	0.080*	0.109*	0.058*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Note: ecm_{t-1} is the error correction term, that is, $ecm_{t-1} = c_{t-1} - \beta_1(\tau)y_{t-1} - \beta_2(\tau)f_{t-1} - \beta_3(\tau)h_{t-1}$

The standard errors are reported in the brackets. * indicates 5% significance level or better.

The estimation results are also illustrated in Figure 5.1, which displays the quantile estimates of all the regressors in Equation 5.5 against quantile indices ranging from 0.1 to 0.9. The evidence from Figure 5.1 can be summarised as

follows: First, the quantile estimate of the ECM parameter starts with a 3.8% adjustment speed at the low quantile 0.2 and then slightly slows down to 3.6% in the mid quantile 0.5. The speed of error correction continues to drop during higher quantiles, where the adjustment speed is recorded as 3.3% in quantile 0.9. In summary, the speed of adjustment for consumption towards long-run equilibrium following a wealth shock exhibits a downward trend in that the speed of error correction is lower during higher quantiles than the speed at lower quantiles. This evidence is consistent with the 'habit persistence' theory (Sundaresan, 1989), which states that consumption is 'sticky' and that households' utility depends on their consumption history. Specifically, during high levels of consumption growth (higher quantiles), with a negative asset price shock, households will only adjust slowly to reduce their consumption, since they are already used to a high standard of living and have no incentive to downgrade their life style. Households may even use their savings or increase their financial leverage to maintain the same level of spending. The prospect theory advocated by Kahneman and Tversky (1979) can also explain such asymmetric consumption behaviour. According to the prospect theory, consumers feel more pain with a loss than they feel pleasure with a gain that is of the same size as the loss. Moreover, people normally exhibit a loss aversion attitude in that they are more willing to take risks to avoid losses than to realize gains. Hence, it is more difficult for households to downgrade their quality of living than to maintain the same standard of living. Consumers would rather raise finance to support their current consumption level following a negative wealth shock.

Second, all the long-run coefficients show a monotonically downward trend through the quantiles except for the coefficient of housing wealth. That is, the elasticity of income and financial wealth are much higher during low quantiles but will fall at higher quantiles. It implies that both income and financial wealth effects on consumption will decrease when consumption growth increases. It is commonly expected that the larger the consumption, the more difficult households will find it to sustain a high spending level. With lower future savings as a result of high consumption, it is harder for households to spend more and maintain a high speed of consumption growth even with a positive asset price shock. Moreover, according to De Veirman and Dunstan (2011, 2012), households might initially expect a wealth shock to be permanent, but gradually establish that it is in fact only transitory. With higher levels of consumption growth, people might have a quicker realization that a given income or wealth shock is transitory. For example, at higher spending growth levels, consumers will become more suspicious of the continuing positive income and wealth shocks. They might fear that the positive income and asset price shocks will not last long and a large downward correction will follow. As a result, people become more cautious about spending even during a 'bull market.'

Nevertheless, compared with the income and financial wealth shock, the housing wealth effect does not substantially fall when consumption increases. In particular, despite there being a quick lift in the elasticity of housing wealth at lower quantiles, the housing wealth effect only exhibits minor downward trends during most of the following quantiles. In other words, with the increase of spending growth, housing wealth will continue to have a large impact on households'

expenditure. The key reason for such different impacts on consumption between financial and housing wealth is that the real estate market is more stable than the stock market historically. While we have witnessed several big collapses in financial markets during the past two decades (e.g. the 1987 Black Monday, 2001 dotcom bubble burst, and 2007 global financial crisis), the movement of housing prices was much steadier except during the most recent subprime mortgage crisis. Alexandre et al. (2007) argue that the estimate of the wealth effect should decrease when asset wealth volatility increases. The less volatile property market implies that housing wealth should have a constant larger impact on consumption, especially when consumption growth is at a high level, since households are more optimistic about the future performance of the housing market than the share market. Furthermore, Benito (2007) shows that people are more likely to withdraw home equity if they face less house price uncertainty. The less volatile evolution of housing prices during the past two decades further enhances the housing wealth effect on consumption through the home equity withdrawal channel.

Third, in terms of short-run dynamics, one of the interesting findings is that the short-run coefficient on lagged consumption decreases monotonically as the quantile increases. This evidence is consistent with the long-run coefficients estimation that when consumption growth is already high on account of inflated asset values, then it seems reasonable for people to expect an asset market correction and so become more cautious with regard to their spending.

In addition, there is also a downward trend for the short-run coefficient of financial wealth, which is in line with its long-run estimation. Nevertheless, there

is an upward trend for the coefficient of housing wealth. It implies that in the short-run, the housing wealth effect on consumption will increase as the quantile increases. In summary, the estimation results of both long-run and short-run relationships clearly confirm that there is strong evidence of location asymmetries between lower and medium-to-higher quantiles for most of the parameters.

Figure 5.1: Parameter Estimates
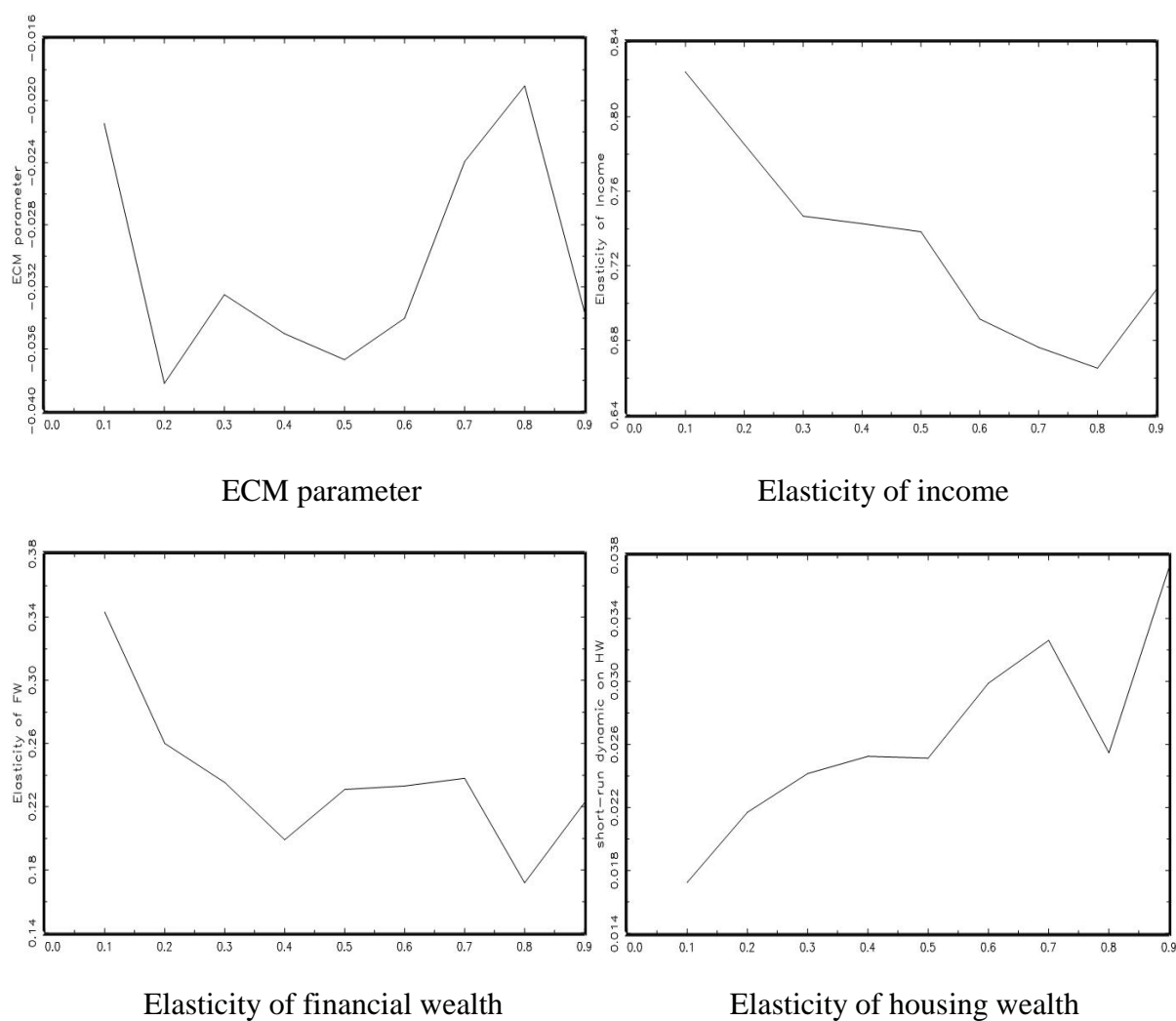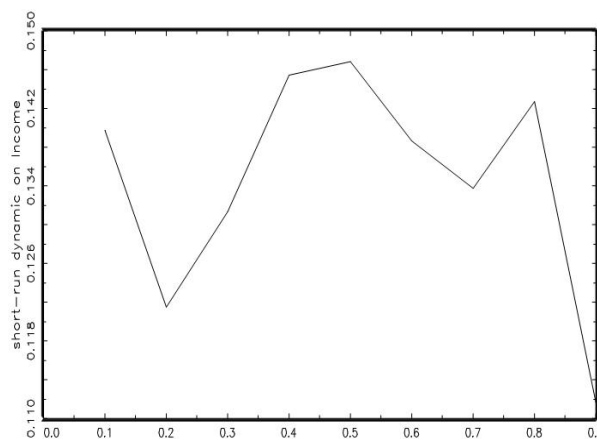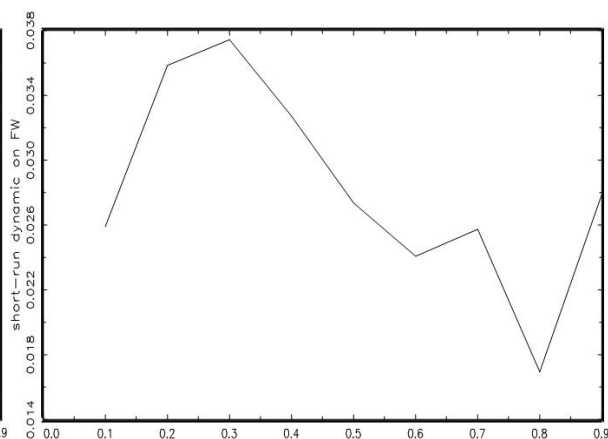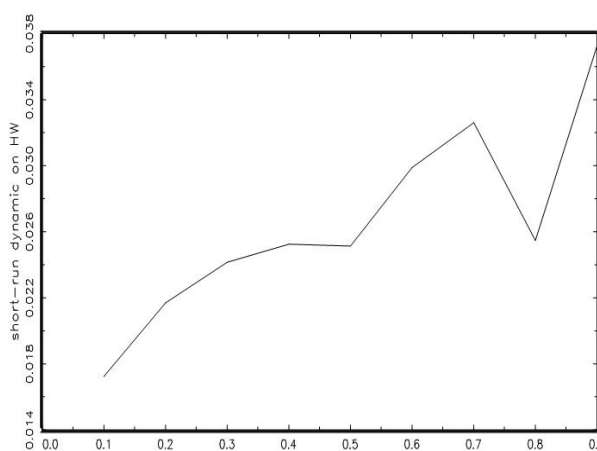
ECM parameter

Elasticity of income

Elasticity of financial wealth

Elasticity of housing wealth

Short-run dynamic on income

Short-run dynamic on financial wealth

Short-run dynamic on housing wealth
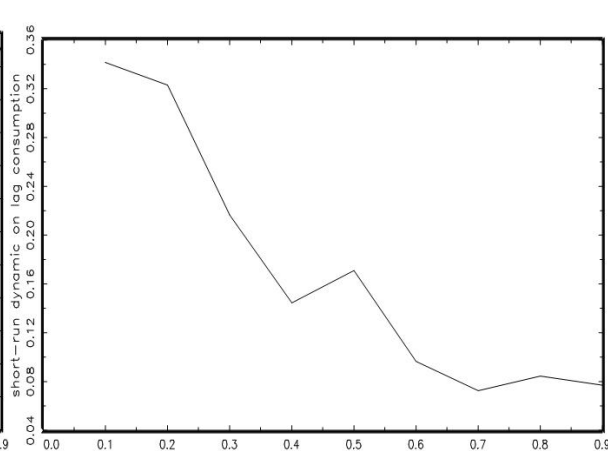
Short-run dynamic on lag consumption
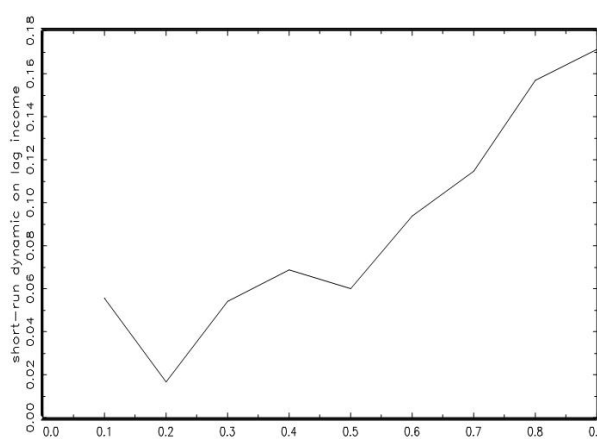
Short-run dynamic on lag income
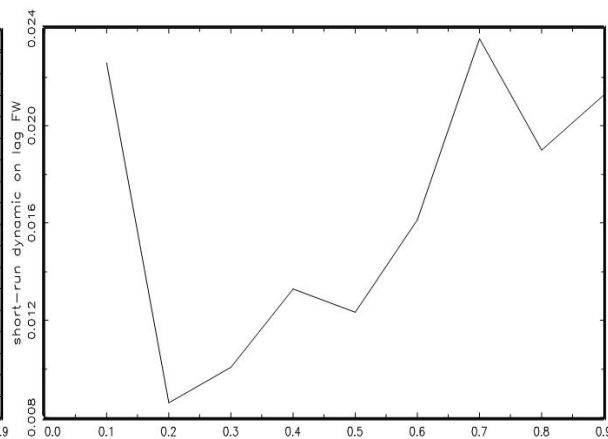
Short-run dynamic on lag financial wealth

Note: the vertical line is the coefficient (details of the coefficients can be seen in Table 5.1), and the horizontal line is the index of the quantile from 0.1 to 0.9.

Since the estimated sample period in this chapter is reasonably long (nearly 60 years), it is important to allow for time-varying patterns of wealth effects on consumption. Equation 5.5 is re-estimated based on the rolling estimation method by repeatedly moving the estimation window forward by a quarter until the end of the sample is reached. Given that a large sample size is required to provide reliable QARDL estimates, the size of the window used is set at 196 quarters. Therefore, there will be 39 moving windows, and the end point of the moving window covers 2001Q1-2010Q2 enabling us to consider events surrounding the global financial crisis.

For clarity, Figure 5.2 only plots the estimated coefficients against the end of the moving window for the $\tau = 0.25, 0.5, 0.75$ quantiles. In terms of the error-correction parameter, while there is no clear trend present during the earlier years, the speed of adjustment for consumption has decreased in recent years, except for the mid (0.5) quantile estimation. It implies that during the recent two decades which surround the favourable movement in asset prices, in response to a wealth shock, it takes longer for consumption to adjust back to the equilibrium level. In other words, following the liberalization of financial markets and the deregulation of mortgage markets in the 1980s, 'sticky consumption' has increased. Households are less willing to downgrade their consumption level even with negative wealth shocks.

In terms of the long-run coefficients, the income and financial wealth effects on consumption were steady during most of the estimated periods. However, after the shock of the 2007-2008 subprime mortgage crisis, the income and financial wealth effects have largely declined. It indicates that since the shock of the most

recent global financial tsunami, consumers' spending has responded less to the shock from income and equity price than to the same sized shock before the financial crisis. During the aftermath of the crisis, households have become more cautious with respect to their spending.

However, surprisingly, despite the stable evolution of the housing wealth effect before the 2007-2008 crisis, after the shock of the global financial crisis, the real estate wealth effect has increased substantially. The US Federal Reserve implemented a quantitative easing (QE) policy shortly after the shock of the recent financial crisis, to stimulate the economy. In fact, under such unorthodox monetary policy, the stock market in the US has picked up strongly. However, in contrast to the share market, the US real estate market still has not fully recovered after the burst of the housing bubble. Homeowners are still largely exposed to the burden of home mortgages. Therefore, households' consumption is more sensitive to the movement of the post-bubble housing price. For example, the further drop of the post-bubble property price not only implies a reduction of housing value, but also indicates that homeowners have to suffer higher loan-to-value ratios, which will increase the risk to borrowers that could arise from adverse economic conditions.

Rolling estimation of the short-run dynamics provides varied results. In particular, while both of the short-run coefficients for income and lagged income have declined after the shock of the 2007-2008 subprime mortgage crisis, the short-run financial and housing wealth effects have increased since the global financial tsunami. The impact of housing wealth on consumption is more evident than the

shock from financial wealth, which is consistent with the findings from the long-run estimation.

In short, location asymmetries across different quantiles of the conditional distribution of consumption are observed, especially since the recent 2001-2010 period surrounding the global financial crisis. In particular, it shows that the speed of adjustment for consumption towards long-run equilibrium following a wealth shock exhibited a downward trend after the 2007-2008 subprime mortgage crisis. While the financial wealth effect on consumption has dropped since the shock of financial crisis, the housing wealth effect, on the other hand, has increased markedly, which is mainly due to unequal development between the stock and real estate markets after the crisis.

Figure 5.2: Moving Window QARDL Estimation (0.25, 0.5, 0.75 quantiles)
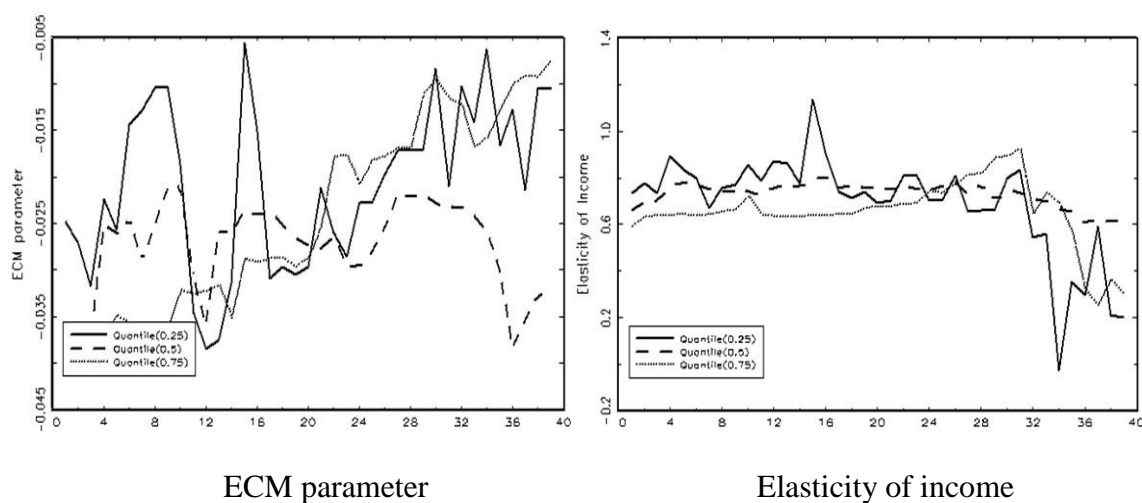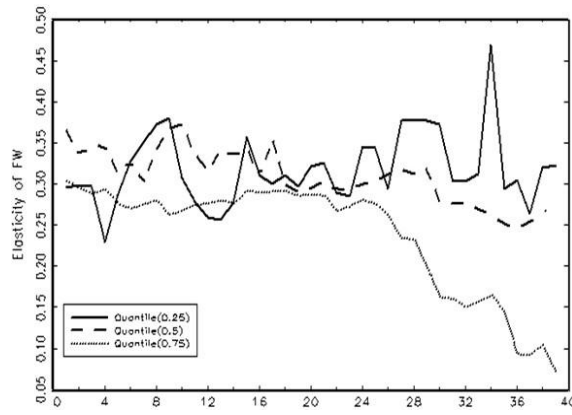
ECM parameter   Elasticity of income
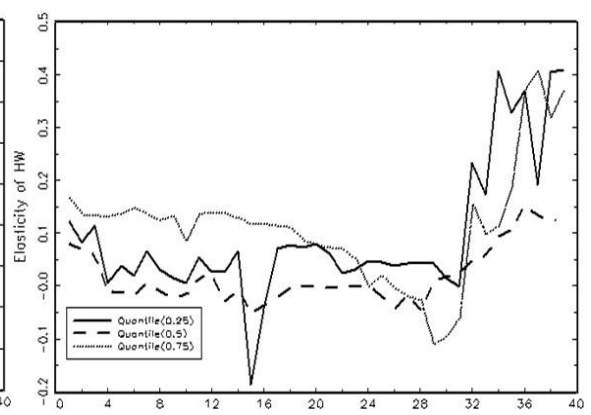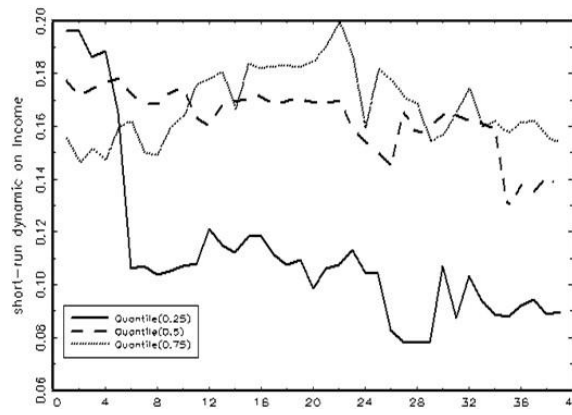
120

Elasticity of financial wealth

Elasticity of housing wealth

Short-run dynamic on income
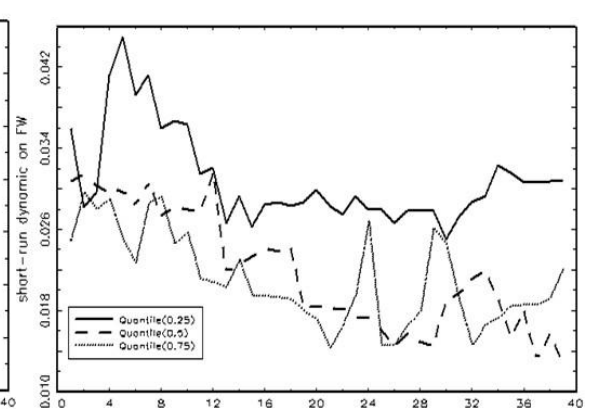
Short-run dynamic on financial wealth
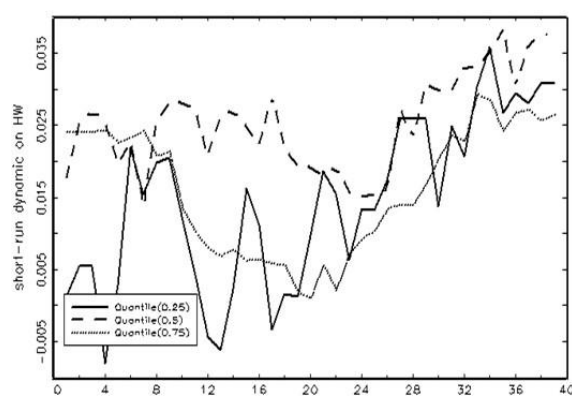
Short-run dynamic on housing wealth
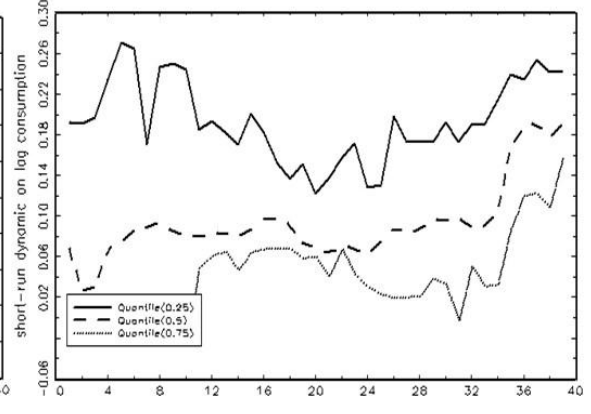
Short-run dynamic on lag consumption
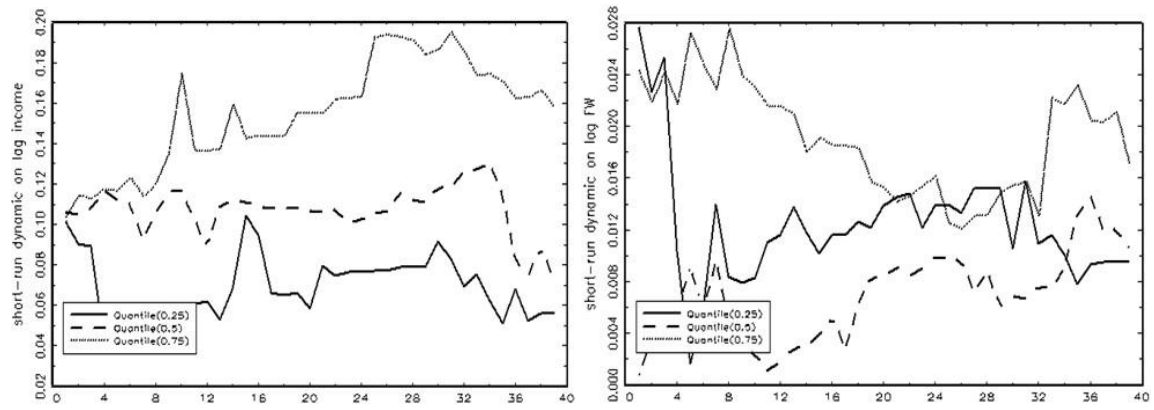
Short-run dynamic on lag income   Short-run dynamic on lag financial wealth

Note: the vertical line is the coefficient, and the horizontal line is the index number of the window (the moving window size is 196 quarters in this case).

5.5 Conclusion

This chapter re-examines wealth effects on consumption by using QARDL estimation and inference. Instead of relying on a single measure of conditional central tendency like the conventional cointegration methods, this approach enables us to explore the relationship between consumption and wealth with quantile-varying cointegrating coefficients.

This chapter provides evidence that there exists a long-run cointegrating relationship between consumption, income, financial and housing wealth, but under the framework of quantiles characterised by differing speeds of adjustment. This study also estimates the long-run and short-run parameters for consumption, income and wealth, and shows that there is strong evidence of location asymmetries between lower and medium-to-higher quantiles for most of the parameters. In particular, the wealth effects on consumption are stronger in the lower quantiles than the higher quantiles.

By using time-varying rolling QARDL estimation, important time-varying patterns for the relationship between consumption and wealth are observed. In particular, after the shock of the 2007-2008 subprime mortgage crisis, while the financial wealth effect on consumer spending has dropped, the housing wealth effect has increased substantially.

These findings have important implications for the effectiveness of tax and other policies that can impact on wealth. Understanding the heterogeneity in consumption behaviour is fundamental to grasping the different impacts of financial and housing wealth shocks. Moreover, due to the different behaviour of financial and housing wealth effects after the recent global financial crisis, it is crucial to implement macro-prudential regulations along with monetary policy to ease adverse effects on financial or housing markets in response to the same monetary decision.

CHAPTER 6: CONSUMPTION AND WEALTH: DOES HAVING A MARKET- OR BANK-BASED SYSTEM MATTER?

6.1 Introduction

Many studies have investigated the effect of asset price movements on consumer spending, using different datasets (macro-economic aggregate time series data versus micro-economic household-level survey data) and econometric methods (single equation models against system equations techniques). Most of these studies have focused on advanced economies such as the United States, where data is more readily available. These empirical studies normally find evidence of a positive and significant long-run relationship between wealth and consumption (see Mehra, 2001; Lettau and Ludvigson, 2001&2004; Kishor, 2007).

However, as Chapter 4 indicated, there might be only a weak cointegrating relationship between consumption, income, financial and housing wealth in the US if we consider the dramatic boom and bust cycles of stock and housing markets in the last decade. It is of interest to find out if this is the case on the international level, especially for industrialized countries, because both the US and other developed countries have experienced downturns since the recent global financial crisis.

This chapter will use panel datasets to provide further empirical evidence to the macro data literature of wealth effects on consumption. While most of the aggregate data literature emphasises the US and UK market, few studies have

been done on the effect of financial and in particular of housing wealth on consumer expenditure internationally. Moreover, most of the multi-country studies on the wealth effect do not cover the time period of the current financial crisis. The principal reason is the lack of up-to-date data on financial and housing wealth at international level. This chapter will use the improved international dataset to estimate the wealth effect on consumption. The international data set is more comprehensive and covers a wider spectrum of geographic variation. Furthermore, the panel data used in this thesis is at quarterly frequency, which allows more precise estimates of the magnitude of the wealth effects on consumption. In terms of econometric modelling, panel data can provide higher test power than time-series data that raise the likelihood of rejecting the null hypothesis of non-cointegration, because the panel data set is larger, thus helping to avoid Type II errors. Panel data techniques are also much more flexible and allow us to distinguish between long-run and short-run relationships in the data.

Empirically, no consensus has been reached with respect to the existence of a stable long-run relationship between consumption, income and wealth at the multi-country level. On the one hand, some studies show that there is a significant long-run cointegrating relationship between consumption, income and wealth (see Ludwig and Slok, 2004; Ciarlone, 2011; De Bonis and Silvestrini, 2012); while on the other hand, some studies indicate that the cointegration evidence between consumption and wealth is ambiguous (Dreger and Reimers, 2006; Skudelny, 2009; Slacalek, 2009).

Since the empirical results with regard to the long-run cointegrating relationship between consumption, income and wealth based on panel data are inconclusive,

this chapter will revisit this issue and provide new evidence from a set of 14 OECD countries using the most recent available data. In contrast to the time-series data of the US market in Chapter 4 and 5, OECD economies have exhibited different degrees of resilience over the recent cyclical downturn, in the sense that some were better than others at weathering and recovering from a set of common shocks.

In addition, the debate between market-based and bank-based financial systems has also been the focus of substantial recent attention in the empirical literature especially after the global financial crisis in the late 2000s. Size, activity, and efficiency of various components of the financial system as well as national regulations on capital markets have normally been estimated to compare the difference between these two financial systems (Levine, 2002; Benito, 2005; Lee, 2012). However, most of these theoretical and empirical discussions on the difference between market- and bank-based systems have focused on the linkage between financial systems and economic growth, which is not directly relevant to the wealth effect on consumption. This chapter, on the other hand, will examine the wealth effect differences between market-based and bank-based economies to contribute to this debate.

In particular, it is commonly believed that household consumption might respond more to the wealth changes in market-based nations for two reasons (Edison and Slok, 2002). First, households in market-based countries have a higher share of their wealth in financial assets. Moreover, the degree of stock market capitalization is also higher in market-based nations (see Demirguc-Kunt and Levine, 1999 and Levine, 2002), and households are able to gain access to deeper

financial systems with more instruments that can provide better access to their wealth. Second, it is easier for households in market-based countries to borrow against their assets (e.g. housing equity withdrawal). Therefore, it is interesting to see if both financial and housing wealth effects are stronger in countries that have a more market-based financial system.

The research on wealth effect differences between these two groups of countries is very limited. To my knowledge, only Ludwig and Slok (2004) and Slacalek (2009) have investigated the different wealth effects on consumption between market-based and bank-based economies. Compared to their reports, this study offers several improvements. First, in terms of panel econometric methodology, more advanced second generation panel unit root and cointegration tests, which provide higher test power and also better address the cross-sectional dependence issue, are employed in this chapter. It is crucial to control for cross-sectional dependence in panel data, because variables like consumption and wealth are expected to be cross-sectionally correlated due to regional and macroeconomic linkages, such as common global financial shocks (e.g. the 2000-2001 dotcom bubble burst and 2007-2008 subprime mortgage crisis), shared global institutions (OECD, WTO, and IMF), and local spillover effects between regions or nations (Liddle and Lung, 2013). Without considering the issue of cross-sectional dependence, standard estimation methods may produce inconsistent parameter estimates and incorrect inferences (Kapetanios et al., 2011). In contrast, Ludwig and Slok (2004) and Slacalek (2009) assume that the cross section units are largely independent.

Second, this chapter applies unit root and cointegration tests to each of the groups of nations to compare the different stationary and cointegrating properties

between the two panels. Such separate estimation will provide important and different implications for further long-run coefficient investigation between market-based and bank-based nations. For instance, if one of the sub-samples exhibits mean reversion or no cointegration, then the following long-run estimation which is based on the cointegrating relationship will be biased.

Third, this chapter presents significant information on the housing wealth effects between market-based and bank-based markets. Moreover, it finds that real estate wealth effects are larger than stock market wealth effects for both market- and bank-based nations. Ludwig and Slok (2004) fail to detect such significant housing wealth effects, while Slacalek (2009) identifies a smaller housing wealth than financial wealth effect. One possible reason might be that their study period does not account for the remarkable development of real estate markets in very recent years. Therefore, another contribution of this chapter is that the sample period of this study covers the dramatic upward development of the housing market in the early 2000s as well as the collapses in property prices during the late 2000s due to the financial turmoil.

The last contribution of this chapter is related to the housing price dataset that is being used. According to Paiella (2009), evidence of a housing wealth effect on consumption is very scarce and inconclusive, mainly due to data deficiencies: different studies tend to construct real estate wealth in different ways. This chapter will use the housing price dataset from the Federal Reserve Bank of Dallas to detect the housing wealth effect. Compared to other housing price databases such as the Bank for International Settlements (BIS) or OECD, this dataset selects the most similar sources from different countries and documents

their differences to clarify the extent to which international sources can be made comparable for empirical research purposes (Mack and Martinez-Garcia, 2011).

The rest of the chapter is organized as follows. Section 6.2 provides a brief review of the empirical literature. Section 6.3 describes the data and methodology. Section 6.4 presents the empirical procedures and results. The last section (Section 6.5) concludes the chapter.

6.2 Literature Review

As introduced in Chapter 4, most of the wealth effect studies have concentrated on the US market. Multi-country studies, on the other hand, are quite limited.

Some studies show that there is a cointegrating relationship between consumption, income and wealth. For example, Ludwig and Slok (2004) employ Pesaran et al. (1999)'s likelihood-based pooled mean group (PMG) estimation procedure to detect the stock and house price effect on consumption in 16 OECD countries. They find a significant positive stock price effect on consumer spending, but an insignificant house price effect. Furthermore, they also show that the impact of asset prices on consumption is stronger for market-based nations than bank-based economies.

De Bonis and Silvestrini (2012) also employ Pesaran et al. (1999)'s PMG method to study the effect of household financial and housing wealth on consumption in 11 OECD countries from 1997 to 2008. They measure not only the effect of total financial wealth on consumption, but also the impact of a subset of those financial assets such as quoted share, mutual funds, and insurance technical reserves that

are more linked to the Stock Exchange and find that the influence of net financial assets is stronger than that of housing assets. They show that all the variables in the panel are non-stationary and cointegrated.

Moreover, Ciarlone (2011) examines the housing and financial wealth effect on consumer spending in a panel of 17 emerging nations from Asia and Central and Eastern Europe based on the PMG approach. He also shows that households' consumption, income and the two measures of real and financial wealth – proxied by house and stock market prices – are cointegrated, with the effect of house prices exceeding the influence from stock prices. Furthermore, he finds that the long-run impact of the rise in house price is generally larger in Central and Eastern European countries than in Asian economies.

On the other hand, some other researchers state that the cointegration evidence between consumption, income and wealth is ambiguous. Dreger and Reimers (2006) examine the long run relationship between private consumption and disposable income for a sample of EU countries. They show that the evidence on cointegration is ambiguous. Moreover, the cointegration vector obtained by efficient estimation methods is not consistent with theoretical reasoning, as it reflects a decline in the savings rate over time. In addition, the MPC out of financial wealth is in the range of 3-5%.

Skudelny (2009) studies the wealth effect in the euro area by using two macro-datasets. One is for the aggregate euro area for the period 1980-2006, and the other is for the individual euro area countries from 1995 to 2006, using panel data techniques. Again, only weak cointegration evidence is found in his study. The results from the euro area aggregate data show the MPC out of financial wealth is

between 2.4 and 3.6 cents, while the panel data estimation is quite low (0.6 to 1.1 cents), meaning that only 0.6 to 1.1 cents will be spent on consumption due to one euro increase in financial wealth. Nevertheless, the MPC out of nominal housing wealth is smaller than the financial wealth effect, lying between 0.7 to 0.9 cents.

Slacalek (2009) follows the methodology introduced by Carroll et al. (2006) based on the sluggishness of consumption growth to measure the financial and housing wealth effect in 16 countries. He also finds mixed evidence on the existence of a stable cointegrating relationship between consumption, income and wealth. He shows that the effect of housing wealth is smaller than that of financial wealth for most countries, but not for the U.S. and the U.K. Moreover, he finds that the wealth effects are much higher in market-based, Anglo-Saxon and non-euro area economies with more developed mortgage markets.

The above empirical evidence indicates that no consensus has been achieved on the stable long-run relationship between consumption, income and wealth, which suggests it is valuable to revisit this topic using more advanced panel data techniques with higher power, and also better addressing the cross-sectional dependence issue.

6.3 Data and Methodology

6.3.1 Data

As introduced in Chapter 3, the dataset consists of a balanced panel of 14 OECD countries. These countries are Australia, Canada, Netherlands, Sweden, Switzerland, the U.K., the U.S., Belgium, Denmark, France, Finland, Germany,

Italy and Spain. The first seven countries are referred to as market-based nations and the latter seven countries are treated as bank-based economies based on the criteria provided by Levine (2002). Total consumption, disposable income, stock and housing price indices will be used in this chapter.

6.3.2 Methodology

This chapter employs a four-stage procedure to examine this long-run equilibrium relationship for a sample of 14 OECD countries. First, the cross section dependence (CD) test developed by Pesaran (2004) is used to determine whether dependence is present in the panel data. If the panel members are correlated to each other, it is necessary to apply panel unit root and cointegration tests that can address the cross-sectional dependence issue to investigate the long-run relationship. Second, Pesaran (2007)'s (CIPS) panel unit root test that is robust to the existence of cross-section dependence in a panel is used to ascertain the order of integration of the variables. The IPS test of Im et al. (2003) will also be implemented for the purpose of comparison. Third, the conventional Pedroni (1999, 2004) panel cointegration procedure is applied to test the long-run cointegrating relationship. The Westerlund (2007) test, which is approved to better handle the issue of cross-sectional dependence, will be employed to carry out robustness checks. Fourth, the panel dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) approaches suggested by Pedroni (2001) are used to estimate the wealth effects.

6.4 Empirical Procedures and Results

6.4.1 Pesaran (2004) CD Test

If there is cross-sectional dependence in the panel data, then conventional unit root and cointegration tests which fail to account for cross-sectional dependence will provide biased results. Therefore, in the first stage, the Pesaran (2004) CD test, which tests the null hypothesis that shocks affecting the panel series are independent, is used to detect such cross-sectional correlation among the panel members.

The Pesaran CD test can be used to examine the general unspecified error cross-sectional dependence and does not need the specification of a spatial weighting matrix. The CD test statistic can be expressed as:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \widehat{\rho}_{ij} \right) \qquad (6.1)$$

where

$$\widehat{\rho}_{ij} = \sum_{t-1}^{T} \frac{\widehat{\varepsilon}_{it} \widehat{\varepsilon}_{jt}}{\left(\widehat{\varepsilon}_i' \widehat{\varepsilon}_i \right)^{1/2} \left(\widehat{\varepsilon}_j' \widehat{\varepsilon}_j \right)^{1/2}} \qquad (6.2)$$

where $\widehat{\varepsilon}_i$ and $\widehat{\varepsilon}_j$ are the (T × 1) vectors of estimated residuals from the augmented Dickey Fuller (ADF) regression equation for each cross-sectional member. All lag lengths are determined using the SIC. The Pesaran CD test shows less size distortions than the standard Lagrange multiplier test based on squared correlation coefficients and can be applied to a large number of dynamic heterogeneous panel data models with short T and large N.

Table 6.1 reports the CD test statistics for both the full sample of 14 OECD countries and the sub-groups of market-based and bank-based nations. It can be clearly seen that the null hypothesis of cross-sectional independence is strongly rejected throughout. Accordingly, this chapter will take cross-sectional dependence into account in testing for unit roots and cointegration.

Table 6.1: Pesaran (2004) Test (CD Test)

Variables	All countries		Market-based nations		Bank-based nations	
	CD-test	p-value	CD-test	p-value	CD-test	p-value
Consumption	109.35***	0.00	52.74***	0.00	52.57***	0.00
Income	60.72***	0.00	20.68***	0.00	39.19***	0.00
Stock price	101.47***	0.00	53.67***	0.00	46.11***	0.00
House price	56.44***	0.00	33.01***	0.00	18.28***	0.00

*, **, *** indicate 10%, 5% and 1% significance levels, respectively

The null hypothesis is that of no cross sectional dependence: CD - N (0, 1)

6.4.2 Panel Unit Root Tests

Before determining whether consumption, income, stock and housing wealth are cointegrated, it is necessary to assess the unit root properties of these variables. Im et al. (2003) developed the IPS test, which allows for a heterogeneous autoregressive unit root process across cross-sections by testing a statistic that is the average of the ADF statistics for each cross-sectional unit, and has been widely used to determine the stationarity for panel data. Nevertheless, the IPS test is only valid under the assumption of no cross-sectional dependence in the data. In the case of the existence of cross-sectional correlation due to common stochastic trends or shocks, the IPS test will provide undesirable results. For instance, under

cross-sectional dependence, it is inappropriate to use the standard normal distribution for the IPS test, because it will lead to size distortion and incorrect acceptance/rejection of the joint null.

Pesaran (2007) develops a second-generation panel unit root test to relax this independence assumption by augmenting the conventional ADF equation with cross-sectional averages of lagged levels and first differences of the series to filter out the effect of an unobserved common factor:

$$\Delta y_{t,i} = \alpha_i + \gamma_{1i} y_{t-1,i} + \gamma_{2i} \bar{y}_{t-1} + \gamma_{3i} \Delta \bar{y}_{t-1} + \varepsilon_{t,i} \qquad (6.3)$$

where $\bar{y}_{t-1}$ is the cross-sectional averages of lagged levels, and $\Delta \bar{y}_{t-1}$ is the first differences of the means. Individual cross-sectional augmented ADF statistics (CADF) can be calculated from Equation 3.1, which are then averaged to obtain the cross-sectional augmented IPS test statistics (CIPS).

The CIPS test results are provided in Table 6.2. The model is estimated both with and without a time trend. IPS test results are also presented for the purpose of comparison. Optimal lag length selection is based on the Schwartz Information Criterion (SIC).   With regard to the IPS test statistics, most of the variables for the whole sample of 14 OECD countries are nonstationary whether include a trend or not, except for stock prices. Stock prices are nonstationary if no trend is included. However, if a time trend is added into the model, then the stock prices show trend stationary at the 5% significance level. The study further examines the stationarity of the variables for both market-based and bank-based countries. This time, all four variables (including stock prices) for market-based nations are nonstationary. Nonetheless, the share prices for bank-based markets still exhibit

trend stationary. It implies that stock price mean reversion may exist in bank-based markets. In fact, it is still controversial whether stock prices follow a random walk or a mean reverting process, so there is still a debate on the efficient market hypothesis (EMH). Most of the existing literature fails to reject the null of non-stationarity (Chaudhuri and Wu, 2003; Narayan and Narayan, 2007; Narayan and Prasad, 2007) and concludes that stock prices follow a random walk. One key reason for this finding is the low test power of conventional linear unit root tests if the behaviour of stock prices is in fact governed by nonlinearities driven by factors such as market frictions, institutional constraints, and transaction costs. After accounting for nonlinearities such as allowing for the presence of market frictions and structural breaks, Lim and Liew (2007), Chen and Kim (2011), and Shen and Holmes (2014 & forthcoming), on the other hand, have found that stock prices are indeed stationary, meaning that the efficient market hypothesis (EMH) might be invalid.

The results of the CIPS test are similar to the findings from the IPS test. That is, all the variables are confirmed to be non-stationary, except the stock price for bank-based countries. This implies that the stock markets in bank-based countries are inefficient, while the efficient market hypothesis (EMH) may still hold for market-based countries. One possible explanation for such differences between market- and bank-based countries is that investors are less actively involved in stock trading in bank-based nations, which will lead to a lower trading frequency and volume. Thus the stock price in bank-based systems may not fully incorporate all the available information due to a lack of trading. Moreover, institutional and psychological factors such as restrictions on mutual funds exchanges, investor loss aversion, and capital gains tax treatment may also contribute to the inefficient

share markets in bank-based systems. The results also imply that previous panel cointegration evidence for bank-based nations might be spurious due to the mean reversion in bank-based stock markets.

Table 6.2: Panel Unit Root Tests (Im et al., 2003 and Pesaran, 2007)

Variables	All countries		Market-based nations		Bank-based nations	
IPS test	No trend	With trend	No trend	With trend	No trend	With trend
Consumption	3.00	0.35	3.40	0.60	0.84	-0.11
Income	1.59	1.96	0.87	1.91	1.38	0.86
Stock price	0.87	-1.84**	0.64	-0.64	0.58	-1.96**
House price	1.88	-0.77	1.66	0.00	1.00	-1.09
CIPS test						
Consumption	-0.29	2.08	2.52	3.90	-1.09	-0.30
Income	1.39	3.41	3.38	3.00	-0.63	1.02
Stock price	-2.42***	-1.70**	-1.02	-0.43	-1.72**	-2.15**
House price	1.22	2.78	2.40	3.04	0.09	1.65

IPS and CIPS denote Im et al. (2003) and Pesaran (2007) tests, respectively

*, **, *** indicate 10%, 5% and 1% significance level, respectively

Optimal lag length selection is based on SIC

Critical values for IPS and CIPS test at 1%, 5%, 10% significance level: -2.33, -1.64, -1.28

Note: t-bar statistics for IPS and CIPS test are standardized to obtain Z[t-bar] which has a normal distribution

6.4.3 Panel Cointegration Tests

Panel cointegration tests are further employed to detect long-run equilibrium relationships between consumption, income, stock and housing wealth. A widely used test for cointegration in panel data was constructed by Pedroni (1999, 2004). The Pedroni panel cointegration test allows the investigation of heterogeneous panels, in which individual specific short-run dynamics, individual specific fixed

effects, deterministic trends and individual specific slope coefficients are permitted.

Following Pedroni (1999), the panel cointegration regression can be estimated as:

$$y_{t,i} = \alpha_i + \rho_i t + \beta_{1i} x_{t,1i} + \ldots + \beta_{Mi} x_{t,Mi} + \varepsilon_{t,i} \tag{6.4}$$

where t=1,…T; i=1,…N; m=1,…M. Here T refers to the number of observations over time, N is the number of individual countries in the panel, and M represents the number of regressors.

Seven residual-based statistics can be calculated, which are the panel variance ratio (v) statistic, the panel Phillips-Perron (PP) rho-statistic, the panel PP t-statistic, the panel augmented Dickey-Fuller (ADF) t-statistic, the group PP rho-statistic, the group PP t-statistic, and the group ADF t-statistic.

The first four statistics are based on pooling the residuals of the regression along the within-dimension of the panel, and test the null hypothesis of no cointegration: H_0: $\theta_i = 1$ for all i where θ_i is the autoregressive coefficient of the residual from the regression. The alternative hypothesis is H_1: $\theta_i = \theta < 1$ for all i's, where it assumes a common value for θ_i's. The last three statistics are based on pooling the residuals of the regression along the between-dimension of the panel, and also test the null hypothesis of no cointegration: H_0: $\theta_i = 1$, but against the alternative hypothesis H_1: $\theta_i < 1$, where no common value for the autoregressive coefficient is presumed. Among the seven test statistics, only the panel v-statistic rejects the null hypothesis of no cointegration with large positive values while the remaining test statistics need larger negative values to reject the null, because the panel v-

statistic diverges to positive infinity, and consequently the right tail of the normal distribution is used to reject the non-cointegration null. Furthermore, the power of each statistic varies with the sample size and the data generating process.

In addition to the Pedroni (1999, 2004) test, this study will also apply the second generation panel cointegration test of Westerlund (2007) to check the robustness of the Pedroni test results. In contrast to the Pedroni test that relies on the testing of the unit root properties of the residuals, the Westerlund test focuses on the significance of the error-correction parameter. The Westerlund test has been shown to provide better size accuracy and higher power than the Pedroni test because the Pedroni test ignores potentially valuable information by imposing a possibly invalid common factor structure on the residuals while the Westerlund test allows for completely heterogeneous residual dynamics. Furthermore, the Westerlund test allows for the heterogeneous specifications of both the long-run and short-run coefficients of the error correction model, and also simulates the finite sample distribution of each test statistic through bootstrapping to allow for cross-sectional dependence.

In a simple case of two variables, the Westerlund error correction model can be represented as:

$$\Delta y_{t,i} = \alpha_i' d_t + \delta_i y_{t-1,i} + \varphi_i' x_{t-1,i} + \sum_{j=1}^{p_i} \delta_{ij} y_{t-j,i} + \sum_{j=0}^{p_i} \gamma_{ij} x_{t-j,i} + \varepsilon_{t,i} \qquad (6.5)$$

where δ_i measures the speed of adjustment towards the long run equilibrium. If -2 $< \delta_i < 0$, then the two variables are cointegrated. In contrast, if $\delta_i \geq 0$, then there is no cointegration.

Westerlund (2007) proposes four test statistics to determine the cointegration. Two pooled panel statistics are used to test the alternative hypothesis that the panel is cointegrated as a whole (P_a and P_t) by estimating on data pooled across cross-sections. The other two group mean statistics are used to test the alternative that there is at least one individual member of the panel that is cointegrated (G_a and G_t) by estimating separately across panel units.

Table 6.3 present the test statistics for both Pedroni and Westerlund panel cointegration tests along with their *p*-values. In terms of the Pedroni test, it shows that for the whole sample of 14 OECD countries, the null of no cointegration can only be rejected by one out of the seven test statistics at the 5% significance level. It indicates that there is a very weak cointegrating relationship between consumption, income, stock price and house price for the entire sample of 14 OECD nations.

This chapter also tests the cointegration for market-based and bank-based nations separately. For the market-based economies, four out of the seven test statistics can reject no panel cointegration at the 5% significance level. Nevertheless, the two most powerful test statistics, the panel ADF-stat and group ADF-stat[4] are not able to reject the non-cointegration null at the 5% significance level. As a result, only a weak cointegrating relationship is apparent for market-based countries. With respect to the bank-based markets, however, none of the seven test statistics provides significant evidence. Bearing in mind that the stock prices for bank-based countries have been shown to be mean-reverting, the cointegration result for

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[4] Pedroni (2004) showed with Monte-Carlo simulations that with small N and T, the two tests with the most power are the panel ADF-stat and group ADF-stat while the group rho-test has the least power of the seven tests and under-reject the null of no cointegration.

bank-based nations might also be biased. Therefore, the stock price variable is excluded in the model and only the cointegrating relationship between consumption, income and housing price is tested. Again, no cointegration evidence is provided.[5] A weak cointegrating relationship between consumption, income and wealth exists in market-based countries but not in bank-based economies.

Westerlund test results are further provided for the purpose of robustness checking. The Westerlund test provides stronger evidence than the Pedroni test that there is no cointegrating relationship between consumption, income and wealth, either for the whole sample or the sub-samples. For instance, neither the two pooled panel statistics nor the two group mean statistics are able to reject the null hypothesis of no panel cointegration based on the bootstrap critical values.

In summary, based on the findings from the Pedroni and Westerlund tests, it is difficult to detect any significant evidence of cointegration relationship between consumption, income and wealth for the panel data. This conclusion is in line with the evidence from Dreger and Reimers (2006), Skudelny (2009), and Slacalek (2009). In addition, this panel data result is also consistent with the time-series evidence from Chapter 4 and 5.

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[5] Test results are not reported here to conserve space but are available from the author upon request.

	All countries		Market-based nations		Bank-based nations	
Pedroni test	Test statistics	p-value	Test statistics	p-value	Test statistics	p-value
Panel v-stat	-0.23	0.59	1.09	0.14	-0.93	0.82
Panel rho-stat	-0.55	0.29	-2.43***	0.00	0.86	0.80
Panel pp-stat	-0.97	0.17	-2.46***	0.00	0.63	0.74
Panel adf-stat	-0.01	0.50	-1.31*	0.10	0.88	0.81
Group rho-stat	-1.15	0.13	-2.54***	0.00	0.92	0.82
Group pp-stat	-1.90**	0.03	-2.98***	0.00	0.29	0.61
Group adf-stat	-0.57	0.28	-1.12	0.13	0.31	0.62
Westerlund test						
G_t	0.93	0.75	0.94	0.80	0.37	0.57
G_a	1.58	0.89	0.90	0.78	1.34	0.89
P_t	0.68	0.77	0.87	0.83	0.18	0.65
P_a	1.14	0.87	0.79	0.84	0.82	0.84

*, **, *** indicate 10%, 5% and 1% significance level, respectively

Optimal lag length selection is based on SIC

Critical values for Pedroni test at 1%, 5%, 10% significance levels: -2.33, -1.64, -1.28

Critical values for Westerlund test are based on 1000 bootstraps.

Note: test statistics for Pedroni and Westerlund test are standardized to obtain Z[t-bar] which has a normal distribution

6.4.4 Panel DOLS- and FMOLS-Based Tests

Finally, Panel DOLS and FMOLS procedures proposed by Pedroni (2001) are implemented to estimate the so-called wealth effects for the cointegrated series.

The DOLS has the advantage that it obviates potential simultaneity bias among regressors by augmenting lead and lagged differences of the regressors to the long-run equilibrium model in Equation 6.4. The DOLS approach also handles the small sample bias among regressors.

The FMOLS procedure applies non-parametric adjustment to the OLS estimates of both the long-run coefficient parameter β_i and the associated t-statistic, which corrects for the potential autocorrelation or endogeneity bias that shows up in the

OLS residuals (Phillips and Hansen, 1990). Moreover, the FMOLS also asymptotically eliminates sample bias[6].

The panel DOLS- and FMOLS-based test results are reported in Table 6.4. Since there is almost no significant evidence of cointegration between consumption, income and wealth for all the samples, only the estimation based on the first-differenced data will be provided. The results from Table 6.4 show that for all cases, the conclusions of the Panel DOLS and FMOLS are in agreement. In particular all the independent variables have significant positive effects on consumption, whereas the coefficient estimates for house prices are higher than the estimates for stock prices for all the samples. The housing wealth effect is identified as being larger than the stock market wealth effect.

In terms of the comparison between the two sub-groups of countries with different financial systems, the tests indicate that the wealth effects are stronger for market-based countries, regardless of the different wealth components. One main reason that the wealth effect is higher in market-based economies may be that market-based nations normally have more efficient equity and mortgage markets. For instance, households in market-based countries are more actively involved in the share markets and have higher stock ownership rates than those in bank-based economies. In addition, due to the high availability of mortgage equity withdrawal and the ease of early mortgage refinancing, it is easier and less costly to borrow against properties in market-based countries. Therefore, consumer spending in market-based economies may experience higher impacts from fluctuations in both stock and real estate markets.

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[6] For more in-depth details on the panel DOLS and FMOLS estimator for the coefficient β_i refer to Pedroni (2001).

Table 6.4: Panel DOLS and FMOLS Estimation

Regressors	All countries Coefficients	Market-based nations Coefficients	Bank-based nations Coefficients
Panel DOLS	First-diff	First-diff	First-diff
Income	0.300***	0.224***	0.359***
Stock price	0.020***	0.025***	0.017***
House price	0.115***	0.128***	0.085***
Panel FMOLS			
Income	0.228***	0.152***	0.391***
Stock price	0.012***	0.016***	0.011***
House price	0.119***	0.128***	0.094***

Note: Dependent variable is Consumption

*, **, *** indicate 10%, 5% and 1% significance level, respectively

Optimal lag length selection is based on SIC

6.5 Conclusion

This chapter employs second generation panel unit root and cointegration tests, which provide higher testing power and better ability to address cross-sectional dependence issues, to investigate the relationship between consumption, income, stock and housing wealth for a panel of 14 OECD countries as well as two sub-groups of nations with different financial systems. Due to the data limitations, stock price and house price indices are used as proxies for financial and housing wealth.

Most of the variables are found to be nonstationary as expected, apart from stock prices in bank-based countries. Moreover, weak evidence of cointegration is identified in market-based nations but not in bank-based economies. This partially explains why some of the previous multi-country studies fail to find a significant long-run cointegrating relationship between consumption, income and wealth. This chapter further shows that the housing wealth effect is larger than the

financial wealth effect for both market- and bank-based nations. These findings are consistent with majority of the time-series and panel data evidence due to the fact that housing wealth has been the most stable and largest component of personal wealth for most of the households. Finally, the two types of private wealth are shown to have larger impacts on consumption in market-based countries.

Some of the results provide important implications for both academic researchers and policy-makers. First, stock prices for bank-based countries show mean reversion, which implies that the efficient market hypothesis (EMH) might not hold in bank-based markets. Second, if stock prices were erroneously treated as nonstationary, cointegration results for stock prices and other $I(1)$ variables would be spurious. It indicates that previous results of cointegration tests in the literature that involve stock prices from bank-based countries might be biased. Third, no cointegrating relationship exists for consumption, income, and wealth in bank-based economies, either including or excluding the stationary stock price series. This provides the second reason why previous significant cointegration results as well as associated long-run coefficient estimations in the literature that test for a panel of countries including bank-based nations may be inefficient. Fourth, wealth effects are observed to be stronger in market-based countries, and high positive wealth effects will stimulate consumer spending, which in turn contributes to the GDP. However, policy makers should still prevent a recurrence of bubble-like increases followed by crashes in both equity and housing prices as has been the case over recent years, because the decline of capital markets has more severe adverse impacts on households' expenditure in market-based economies than in bank-based nations. For example, the recent global financial crisis has hurt the

financial and housing markets more severely in market-based nations such as the United States, whereas in bank-based countries like Germany it has had less influence.

CHAPTER 7: WEALTH EFFECTS AND CONSUMPTION: A PANEL VAR APPROACH

7.1 Introduction

Chapter 6 suggests that there might be only a very weak cointegrating relationship between consumption, income and wealth for OECD countries, thus conventional long-run estimation based on level-data would be biased. This chapter further explores the short-term dynamics between consumption, income and wealth based on the first-differenced data. Several questions need to be addressed. Is the stock wealth effect larger than the net housing wealth effect? Do these two wealth effects change over time? Does consumption exhibit an asymmetric response to positive and negative stock and house price shocks?

It is vital to understand the different roles of stock and housing wealth when undertaking appropriate policy responses to asset price shocks. In the presence of a shock that raises asset prices and the prospect of economic volatility, policy makers face a dilemma. Should they adopt a monetary policy that affects asset markets broadly, or should they distinguish between asset classes and adopt a more targeted approach? An example of a targeted approach involves the current attention to macro prudential regulations in a number of OECD countries. The regulations are designed to reduce house price volatility specifically, since this asset class may offer greater risk than other, competing asset classes.

Theoretically, it is unclear whether there is a difference between the effect of stock and housing prices on consumption (and therefore others areas of policy interest). According to the life-cycle hypothesis (Ando and Modigliani, 1963), an increase

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in stock or housing wealth should have the same positive effect on consumption because the MPC out of wealth is slightly larger than the real interest rate in the long-run. However, there are alternative views that challenge the life-cycle hypothesis (Mishkin, 2007). One view argues that the housing wealth effect should be larger than the stock wealth effect because housing wealth is more widely distributed across households. For instance, in the US, more than two-thirds of households are homeowners, while only half own stocks, bonds or mutual funds (Cooper and Dynan, 2013). Another reason is that property prices have a relatively lower volatility than share prices, so changes in housing wealth might last longer than changes in stock market wealth.

There is an alternative view that real estate wealth has a smaller effect on consumption on account of the dual natural role of housing assets. In particular, the 'net housing wealth effect' is smaller because a rise in house price has both a positive wealth effect and a negative price effect on consumption (Poterba, 2000). In particular, a positive wealth effect caused by an increase in capital income may be partly offset by a negative price effect caused by an increase in the cost of housing services. Other studies show that an increase in share market valuation is more clearly related to future economic growth than changes in real estate wealth, which leads to a relatively smaller housing wealth effect.

Much of the existing literature has focused on the relationship between consumption and a single measure of wealth – either financial, non-financial, or total wealth (for example, Lettau and Ludvigson, 2001 & 2004; Ioannidis et al., 2006; Fisher et al., 2012; and McMillan, 2013). The number of studies offering a comparative assessment of stock and housing wealth effects is much more limited.

Most of the comparative work has been on a time-series basis (Kishor, 2007; Fisher et al., 2010; and Carroll et al., 2011). The evidence based on cross-country evidence is scarce and has led to ambiguous conclusions. For example, studies which find that the stock wealth effect is the larger include Ludwig and Slok, 2004, Skudelny, 2009, De Bonis and Silvestrini, 2012, while studies such as Case et al., 2005, Carroll et al., 2011, and Ciarlone, 2011, find that the housing wealth effect is the stronger.

These ambiguous findings might be attributable to the cross-country differences in empirical estimates reflecting a failure to account for differences in the nature of the shocks to consumption and wealth. This chapter employs a Panel VAR approach based on a methodology advocated by Love and Zicchino (2006) to better address the issue of unobserved heterogeneity by correcting for fixed effects. To the best of my knowledge, there are no cross-country studies that explore decomposed wealth effects in this way. Most of the previous multi-country studies rely on a single-equation framework. However, Lettau and Ludvigson (2001, 2004) point out that unless consumer spending (and not income or wealth) does all the adjustment in response to a shock, it is important to take into account all the variables in the system. Hence, the system estimation is necessary. Indeed, the VAR model has the advantage of explicitly allowing for feedback effects from consumption to wealth or income, something that the single-equation approach cannot address. The VAR approach can also illustrate how the responses of consumption and wealth vary according to the nature of the shocks on them.

In addition, since most of the previous wealth effect estimations are based on the strong assumption of a cointegrating relationship between consumption, income

and wealth, their results would be biased if they fail to find such cointegrating relationships. In fact, Chapter 6 as well as some other studies have shown that no cointegration exists between consumption, income and wealth for some countries (see Hahn and Lee, 2001; Rudd and Whelan, 2002; Slacalek, 2004; and Benjamin et al., 2004). The existence of stationary series in the cointegrating equation would also make the cointegration relation invalid, which then produces inefficient wealth effect estimations (as has been the case in Chapter 6). For example, there are a number of studies indicating that stock price is stationary (Chaudhuri and Wu, 2004; Lean and Smyth, 2007; Narayan, 2008; Lee et al., 2010; Shen and Holmes, 2014 & forthcoming). The panel VAR model, however, will still be able to estimate the wealth effect on consumption regardless of the presence of a cointegrating relationship, due to the use of stationary series (I(0)) for all the variables in the equations.

The second aim of this chapter is to examine potential asymmetric wealth effects on consumption in terms of positive and negative price shocks. Understanding asymmetric responses can provide valuable insights into theoretical arguments (e.g. based on 'sticky' consumption). A deeper knowledge of asymmetric responses can also be useful for policy analysis if consumption and asset prices behave differently during different phases of the business cycle. Arden et al. (2000) find that after accounting for the asymmetric specifications in a large scale macroeconomic model, very different model simulations are obtained with significantly different policy implications. The asymmetric effect from wealth fluctuations has implications for wealth distribution between homeowners and renters. While most previous asymmetric wealth effect studies have concentrated on the US stock market (see Stevans, 2004; Apergis and Miller, 2005a, 2005b,

2006), the existing empirical evidence provides very limited guidance on asymmetric responses to housing price shocks. As far as I know, this chapter is the first investigation of asymmetric consumption responses to both stock and house price shocks for OECD countries based on a panel VAR model. In making a further contribution to the literature, it can be noted that there are few studies on asymmetries in consumer wealth effects over the recent global financial crisis period which cover the most significant boom-bust wealth cycle for most developed countries since the Great Depression.

This chapter is structured as follows. The next section introduces the panel VAR procedure that is employed to detect the wealth effect on consumption. Section 7.3 describes the dataset and presents the empirical results. Section 7.4 concludes and also provides policy implications.

7.2 Econometric Modelling

This chapter employs the panel VAR method developed by Love and Ziccino (2006) to examine the wealth effect on consumption by modelling the endogenous behaviour between consumption, income and wealth. The panel VAR approach inherits advantages from the traditional VAR model in that all the variables in the system are treated as being endogenous. In fact, Lettau and Ludvigson (2004) show that both consumption and wealth are endogenous, and that the conventional method which implicitly treats wealth as an exogenous variable leads to bias, since wealth also responds to underlying exogenous shocks. The panel VAR procedure also has advantages based on a panel-data framework that allows for unobserved

individual heterogeneity for all the variables by introducing fixed effects, which enhances the consistency of the estimation. In terms of the variables employed in this chapter, *TC* and *DIN* are the changes of the household total consumption and disposable income. *SP* and *HP* indicate the decomposed wealth effects from the growth rate of stock and housing, respectively. In order to distinguish between positive and negative asset wealth shocks and capture potential asymmetric wealth effects on consumption, positive and negative values of stock and house price changes are calculated to denote the positive and negative wealth shocks: *SPP* and *SPN* represent the positive and negative stock market shocks respectively, and *HPP* and *HPN* are the positive and negative housing market shocks. The panel VAR model can be specified as follows:

$$X_{t,i} = \alpha_i + \Theta(L)X_{t,i} + F_i + D_{t,c} + \varepsilon_{t,i} \tag{7.1}$$

where $\Theta(L)$ is the lag operator and $X_{t,i}$ represents a vector of four endogenous variables (*TC*, *DIN*, *SP*, *HP*) or a vector of six variables (*TC*, *DIN*, *SPP*, *SPN*, *HPP*, *HPN*). Subscripts *t* and *i* refer to time and country. F_i denotes the fixed effect and $D_{t,c}$ is the country-specific time dummy. $\varepsilon_{t,i}$ represents the vector of residuals. Following Simo-Kengne et al. (2012), this study distinguishes between positive and negative shocks which are captured respectively by positive and negative values of asset price changes. This is achieved by using two dummy variables $d_{t,i}^p$ and $d_{t,i}^n$. $d_{t,i}^p$ is set to be equal to one for the positive values of asset price changes and equal to zero for negative values. Conversely, $d_{t,i}^n$ is equal to one for the negative values of asset price changes and equal to zero for positive values. Therefore, *SPP* is computed as $d_{t,i}^p \times SP$ and *SPN* as $d_{t,i}^n \times SP$, so do *HPP*

and *HPN*. The Schwarz information criterion (SIC) is used to select the optimal autoregressive order.

When applying the VAR approach to the panel-data framework, restrictions need to be imposed to ensure that the underlying structure is the same for all the cross-sectional members. Since this constraint is likely to be violated in practice, one way to overcome the restriction on parameters is to allow for individual heterogeneity in the levels of the variables by using fixed effects denoted by F_i. However, the conventional mean-differencing approach that is commonly employed to remove the fixed effects might lead to biased coefficients because the fixed effect assumption is that the individual specific effect is correlated with the independent variables. One way to avoid this problem is the adoption of forward mean-differencing, or 'Helmert transformation' (Arellano and Bover, 1995). This 'Helmert procedure' helps to remove the forward mean which then preserves the orthogonality between transformed variables and lagged independent variables (Love and Zicchino, 2006).

The differencing might also result in a simultaneity problem since lagged regressors are correlated with the differenced error term. Also, heteroscedasticity may exist due to the presence of heterogeneous errors with different cross-sectional members in the panel data. Therefore, after the fixed effects are eliminated by differencing, an instrumental variable method using lagged regressors as instruments needs to be applied to estimate the coefficients more consistently. A panel generalized method of moments (GMM) estimator will be used for the system estimator.

The panel VAR model also allows for country-specific time dummies, denoted by $D_{t,c}$, to capture aggregate macroeconomic shocks such as the global financial crisis that may influence each country's stock and housing market in a similar way. These country time dummy variables can be removed by subtracting the means of each variable calculated for each country-year.

In Equation 7.1, $\varepsilon_{t,i}$ is the vector of error terms which is assumed to be independent and identically distributed. Nevertheless, this assumption normally fails in practice since the actual variance-covariance matrix of the residuals is unlikely to be diagonal. In other words, the innovations in the impulse-response functions may be contemporaneously correlated. In order to estimate the shocks to one of the variables in the system independently, it is important to decompose the errors to make sure that they are orthogonal. Sims (1980) proposes a contemporaneous recursive causal ordering of variables in the VAR based on their degree of exogeneity to address this issue. This approach is based on the Choleski decomposition of variance-covariance matrix of residuals to ensure the orthogonalisation of shocks. In particular, the variables that appear earlier in the ordering are more exogenous, which will affect the following variables contemporaneously or even with a lag, while the variables that come later in the systems are more endogenous and only affect the previous variables with a lag. In this chapter, the wealth shocks are ordered after consumption and income for two reasons. First, according to Lettau and Ludvigson (2004), consumption, income and wealth are all endogenously determined. However, based on system-equation estimation, they find that subsequent to an equilibrium-distorting shock, it is wealth, but not consumption or income, which adjusts to restore the long-run

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equilibrium. Therefore, wealth is relatively more endogenous than consumption and income. Second, previous evidence has shown that the asset market can react contemporaneously to all other shocks. But the variables identified before the asset market react with a lag to asset market news, so previous studies have usually ordered asset market wealth such as stock and housing last (see Patelis, 1997; Thorbecke, 1997; and Neri, 2004). In addition, Cochrane (1994) and Fisher et al. (2003) also show that consumption is weakly exogenous, so it should be ordered first[7].

Finally, in order to analyse the impulse-response functions (IRF), the estimation of the confidence intervals for the IRF is required. Since the impulse-response functions are constructed from the estimated VAR coefficients and their standard errors, Monte Carlo simulations are employed to generate confidence intervals based on the estimated coefficients and the standard errors. The fifth and 95th percentiles of the distribution of the generated coefficients from 1000 bootstraps are used as the confidence interval for the impulse responses. Variance decompositions are also presented to show how essential a shock is in specifying the variations of variables in the panel VAR model by providing the proportion of the movement in one variable that is explained by the shock to another variable over time. Compared with impulse response functions that illustrate the future direction of the variables following a shock, variance decompositions express the magnitude of the overall effect.

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[7] This chapter also considers alternative orderings. For example, placing asset wealth in front of consumption, did not lead to any qualitatively different results from the Panel VAR estimation.

7.3 Data and Results

7.3.1 Data Description

The dataset used in this chapter is the same as the one in Chapter 6 and is based on a balanced panel of 14 OECD countries. Again, total consumption, disposable income, stock and housing price indices will be employed in this chapter.

7.3.2 Empirical Results

7.3.2.1 Stock Market Wealth Effect versus Housing Wealth Effect

The hypothesis of a 'net housing wealth effect' is first tested based on the panel VAR model. Bearing in mind that Chapter 6 cannot find significant evidence of long-run cointegrating relationship between consumption, income and wealth for OECD countries, a panel VAR model is estimated in this chapter instead of a panel VECM framework. Since a rise in house price will generate both a positive capital value effect and a negative housing service effect on consumer spending, it is possible that the 'net housing wealth effect' will be smaller than stock market wealth effects if the negative housing service effect is sufficiently large. Impulse response functions[8] which provide the analysis of spillover effects are conducted to estimate the impact of unanticipated asset wealth shocks on consumers' expenditure. Figure 7.1 illustrates the response of total consumption to a unit shock in stock price growth and housing price growth respectively during the overall study period. It visually shows a hump-shaped consumption response to a financial or housing price shock. Specifically, there is a positive response of

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[8] The main focus of this chapter is on the impulse response of consumption resulting from shocks to asset wealth. Given that an optimal lag length of four is used in the GMM estimation of both the four- and six-variable VAR models, the full results for Equation 7.1 are not reported here in order to conserve space. These estimates are available from the author upon request.

consumption to stock and housing price shocks which peaks after one quarter and then gradually returns to the baseline over three quarters. The hump-shaped consumption response might be explained by the work of Caliendo and Huang (2008) who argue that over-confidence concerning the mean return on savings can produce a work-life consumption hump. Moreover, a unit shock in equity price growth has a relatively larger impact effect on consumption. This is consistent with a dual impact from housing prices and implies that the positive housing capital income effect is offset by the negative housing service effect.

Figure 7.1: Impulse Responses of Consumption to Asset Wealth Shock (Total Sample)
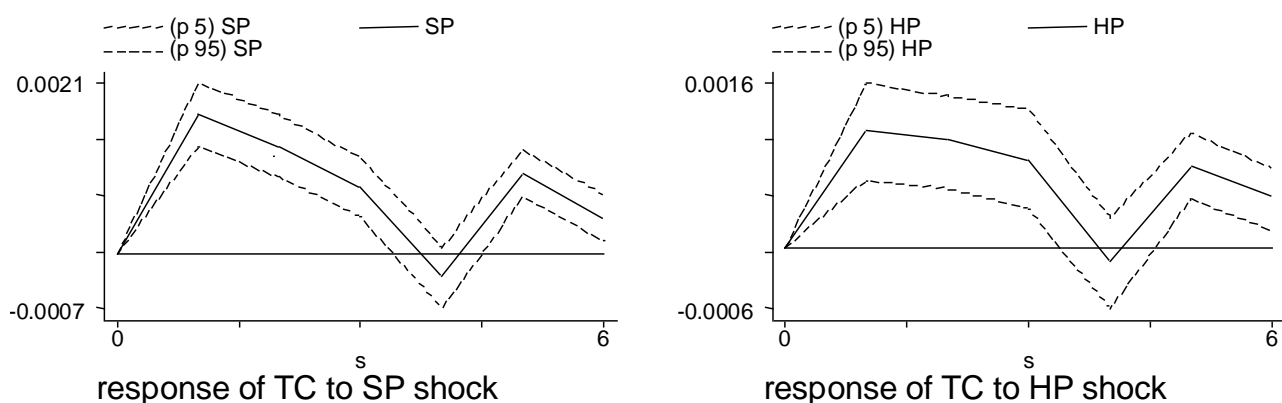
It is interesting to explore the determinants of the extent to which the positive housing capital value effect is offset by the negative housing service effect. According to Deaton and Muellbauer (1980), home ownership rate is one of the most critical determinants because the positive housing capital value effect is stronger for homeowners than for non-homeowners. In other words, the 'net housing wealth effect' will be larger if owner-occupiers account for a higher proportion of the total households. Another important determinant is the loan-to-

value ratio. According to the leverage effect, the positive housing capital value effect will be larger if the mortgage to property value ratio increases. It is then possible that the 'net housing wealth effect' will approach or even exceed the stock market wealth effect if both the homeownership rate and loan-to-value ratio are large enough. Therefore, it is interesting to see how the 'evolution' of homeownership rates and mortgage ratios has impacted the relative strengths of the positive housing value effect and the negative housing service effect. In order to explore this further, the sample is split into two sub-sample periods, 1975 to 2000 and 2001 to 2011[9].

Figure 7.2 plots the sub-period consumption response to the shocks from stock and house price changes based on the impulse response functions. It shows that for the first sub-period (1975-2000), the stock market wealth effect is larger than the net housing wealth effect, which is consistent with the result from the whole sample period. However, during the second sub-period (2001-2011), the net housing wealth effect is stronger than the stock market wealth effect. When comparing the asset wealth effects between the two sub-periods, the housing wealth effects have increased significantly over time, but this is not the case for the stock market wealth effects. One explanation for the increased impact of housing wealth effects on consumption may be the rise in homeownership rate and the loan-to-home value ratio in recent decades. Both the homeownership rate and mortgage ratio have increased for most of the OECD countries during the study period. For

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[9] This chapter sets the break at the year 2000 for two reasons. First, pretesting based on the Bai and Perron (2003) structural break test applied to each country showed that the break date across countries ranges from 1998 to 2002 if only one break date was allowed (test results are available from the author upon request). Therefore, this study chooses the mid-point of the year 2000 as the break date. Second, the housing market boom started in the early 2000s and the stock markets collapsed at the same time due to the dot-com bubble burst in 2001. Moreover, this period was also characterized by the start of the common monetary policy in 1999 and the introduction of the euro in 2002.

example, the homeownership rate in the US rose from 64.5% in 1975 to 69% in 2007. The homeownership rate in the UK also increased to 67.4% in 2010 from 54% in 1975. More importantly, there has been an even sharper increase in loan-to-value ratios. For example, the loan-to-value ratio in the US jumped from 32% in 1975 to 60% in 2010, and the most significant appreciation takes place during the most recent decade, where the mortgage ratio has risen by 54% since 2001. The loan-to-value ratios have also generally exceeded 80% in most OECD countries and even reached 100% in the Netherlands and the UK. Consequently, mortgage market innovation, along with the climb in homeownership rates, has boosted the boom in the real estate market which has then led to a stronger housing wealth effect on consumption in recent years. In addition, the 'evolution' of the housing wealth effect also implies that the consumption purpose of real estate is relatively stronger in the first sub-period, while the investment purpose of housing dominates the housing service consumption purpose since the housing market boom during the second sub-period.

Figure 7.2: Impulse Responses of Consumption to Asset Wealth Shock (Sub-samples)

1975-2000:

2001-2011:

response of TC to SP shock

response of TC to HP shock
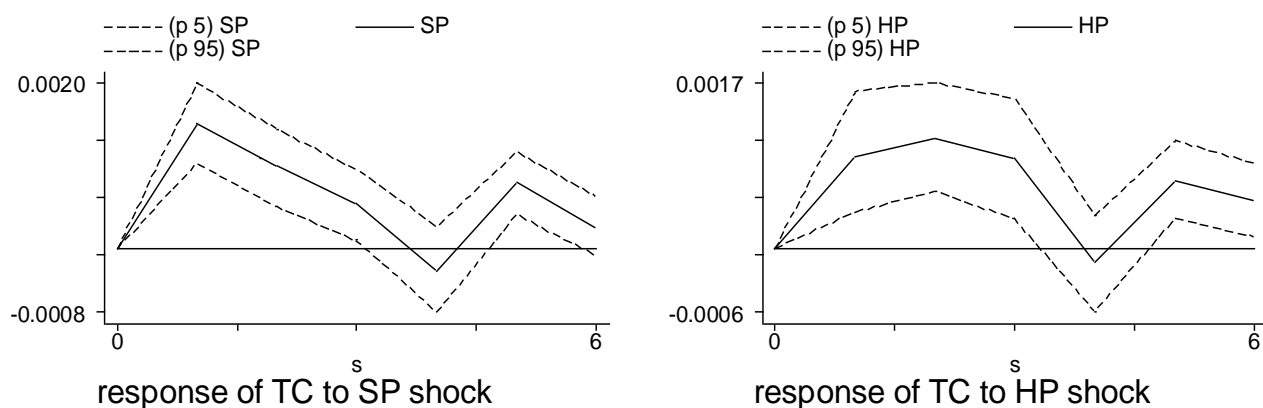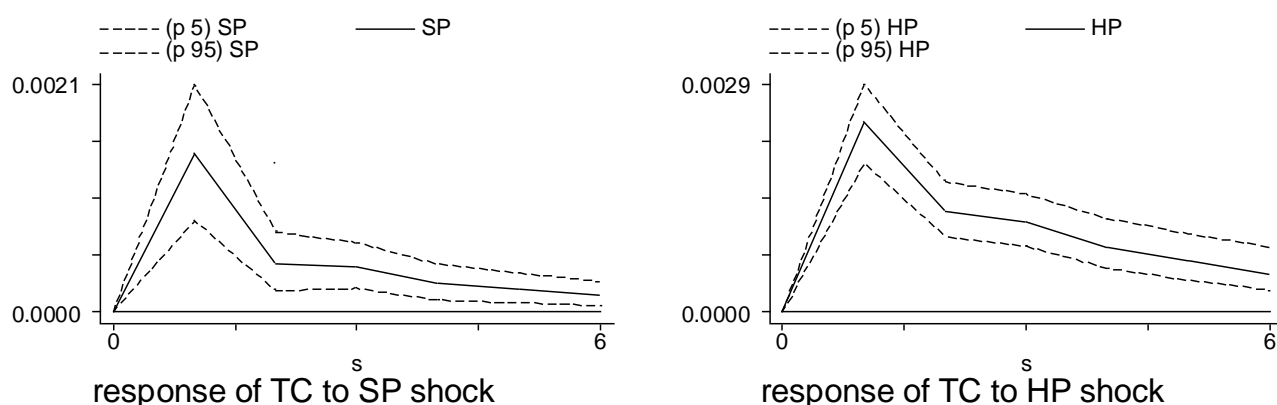
In order to compare the consumption multipliers based on the differing types of wealth shocks, the six-quarter impact effects are further tabulated in Table 7.1. Looking at the full sample period, an examination of the overall impacts from stock and housing price shocks reveals that a 5% increase in a stock price shock after one quarter leads to an increase in consumption of around 0.17%, which is larger than the corresponding impact from a housing price shock (0.11%). Both of these shocks exhibit similar effects after three quarters. In the context of the sub-period measurement, the stock price shock again is stronger at the beginning (0.15% against 0.09%) but there is no big difference in the property price shock after three quarters for the first sub-period (1975 to 2000). During the second sub-period, however, the housing price shock is in turn substantially bigger than the stock price shock at all times.

Table 7.1: The Percentage Change of Consumption to a 5% Shock to Asset Wealth

	Stock price shock			House price shock		
	1-quarter	3-quarter	6-quarter	1-quarter	3-quarter	6-quarter
TC (1975-2011)	0.17%*	0.08%*	0.04%*	0.11%*	0.08%*	0.05%*
TC (1975-2000)	0.15%*	0.06%*	0.03%*	0.09%*	0.09%*	0.05%*
TC (2001-2011)	0.15%*	0.04%*	0.01%*	0.24%*	0.12%*	0.05%*

*Note: * indicates statistical significance level of 5%.*

Forecast error variance decomposition analysis is also conducted to provide an alternative way of estimating asset price shocks on consumption as presented in the impulse response functions, where the variance decomposition focuses on the magnitude of the entire effect. Table 7.2 shows that the variance decomposition results are in line with the conclusions from impulse response functions in Figure 7.1 and 7.2. That is, the stock market wealth effect is stronger than the housing wealth effect for the whole sample (3.4% vs 2.1%). For the sub-period estimation, the stock wealth effect outweighs the real estate wealth effect during the first sub-period (2.0% vs 1.6%), while the housing wealth effect on consumption instead dominates the effect from stock market wealth in the second sub-period (10.4% vs 2.6%). Thus, there is a significant improvement in the housing wealth effect.

Table 7.2: Variance Decomposition (4-variable Panel VAR model)

	TC	DIN	SP	HP
TC (1975-2011)	92.2%	2.3%	3.4%	2.1%
TC (1975-2000)	93.2%	3.2%	2.0%	1.6%
TC (2001-2011)	86.2%	0.8%	2.6%	10.4%

The table shows the percent of variation in the row variable (10 periods ahead) explained by column variable.

To summarise so far, the evidence of a larger stock market wealth effect in general is in line with Ludwig and Slok (2004), Skudelny (2009), and De Bonis and Silvestrini (2012). It also confirms the 'net housing wealth effect' hypothesis that a positive housing price effect is partly offset by a negative housing service effect. However, in terms of the 'evolution' of the wealth effect, the housing wealth effect develops more significantly than the stock market wealth effect. Indeed, the housing wealth effect has outweighed the stock market wealth effect in the past decade.

7.3.2.2 Asymmetric Asset Price Effects

The dramatic fluctuations in both the stock and real estate markets in recent years prompt us to investigate the potential asymmetric effects of asset wealth on consumption behaviour in OECD countries. Figure 7.3 presents the impulse responses of consumer spending to a same-sized shock from both positive and negative asset price for the whole sample period. The results from Figure 7.3 show that both unexpected positive and negative shocks in stock and housing prices will have significant impacts on consumption. In particular, increases in both equity and property prices produce larger effects on consumers' expenditure than decreases in asset prices. This implies that both stock and housing price changes affect household consumption asymmetrically. In particular, both of the responses to consumption following positive and negative stock price shocks will peak after one quarter. However, while the response of consumption to a positive share price shock will still stay steady after the peak and then slowly die away after six quarters, the response of consumer spending to a negative stock price shock will

fade out quickly within one quarter after the peak. In other words, a positive stock price shock is more persistent than a negative share price shock. In terms of housing price impacts, there is a slower response to consumption following a positive housing price shock, which does not peak until the third quarter, while the response of consumption to a negative real estate price shock will reach the top within one quarter and then gradually fade away. Again, a positive housing price shock is also more persistent than a negative property price shock.

Figure 7.3: Impulse Responses of Consumption to Positive and Negative Asset Wealth Shock (Total Sample, Absolute Value)

response of TC to SPP shock

response of TC to SPN shock

response of TC to HPP shock

response of TC to HPN shock
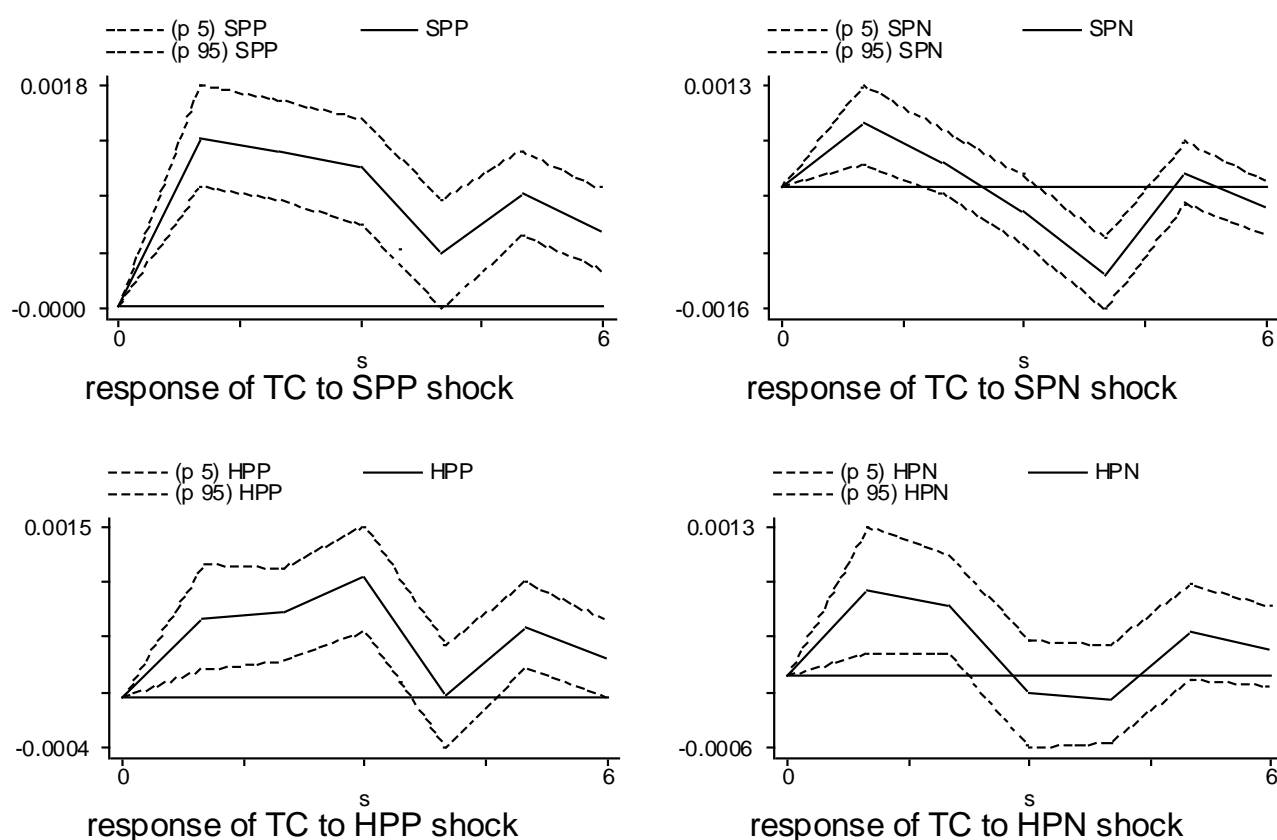
The evidence of asymmetric wealth effects on consumption is consistent with consumption behaviour of the Duesenberry (1949) type, where the consumption function is steeper for increases in wealth and flatter for wealth reductions. One

possible explanation for such ratchet effects in consumption is the prospect theory of Kahneman and Tversky (1979), who suggest that people dislike losses more than they like gains. In the face of the recent property market slump, for example, home owners in some OECD countries have withdrawn their houses from sale, preferring to defer the house sale until an expected resurgence in prices. The notion of 'habit persistence' from Sundaresan (1989) states that consumer spending is more 'sticky' during periods of dropping asset prices, because consumers' utility depends on their consumption history. In this respect, households may use past savings or credit sources to mitigate the negative wealth effect on consumption. Another possible explanation for this asymmetric response from consumption might be the evolution of mortgage equity withdrawal since households can more easily finance their spending through equity extraction from their homes when housing prices increase. According to Benito (2007), households are even more likely to extract home equity if they face less housing price uncertainty. It has been the case that the behaviour of housing prices has been less volatile than stock prices in recent decades for the OECD countries. This has made households regard increases in housing values as being more persistent than decreases. Therefore, home equity withdrawal reinforces the positive wealth effect on consumption to some extent since such an effect only takes place when there is a favourable housing price shock.

The asymmetric response of consumption also provides some insights into the dual impact of housing price shocks. The higher positive housing wealth effect indicates that homeowners' consumption responds more to housing value appreciation than depreciation. Another consideration is that renters respond more to a fall in property prices. Since the housing service cost is the largest proportion

of non-homeowners' daily spending, falling housing prices will depress the rental price and even lower the mortgage payments for potential first-home buyers, which then encourages non-homeowners to consume more.

Table 7.3 provides a numerical analysis of the asymmetric responses of consumption to positive and negative asset price shocks. It indicates that the responses to both positive stock and property price shocks are bigger than those to negative shocks. In particular, a positive stock price shock has a significantly bigger effect than a negative share price shock at all times. Moreover, a positive housing price shock is substantially larger than a negative property price shock for the first three quarters, but there is no difference between them after the fourth quarter.

Table 7.3 also provides the percentage of the variation of consumption that is explained by a unit shock in total consumption, disposable income, as well as the positive and negative asset price changes that accumulate over time in the whole sample period. The results in Table 7.3 tell the same story as the findings from Figure 7.3. Responses to positive stock and housing price shocks are larger than the negative stock and property price shocks for the whole sample period, because the contribution of positive stock and housing price shocks to the variance of consumption is bigger than the contribution from negative stock and housing price shocks (3.1% versus 1.5%, and 1.4% against 0.6%, respectively). This finding is consistent with the empirical evidence from Stevans (2004) and Apergis and Miller (2005a & 2005b) who identify a stronger positive stock market wealth effect on consumption along with Disney et al. (2010), Das et al. (2011), and Simo-Kengne et al. (2012) who find a larger positive housing wealth effect.

Table 7.3: The Asymmetric Response of Consumption to Asset Wealth Shocks

Impulse Response	Positive shock			Negative shock		
	1-quarter	3-quarter	6-quarter	1-quarter	3-quarter	6-quarter
Stock price shock	0.13%*	0.11%*	0.06%*	0.08%*	-0.03%	-0.03%
House price shock	0.07%*	0.10%*	0.03%	0.08%*	-0.02%	0.02%
Variance Decomposition	TC	DIN	SPP	SPN	HPP	HPN
	90.9%	2.4%	3.1%	1.5%	1.4%	0.6%

*Note: * indicates statistical significance level of 5%.*

7.4 Conclusion

There is a long history of estimating the wealth effect on consumption in both macro- and micro-economic literature. The recent subprime mortgage crisis in the U.S. and the European sovereign debt crisis associated with the remarkable fluctuations in both stock and housing markets have brought new concerns about the response of consumer spending to asset price shocks.

This chapter employs a panel VAR procedure to investigate the decomposed stock and housing wealth effects on consumption for a panel of 14 OECD countries over the period 1975–2011. The 'evolution' of the equity and property wealth effects over different time periods is also measured based over two sub-periods. The study finds that in responding to the same sized shock, the overall stock market wealth effect is larger than the 'net housing wealth effect,' since the positive housing capital income effect from the rise of property price will be partly offset by the opposite negative housing service effect. However, due to the significant boom in housing markets associated with high levels of leverage and homeownership rates in recent years, the net housing wealth effect has increased faster in relation to the stock market wealth effect over time. In fact, the real estate wealth effect has clearly exceeded the share market wealth effect over the past decade.

In addition, a potential ratchet effect of stock and housing wealth on consumption is also detected based on the same panel VAR framework. The results show that a gain in stock and housing wealth generates a bigger and more persistent increase in consumer spending than a decline in consumption for a similar reduction in equity and property wealth. This finding is consistent with the theoretical work on prospect theory and the 'habit persistence' hypothesis. The stronger and more persistent positive housing wealth effect on consumption might also be attributed to the evolution of housing equity withdrawal. Such findings also provide insights into the wealth distribution between homeowners and non-homeowners. That is, homeowners benefit more from a house price rise, while renters gain more from falling house prices.

The results of this chapter provide important policy implications. First, according to the 'retirement-savings puzzle' proposed by Banks et al. (1998), there are unanticipated adverse shocks occurring around the time of retirement which lead to a fall in consumption for households whose heads retire. They suggest that illness or poor health may be one of those unexpected shocks. The findings of this study contribute to their study that unanticipated shocks from stock and housing price changes may also significantly affect older households' spending as they retire. In fact, Campbell and Cocco (2007) and Morris (2007) have shown that the housing price effect is stronger for older people than young households, so falling house prices will have more adverse impact on older people's spending. As a result, it is important to maintain stabilization of asset markets and prevent any potential bubbles, especially in the real estate market due to the stronger housing price effect on consumption in recent years along with the high loan-to-value ratio.

Second, the evidence of asymmetric asset price effects on consumption has implications for economic growth. During an asset market boom, GDP will grow faster due to the stronger response from consumer spending. However, during a downturn in the asset market, the decline in economic growth may be less than it would be because of consumption hysteresis.

Third, the conclusion of ratchet asset price effect on consumer spending also implies that policy makers should respond more to the rise of asset prices to obviate inflationary pressures, and pay less attention to falling asset prices. This is because a given monetary tightening is less likely to dampen consumption growth as much as an equal but opposite effect from monetary loosening. Specifically, policy makers need to identify asset bubbles in the early stages to avoid much larger bubbles bursting in the future, which may lead to more macroeconomic problems. Moreover, it may be necessary to prevent over-consumption in response to the positive asset wealth shock that could raise the volatility of future GDP growth. Furthermore, the real estate market should receive priority from policy makers since the housing price effect has increased significantly and outweighed the stock price effect in recent years, especially in regards to the enhanced positive housing price shocks. Although the housing markets in some countries such as the US, Japan and Spain have cooled down since the subprime mortgage crisis and the Eurozone financial crisis, potential inflationary pressures or bubbles may still exist in some other OECD countries. For instance, the house prices in Australia, Canada, and Norway lifted by 27.5% from the end of 2006 to 2011 associated with higher mortgage ratios. Therefore, monetary stabilization policies are more necessary for these nations.

CHAPTER 8: CONCLUSION

There is a long history of estimating the wealth effect on consumption in both macro- and micro-economic literature. The recent subprime mortgage crisis in the US and the European sovereign debt crisis associated with the remarkable fluctuations in both stock and housing markets have brought new concerns about the response of consumer spending to asset price shocks. This thesis re-investigates the relationship between consumption, income, financial and housing wealth, in terms of the wealth effect on consumption in the context of macroeconomics and relevant monetary policies, based on macro/aggregate data. Both time-series and panel data are used to provide evidence at the domestic and international level.

By addressing the research questions stated at the beginning of the thesis, four conclusions can be drawn from the analysis. First, based on time-series data from the US market, Chapter 4 finds that a regime-switching framework is found to be preferable to a conventional single-regime model. Therefore, the relationship between consumption, income and wealth is better explained in regime-specific terms. For example, a dollar increase in housing wealth increases consumption by 10 cents during a housing boom state, and only increases consumption by 8 cents during the other state. On the other hand, an additional dollar of financial wealth raises consumer expenditure by 4 cents and 5 cents in the respective regimes. The housing wealth effect is larger than the financial wealth effect in both regimes, and the difference between those two effects is even larger during a housing boom regime, which is the condition covering the recent housing market boom in most

of the 2000s. The MPC estimates are in line with the theoretical and empirical bounds on the MPC from aggregate wealth.

Chapter 4 also shows that there is only weak evidence of a linear-based cointegrating relationship between consumption, income and wealth. However, consumption and financial and housing wealth show error corrections during their own particular regimes. As a result, estimation of the system suggests that short-term derivations in the consumption-wealth ratio will predict either consumption growth or asset returns, depending on the state of the economy. In contrast to a conventional Markov-switching model that relies on the FTP of switching between regimes, this chapter further indicates that TVTP outperforms FTP where monetary policy indicators such as interest rate and term structure significantly drive the transition probabilities. In particular, monetary tightening might result in a relatively stronger negative financial wealth shock, while monetary loosening could lead to a relatively larger positive housing wealth effect on consumption.

Secondly, while most existing nonlinear studies have only focused on the dynamics of asymmetric wealth shocks, Chapter 5 examines the consumption and wealth relationship in the US by focusing on the heterogeneity in consumption, based on the QARDL model. Instead of relying on a single measure of conditional central tendency like the conventional cointegration methods, this approach enables us to explore the relationship between consumption and wealth with quantile-varying cointegrating coefficients.

Chapter 5 shows that there is indeed a long-run cointegrating relationship between consumption, income, financial and housing wealth, but under the framework of quantiles characterised by differing speeds of adjustment. By estimating the long-

run and short-run parameters for consumption, income and wealth, Chapter 5 further finds that there is strong evidence of location asymmetries between lower and medium-to-higher quantiles for most of the parameters. In particular, the wealth effects on consumption are larger in the lower quantiles (lower consumption growth) than the higher quantiles (higher consumption growth). Moreover, by using time-varying rolling QARDL estimation, Chapter 5 observes important time-varying patterns for the relationship between consumption and wealth. In particular, after the shock of the 2007-2008 subprime mortgage crisis, while the financial wealth effect on consumer spending dropped, the housing wealth effect, on the other hand, increased substantially.

Thirdly, compared with Chapters 4 and 5 concentrating on the wealth effects in the US market, Chapter 6 further provides analysis of a panel of 14 OECD countries, since few studies on the effect of financial and in particular of housing wealth on consumer expenditure have been done in the international context. In particular, Chapter 6 examines whether a long-run cointegrating relationship between consumption, income and wealth exists in OECD countries. It also investigates if there is a difference between market- and bank-based countries in terms of wealth effects on consumption, because most of these theoretical and empirical discussions on the difference between market- and bank-based systems have focused on the linkage between financial systems and economic growth, which is not directly relevant to the wealth effect on consumption.

By employing second generation panel unit root and cointegration tests, which provide higher testing power and better ability to address cross-sectional dependence issues, Chapter 6 finds that the stock prices in bank-based economies

exhibit mean-reversion. Moreover, weak evidence of cointegration between consumption, income and wealth is identified in market-based countries but not in bank-based nations, partially explaining why previous multi-country studies only find mixed evidence of a long-run cointegrating relationship between consumption, income and wealth (Dreger and Reimers, 2006; Skudelny, 2009; Slacalek, 2009). Chapter 6 further shows that the wealth effects in market-based nations are stronger than those in bank-based economies. In particular, the housing wealth effect is found to be larger than the financial wealth effect for both market- and bank-based countries, which is consistent with the background that housing wealth has been the most stable and largest component of personal wealth for most households.

Fourthly, Chapter 7 provides additional information to Chapter 6 by employing the same panel dataset. While Chapter 6 contributes to the testing of the existence of a long-run cointegrating relationship between consumption, income and wealth among OECD countries, Chapter 7 focuses on the comparison between stock market wealth effect and 'net housing wealth effect' as well as the 'evolution' of these two different wealth effects over time. A potential ratchet effect of stock and housing wealth on consumer spending is also estimated in Chapter 7.

Based on a panel VAR procedure which can explicitly allow for feedback effects from consumption to wealth or income, as well as illustrate how the responses of consumption and wealth vary according to the nature of the shocks on them, Chapter 7 finds that in responding to a same-sized shock, the overall stock market wealth effect is larger than the 'net housing wealth effect,' since the positive housing capital income effect from the rise of property price will be partly offset

by the opposite negative housing service effect. Nonetheless, due to the significant boom in housing markets associated with high levels of leverage and homeownership rates in recent years, the net housing wealth effect has increased faster in relation to the equity market wealth effect over time. In fact, the real estate wealth effect has clearly outweighed the share market wealth effect over the past decade.

Chapter 7 also shows that a gain in stock and housing wealth generates a bigger and more persistent increase in consumer spending than a corresponding decline in consumption for a similar reduction in equity and property wealth. This finding is consistent with the theoretical work on prospect theory and the 'habit persistence' hypothesis. The stronger and more persistent positive housing wealth effect on consumption might also be attributed to the evolution of housing equity withdrawal. Furthermore, such ratchet evidence provides insights into the wealth distribution between homeowners and non-homeowners. That is, homeowners benefit more from a house price rise, while renters gain more from a falling house price.

These findings have several important policy implications. First, asymmetric monetary policies should be responsible for the movement in asset prices in analysing future inflation and aggregate demand due to the sensitivity of financial and housing wealth effects in different economic states. In particular, the asymmetry in the consumption-wealth channel suggests that central banks should recognize the fact that monetary loosening might over-boost the real estate market with excessive credit growth in the mortgage sectors which could lead to a higher potential housing price bubble, while on the other hand, monetary tightening

could dampen the financial market more, which in turn, discourages household consumption, especially for those consumers who have a heavy share of their wealth in stocks, bonds and mutual funds. As a result, it is crucial to re-assess monetary policy, especially during periods of uneven development between financial and real estate markets.

Secondly, in response to the changes in stock and housing prices, policy makers should respond more to the rise of stock and property prices to obviate inflationary pressures, and pay less attention to falling asset prices. This is because a given monetary tightening is less likely to dampen consumption growth as much as the equal but opposite effect from monetary loosening. Specifically, policy makers need to identify asset bubbles in an early stage to avoid much larger bubble bursts in the future, which may lead to more macroeconomic problems. It may also be necessary to prevent over-consumption in response to positive asset wealth shocks that could raise the volatility of future GDP growth. Furthermore, the real estate market should receive priority from policy makers since the housing price effect has increased significantly and outweighed the stock price effect in recent years, especially in regard to enhanced positive housing price shocks. Although the housing markets in some countries such as the US, Japan and Spain have cooled down since the subprime mortgage crisis and the Eurozone financial crisis, potential inflationary pressures or bubbles may still exist in some other OECD countries. For instance, house prices in Australia, Canada, and Norway have lifted by 27.5% from the end of 2006 to 2011, associated with higher mortgage ratios. Therefore, monetary stabilization policies are more necessary for these nations.

Thirdly, it is also important to understand the heterogeneity in consumption behaviour which is fundamental to grasping the impacts of wealth shocks, and the effectiveness of tax and other policies that can impact on wealth. Due to the different behaviour of the financial and housing wealth effects after the recent global financial crisis, it is also crucial to implement macro-prudential regulations along with monetary policy to ease the adverse effects on financial or housing markets in response to the same monetary decision, and in particular, reduce house price volatility.

Fourthly, policymakers should pay more attention to equity and housing prices in market-based countries, since the wealth effects are stronger in market-based countries than in bank-based nations: the decline of capital markets would have more severe adverse impacts on households' expenditure in market-based economies. For example, the recent global financial crisis has hurt the financial and housing markets more severely in market-based nations such as the United States, whereas in bank-based countries like Germany it has had less influence.

This thesis has some limitations. For example, generally there are two methods (with somewhat different objectives) for estimating the wealth effect on consumption. One is based on macro/aggregate level data and the other is based on micro/household level data. The advantage of macro data lies in the long time series available for many countries. The aggregate data-based approach also allows us to distinguish between the long-run and short-term relationships between consumption and wealth, and identify which variables adjust to restore the long-run equilibrium following a shock, as well as estimate the time taken by the adjustment process. However, macro data is not able to detect individual

wealth effects. Individual wealth effects depend on age, gender, race, income, and other demographic features. The estimation of consumer confidence effects also requires the use of the corresponding micro data. Since the main focus of this thesis is in the context of macroeconomics and relevant monetary policies, only macro data-based approaches were employed to investigate the wealth and consumption relationship.

The other main limitation concerns the panel data set employed in this research. First, panel data uses total consumption instead of non-durable consumption for the multi-country investigation, since a measure of non-durable consumption is not available for most of the studied countries. Second, the study uses total disposable income rather than labour income, due to data availability. Third, consistent measures of financial and housing wealth are not available on a broad basis for the sample of 14 OECD countries, so they have been proxied by stock price and house price indices. For example, considering the relatively long time-span of the estimated period, consistent measures of asset wealth required for a balanced panel are only available in a limited number of cases such as the US, the UK and Australia. However, price series are readily available across countries, and are reported at the desired frequencies. In fact, most of the previous empirical panel-data wealth effect studies have encountered the same problems and adopted the strategy of using price indices instead of real values (Ludwig and Slok, 2004; Dreger and Reimers, 2006 & 2011; Ciarlone, 2011). Therefore, to be consistent with earlier studies and be more easily comparable, this research also uses asset price index data.

There are several possible avenues for future research. First, from Chapter 4, one research extension would be to apply a three-regime Markov switching model to provide a deeper understanding of the consumption-wealth channel in "boom", "steady-state" and "collapse" regimes. Secondly, the role of fiscal policy could be investigated to assess its impact on the consumption-wealth channel both in the US and OECD countries. However, the availability of consistent data across a panel of OECD countries would be a potential problem. Thirdly, much of the debate in international organizations and academia has looked at the experience of developed countries. It might also be interesting to examine the consumption and wealth relationship in emerging market economies. It is important to extend the existing literature to these countries, since they have become a key component of the global economy and they might face the same economic issues that the advanced economies currently confront due to globalization, e.g. increasingly financially integrated capital markets. Finding adequate data for this task will be a huge challenge.

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