

The Q Theory Model of Housing

A Macroeconomic Analysis of the Dynamics in the Norwegian Housing Market

Eli Skjeggedal

Supervisor: Professor Gernot Doppelhofer

Master Thesis/Major in Finance

NORGES HANDELSHØYSKOLE

This thesis was written as a part of the Master of Science in Economics and Business Administration program - Major in Finance. Neither the institution, nor the advisor is responsible for the theories and methods used, or the results and conclusions drawn, through the approval of this thesis.

Abstract

This thesis develops a q theory model of housing, where the value of Norwegian housing, q , is defined as the ratio of housing prices to the construction costs of new housing and housing is defined as the aggregate housing stock in Norway's national accounts. This thesis analyzes the development in q during the period 1992-2011 and show that q is positively and significantly related to housing investment when assuming that shocks in the economy are both absent and present. In the assumption that shocks are present in the economy, developments in income, debt, population, initiation of new housing construction, interest rates and taxes were analyzed. Empirical estimates show that the developments in population and interest rates in particular may explain the variance in q . The positive relationship between the value of housing and the aggregate housing stock suggests that there may be a presence of bubbles in the Norwegian housing market and that the dynamics in the housing market may be influenced by non-fundamental variables such as animal spirits and irrational exuberance. This finding must however be interpreted with caution since it is difficult to measure bubbles before they have burst. In addition, the empirical estimates have not accounted for all the variables that may impact the dynamics of the housing market and it is discussed that land prices in particular may have contributed to the rising housing prices. Thus it can neither be proved nor disproved that a bubble may exist in the Norwegian housing market. Nevertheless, this does not alter the main result in this thesis, that the value of housing is significantly related to housing investment according to the q theory model of housing.

Preface

The inspiration to write this thesis came from the lectures about the Ramsey model in Long-term Macroeconomic Analysis (FIE 421). The initial idea was to use a phase diagram similar to the Ramsey model in order to investigate asset prices. In the choice of asset, it felt natural to choose housing due to the ongoing discussion of the possible presence of a bubble in the Norwegian housing market. Right before I settled on my research topic, Yale Professor, Robert Shiller stated in the media that he believes that the Norwegian housing market resembles a bubble (Sandø 2012). Thus, I found it interesting to investigate the developments in the Norwegian housing market and if we really need to be concerned about the possible presence of bubbles.

By writing this thesis I have learned a lot about the determinants of the housing market and myself as an individual researcher. The dynamics of housing markets is a complex economic field, where I have faced many interesting problems throughout the process. It is inspiring to experience that my knowledge extends far and that it is possible to solve complicated problems through theory and guidance. It is particularly nice that my program at NHH is completed by a thesis which allows me to apply knowledge gained through five years of education.

Finally, I would like to thank my supervisor, Professor Gernot Doppelhofer for good feedback and fruitful discussions. I would also like to thank the participants in the KOV Macro Project for their contributions in connection with the project presentations throughout the semester.

Contents

ABSTRACT	2
PREFACE	3
CONTENTS	4
FIGURES	7
TABLES	9
1. INTRODUCTION	10
1.1 MOTIVATION	10
1.2 RESEARCH QUESTIONS	11
1.3 EXISTING LITERATURE	11
1.4 STRUCTURE.....	12
2. BACKGROUND	13
2.1 HISTORICAL DEVELOPMENT IN THE HOUSING PRICES.....	13
2.2 HOUSING PRICE DETERMINANTS.....	14
2.2.1 <i>Supply</i>	14
2.2.2 <i>Demand</i>	16
3. A Q THEORY MODEL OF HOUSING	27
3.1 ASSUMPTIONS	27
3.1.1 <i>The Household's Preferences</i>	27
3.1.2 <i>The Housing Accumulation Constraint</i>	32
3.1.3 <i>Adjustment Costs</i>	32
3.1.4 <i>The Household's Problem</i>	33
3.2 A DISCRETE-TIME VERSION OF THE HOUSEHOLD'S PROBLEM	33
3.3 A CONTINUOUS-TIME VERSION OF THE HOUSEHOLD'S PROBLEM	35
3.4 TOBIN'S Q	37
3.5 ANALYZING THE MODEL	37
3.5.1 <i>The Phase Diagram</i>	39

3.6	IMPLICATIONS.....	41
3.6.1	<i>The Effects of Utility Movements.....</i>	41
3.6.2	<i>The Effects of Interest Rate Movements.....</i>	43
3.6.3	<i>The Effects of Taxes.....</i>	44
4.	HOUSING BUBBLES.....	47
4.1	DEFINITIONS.....	47
4.1.1	<i>Fundamental Value.....</i>	47
4.1.2	<i>Animal Spirits and Irrational Exuberance.....</i>	47
4.1.3	<i>Bubbles.....</i>	48
4.2	PRICE/EARNINGS ANALYSIS.....	49
5.	DATA PROCESSING.....	50
5.1	THE GROSS DOMESTIC PRODUCT DEFLATOR VERSUS THE CONSUMER PRICE INDEX.....	50
5.2	REGRESSION ANALYSIS.....	50
5.2.1	<i>Scatter Diagrams.....</i>	51
6.	THE MODEL INGREDIENTS.....	52
6.1	THE VALUE OF HOUSING, q	52
6.1.1	<i>The Components of q.....</i>	52
6.1.2	<i>Analyzing q.....</i>	53
6.2	THE HOUSING STOCK, H	55
6.2.1	<i>Analyzing H.....</i>	56
7.	ANALYZING THE BEHAVIOUR OF Q AND H.....	59
7.1	THE PHASE DIAGRAM.....	59
7.1.1	<i>Path Developments.....</i>	60
7.2	REGRESSION ANALYSIS.....	62
7.2.1	<i>The Levels of q and H.....</i>	62
7.2.2	<i>The Change in q and H.....</i>	64

7.3	IMPLICATIONS FOR THE BEHAVIOUR OF Q AND H	67
7.3.1	<i>Is there a Long-run Equilibrium?</i>	67
7.3.2	<i>Is the Transversality Condition Failing?</i>	67
8.	ANALYZING SHOCKS	69
8.1	THE EFFECTS OF UTILITY MOVEMENTS.....	69
8.1.1	<i>The Effects of Changes in the Household's Preferences, π</i>	69
8.1.2	<i>The Effects of Changes to the Aggregate Housing Stock, H</i>	72
8.2	THE EFFECTS OF INTEREST RATE MOVEMENTS.....	73
8.2.1	<i>The Effects of the Financial Crisis</i>	74
8.3	THE EFFECTS OF TAXES.....	75
8.3.1	<i>The Tax Reform in 1992</i>	75
8.3.2	<i>The Tax Reform in 2005</i>	76
8.4	REGRESSION ANALYSIS.....	77
8.4.1	<i>The Variables</i>	77
8.4.2	<i>Regression Analysis of Levels</i>	78
8.4.3	<i>Regression Analysis of Changes</i>	82
8.4.4	<i>Regression Results of Shocks</i>	86
9.	DISCUSSION.....	87
9.1	RESULTS.....	87
9.2	IS THERE A BUBBLE IN THE HOUSING MARKET?.....	87
9.2.1	<i>Land Prices</i>	88
9.2.2	<i>Non-fundamentals</i>	89
9.3	COMMENTS ON POSSIBLE WEAKNESSES.....	90
10.	CONCLUSION.....	91
	REFERENCES.....	92
	APPENDIX.....	98

Figures

Figure 1: Nominal housing price index (2005=100) 1992-2011	14
Figure 2: Nominal construction cost index (2000=100) 1992-2011	15
Figure 3: Initiation of new housing construction 1993-2011	16
Figure 4: Households' real disposable income 1992-2010	17
Figure 5: Households and non-profit organisations nominal and real disposable income 2002-2011	17
Figure 6: Population growth and initiation of new housing construction 1992-2011	18
Figure 7: Trends in urban and less urban population 1992-2011	19
Figure 8: Number of individuals in the age group 25-34 years 1992-2011	20
Figure 9: Banks' lending and deposit rates 1992-2011	21
Figure 10: Weighted average lending rates including provisions 2002-2011	22
Figure 11: Consumer confidence 1992-2011	23
Figure 12: Households and non-profit organizations nominal and real debt 1995 (fourth quarter)-2011	25
Figure 13: Households' LTI ratios 2004-2010	25
Figure 14: The dynamics of H	38
Figure 15: The dynamics of q	39
Figure 16: The phase diagram	39
Figure 17: The saddle path	40
Figure 18: The effects of a permanent increase in housing utility	42
Figure 19: The effects of a temporary increase in housing utility	43
Figure 20: The effects of a permanent decrease in the interest rate	44
Figure 21: The effects of a permanent investment tax credit	45
Figure 22: The effects of a temporary investment tax credit	46
Figure 23: Nominal housing price index (1992=1) 1992-2011	53
Figure 24: Nominal construction cost index (1992=1) 1992-2011	53

Figure 25: Average q as defined in equation (3.23) (1992=1) 1992-2011	54
Figure 26: The change in q as defined by equation (3.25) 1992-2011	55
Figure 27: Nominal and real housing 1992-2011	56
Figure 28: Change in real housing as defined by equation (3.24) 1992-2011	57
Figure 29: Change in H in 2009 prices	57
Figure 30: The relationship between q and H in relation to figure 16	59
Figure 31: The slopes of the development in q and H	61
Figure 32: Linear regression of the levels of q and H in 2009 prices	63
Figure 33: Linear regression of the levels of q and H deflated by the CPI	64
Figure 34: Linear regression of the change in q and H in 2009 prices	65
Figure 35: Linear regression of the change in q and H deflated by the CPI	66
Figure 36: Continuous permanent increases in π	71
Figure 37: Continuous permanent increases in π where the economy lacks time to adjust	71
Figure 38: Continuous temporary and continuous increases in π where the economy lacks time to adjust	72
Figure 39: Permanent decrease in interest rates	74
Figure 40: The effects of the Financial Crisis	74
Figure 41: The effects of the tax reform in 1992	76
Figure 42: The effects of the tax reform in 2005	76
Figure 43: Residual correlation between the levels of q and H	82
Figure 44: Residual correlation between the changes in q and H	85
Figure 45: Housing prices, land prices and construction costs (1985=100)1985-2009	89

Tables

Table 1: The size of the slopes.....	60
Table 2: Regression results q vs H in 2009 prices	63
Table 3: Regression results: q vs H deflated by the CPI.....	64
Table 4: Regression results: change in q vs change in H in 2009 prices.....	65
Table 5: Regression results: change q vs change H deflated by the CPI.....	66
Table 6: Regression results: income (2002-2011).....	79
Table 7: Regression results: debt (1995-2011)	79
Table 8: Regression results: income and debt (2002-2011).....	79
Table 9: Regression results: population (1997-2011)	80
Table 10: Regression results: construction (1993-2011).....	80
Table 11: Regression results: population and construction (1997-2011).....	80
Table 12: Regression results: interest rates (2002-2011)	81
Table 13: Regression results: all shocks (2002-2011).....	81
Table 14: ANOVA results	82
Table 15: Regression results: changes in income (2002-2011).....	83
Table 16: Regression results: changes in debt (1995-2011).....	83
Table 17: Regression results: changes in income and debt (2002-2011)	83
Table 18: Regression results: changes in population (1997-2011).....	83
Table 19: Regression results: changes in construction (1993-2011).....	83
Table 20: Regression results: changes in population and construction (1997-2011)	84
Table 21: Regression results: changes in interest rates (2002-2011)	84
Table 22: Regression results: changes in all shocks (2002-2011).....	84
Table 23: ANOVA results: changes.....	85
Table 24: Quarterly real and nominal housing in millions (obtained from SSB personally) 1992-2011	98

1. Introduction

In order to introduce the topic of this thesis, the motivation for investigating the dynamics of the Norwegian housing market is first presented, followed by a presentation of the research questions. The existing literature related to the thesis' main findings is presented in section 1.3 and an overview of the thesis' structure is given in section 1.4.

1.1 Motivation

Housing is important for Norwegian households since the majority of Norwegian households own their own house and the house constitutes the bulk of the households' total wealth (Jansen 2012). In 2011, households' investment in housing accounted for 22.5 % of total investment in fixed real capital and the total housing stock accounted for 35 % of the total stock of fixed real capital (SSB 2012m). As a result, housing investment and the housing stock are important variables for the Norwegian economy. Similarly, the consumption of housing constitutes a major part of households' total consumption¹. Households' investment in housing is in addition characterized by a large degree of debt financing (Finansdepartementet 2011), which indicates the presence of self-reinforcing effects between housing and debt (Anundsen and Jansen 2011).

Since the collapse of the US sub-prime market in 2008, there has been increased attention to the robustness of housing markets. The presence of self-reinforcing effects between housing and debt is a typical pattern in housing markets, which makes households vulnerable in situations where interest rates suddenly increase or economic prospects weaken. In Norway, Norges Bank (2011) is concerned that this development may pose a threat to financial stability. The IMF (2012) shares this view and highlights high household debt levels compared to other countries and a growing share of households with debt-to income ratios excess 500 % as main risks to financial stability. In addition, the IMF estimates that there may be an overvaluation in the housing market in the range of 15-20 %.

¹ Baug and Dyvi (2008: 191) define housing consumption as 'housing services that mainly consists of rent and the user value of owning a house'.

1.2 Research Questions

Based on the importance of the housing market in the Norwegian economy and the rising concern about the levels of the housing prices it is interesting to analyze the dynamics of the housing market in a q theory model of investment. This theory will from now on be referred to as the q theory model of housing. The time period analyzed is the period 1992-2011 because the housing price index is available from Statistics Norway (SSB) since 1992. This thesis will address the following research questions:

First, a q theory model of housing is developed. In this model, investment in housing is analyzed analogously to a firm's investment decisions in the presence of adjustment costs. The value of housing is defined as the housing price index deflated by the construction price index, denoted by q , and housing is defined as the housing stock in Norway's national accounts, denoted by H . Based on this model, it is discussed how shocks affect the steady state and the dynamic relationship between q and H . Third, this thesis tests if the development of q and H between 1992-2011 can be explained by such shocks, or if some parts of the relation between q and H cannot be explained by shocks. Fourth, this thesis provides a tentative conclusion about the importance of shocks and the possible presence of bubbles in the Norwegian housing market.

1.3 Existing Literature

There is a range of literature on the dynamics of housing markets and Tobin's q (Tobin 1969) is a commonly used theory in this literature. Tobin's q is based on the assumption that the rate of investment should be related to the value of capital q , and can be extended to apply to a variety of sectors and assets (Tobin 1969). In Norway, the Ministry of Finance and SSB analyze the dynamics in the housing market using the housing block in MODAG² (Baug and Dyvi 2008). This model assumes that investment in housing depends on the relationship between housing prices and construction costs which is consistent with Tobin's q .

Various researchers have applied Tobin's q in the housing market. Corder and Roberts (2008) use Tobin's q to explain movements in UK housing investment and Berg and Berger

² MODAG is developed by SSB and is used to project and analyze key variables in Norwegian economy (Baug and Dyvi 2008).

(2005) apply Tobin's q in Swedish and find that there is a high correlation between q and housing investment. Jud and Winkler (2003) present estimates of a q model of housing investment, using quarterly values for the US and finds that q is positively and significantly associated with housing investment. This research is consistent with the findings in this thesis that q is positively and significantly associated with housing investment. Grytten (2009) measures the development of q in the Norwegian housing market from 1978 to 2009 and finds that q rises quickly and significantly from the trough in 1992 until 2007, to slightly fall under the housing price decline in 2008. Based on the information summarized in q , Grytten believes that it is too easy to conclude that there is not a housing bubble in the Norwegian housing market. This result is consistent with this thesis' analysis of the historical development in q , and the rising levels of q may suggest a possible presence of bubbles. This thesis discusses however the importance of shocks in the development of q and this implication for the possible presence of bubbles in the Norwegian housing market.

Iacoviello (2005) develops a monetary business cycle model with nominal loans and collateral constraints tied to housing values and finds that demand shocks move housing prices and are amplified and propagated over time. The result that demand shocks amplify and propagate housing prices is consistent with this thesis, which shows that continuous shocks may explained the development in q . Madsen (2011) uses historical data for Norway and six other industrialized countries and develops a Tobin's q model of housing prices and shows that shocks to demography, demand and interest rates have temporary effects on housing prices. This result is consistent with this thesis' findings where the developments in population and interest rates in particular may have contributed to explain the variance in q .

1.4 Structure

The paper is organized as follows. Section 2 describes the historical development in the housing prices and the housing market's main determinants. The theoretical background is presented in three parts, where section 3 presents a q theory model of housing, section 4 introduces theory about bubbles and section 5 briefly explains the data processing methods applied in the analysis. The analysis also consists of three parts, where section 6 builds a q theory model of housing and analyzes the model ingredients, section 7 analyze the model ingredients in relation to each other, and section 8 studies the model implications of shocks. Section 9 discusses the results and the possible presence of bubbles and section 10 concludes.

2. Background

In order to provide an intuition of the current level and the main determinants of the housing market, this section describes the historical development in the housing prices and the main forces of housing supply and demand.

2.1 Historical Development in the Housing Prices

Statistics on housing prices are available from SSB through the housing price index³ and this thesis analyzes the time period 1992-2011. To analyze the housing market in this period, it is essential to have an understanding of the state of the Norwegian economy in this period, and in the years leading up to 1992.

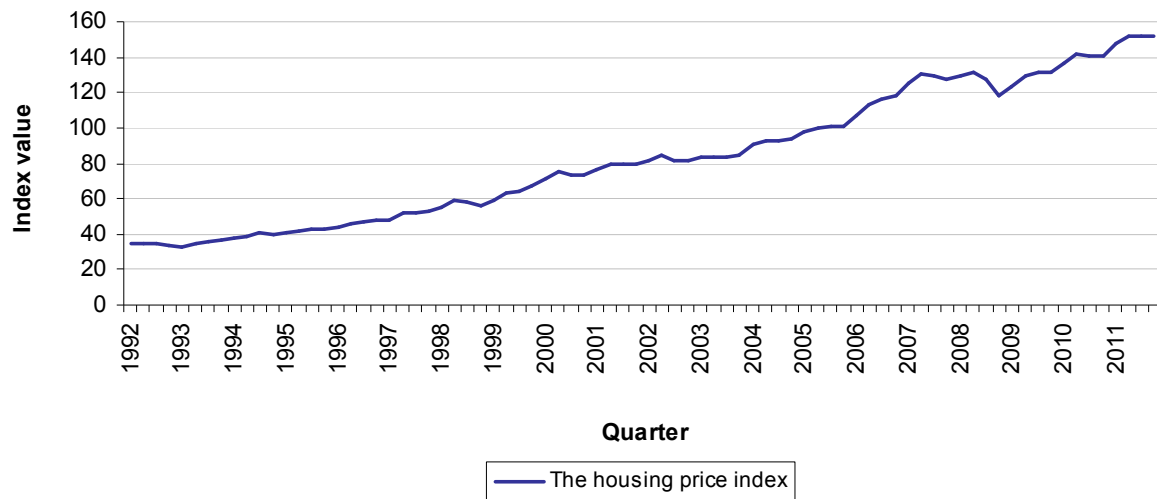
Until the beginning of the 1980s, low interest rates were one of the main pillars of Norwegian macroeconomic policy (Steigum 2010). This policy assumed credit rationing beyond the natural rationing of the unsecured credit that was in the banks self-interest. In the early 1980s, the government implemented a liberalisation policy, which involved a clear breach from former economic policy. From this credit liberalization, and the development towards the Bank Crisis in 1991-1992, there was a classical 'boom-bust cycle'. A credit boom was followed by a fall in the asset prices and the strongest economic downturn since the interwar period (Steigum 2010) and from 1988 to 1993 the housing prices fell by approximately 40 % (Jansen 2012). In the analysis of the Norwegian housing market it is therefore important to recall that the housing prices in the early 1990s were historically low.

Since 1993, the economy recovered from the Bank Crisis and the housing prices have increased significantly. This is illustrated in figure 1 which shows the development in the housing price index from 1992 to 2011 (SSB 2012h). The continuous trend in the housing prices has only been interrupted by a smaller setback in 2002, and the effects of the Financial Crisis, which gave a temporary fall in the housing prices at the end of 2008. From the second

³ The housing price index measures the value of the total housing stock, based on continuous information about new and used houses sold. The housing price index is given in quarterly values from 1992 where 2005 is the index year with a value of 100. In the beginning, the index represented prices for freehold houses, but after 2003 prices for housing cooperatives were also included. Until 2002, the information about sales prices was collected in a quarterly survey from buyers of freehold houses. After 2002, this data was collected from Finn.no. The prices of sold housing cooperatives were first gathered directly from Norsk Boligbyggelag, but after 2009, Finn.no became the data source for both ownership forms (SSB 2012h)

quarter of 2002 to the end of 2002 the prices fell by 4 % and during the same period in 2008 the prices fell by approximately 10 %. During the Financial Crisis the economy was influenced by low consumer confidence and interest rates soared to above 7 % in both the third and the fourth quarter of 2008⁴. During the first quarter of 2009 the interest rates was lowered to around 5 % and the housing prices began to climb again.

Figure 1: Nominal housing price index (2005=100) 1992-2011



2.2 Housing Price Determinants

Housing prices are determined by housing supply and demand. In the long-run, housing supply is to a large extent given by construction costs and regulatory conditions, while housing demand mainly depends on income, population, the user cost of housing and financial conditions (Finansdepartementet 2011).

2.2.1 Supply

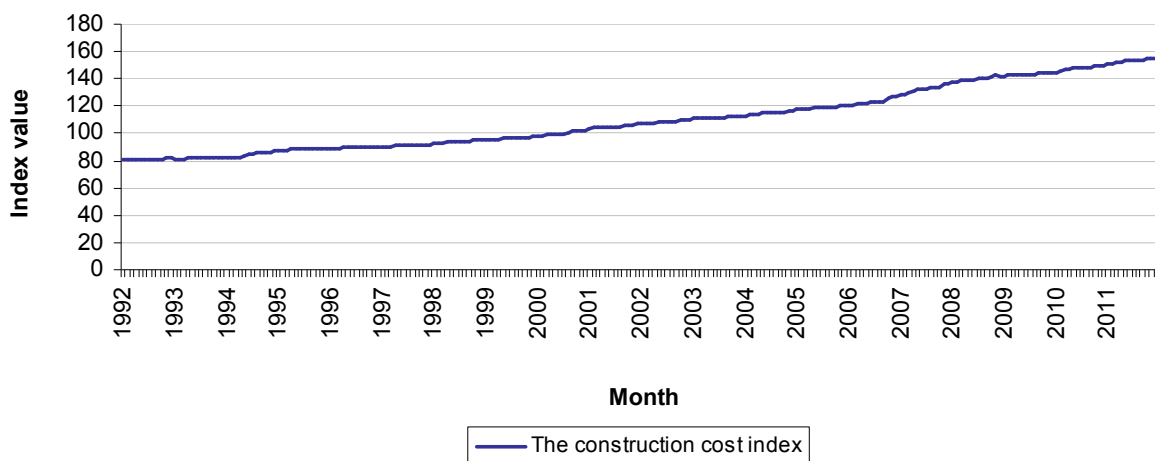
Housing supply can be measured by the housing stock and is fairly stable in the short-run because housing construction takes time and is low in relation to the total housing stock (Jacobsen and Naug 2005). The level of the housing stock depends on construction costs and regulatory conditions.

⁴ See figure 11 and 9 respectively.

Construction Costs

Construction costs include the costs of materials, machinery, labour, transportation and other inputs that are included in the production of houses (SSB 2012i). SSB (2012i) publishes a construction cost index⁵, which measures the monthly cost developments in the production of new houses. This index is displayed in figure 2 which shows that nominal construction costs have increased by 92 %.

Figure 2: Nominal construction cost index (2000=100) 1992-2011



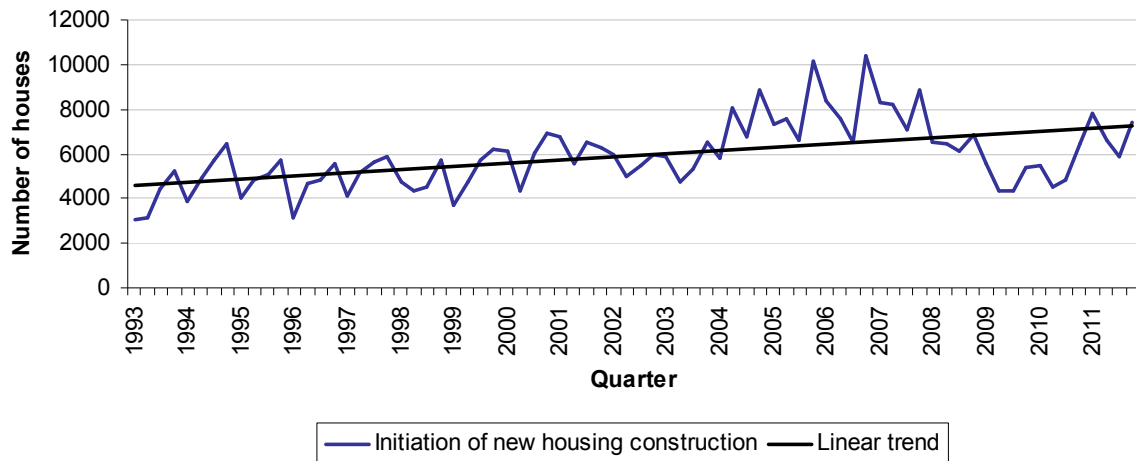
Initiation of new housing construction is stimulated when housing prices increase in relation to construction cost (Jacobsen and Naug 2005). The development in the initiation of new housing construction is illustrated in figure 3, which shows that the initiation of new housing construction in the period 1993-2011 have increased in a fluctuating manner⁶ (SSB 2012n). The initiation of new housing construction was particularly high during the years leading up to the Financial Crisis, 2004-2007, but in the second quarter of 2009, the number of initiation of new housing construction was at its lowest since the first quarter of 1997. This

⁵ SSB (2012i) constructs the construction cost index by using a price survey of all the goods and services that are included in the production of houses. Material prices are collected from firms that sell construction goods to entrepreneurs, building contractors, installers and so on. Labour costs are collected from SSB's quarterly wage statistics and is annually adjusted for changes in employer fees, number of vacation days, and other labour costs that is not included in the 'wage' term. The machinery costs are adjusted with NTNU's monthly statistics of machinery costs, while the transportation costs are adjusted with SSB's monthly cost indexes for trucking.

⁶ The linear trend is estimated in Excel by applying the ordinary least square method. This applies for all the figures where a linear trend line is illustrated.

involved a 58 % decrease from the peak in the fourth quarter of 2006 which highlights the severity of the Financial Crisis in the market for housing construction.

Figure 3: Initiation of new housing construction 1993-2011



Regulatory Conditions

In addition to construction costs, contractors must consider regulatory conditions when initiating new housing construction. The use, protection and development of land and physical environments are regulated in Chapter 12 in the Planning and Building Act (Miljøverndepartementet 2008) where paragraph §12-7 presents the different conditions that are regulated. Contractors must for instance satisfy requirements concerning housing design, the number of houses situated in the same area, accessibility to public transport and energy use in the initiation of new housing construction. Thus, regulatory conditions limit contractors' access to land.

2.2.2 Demand

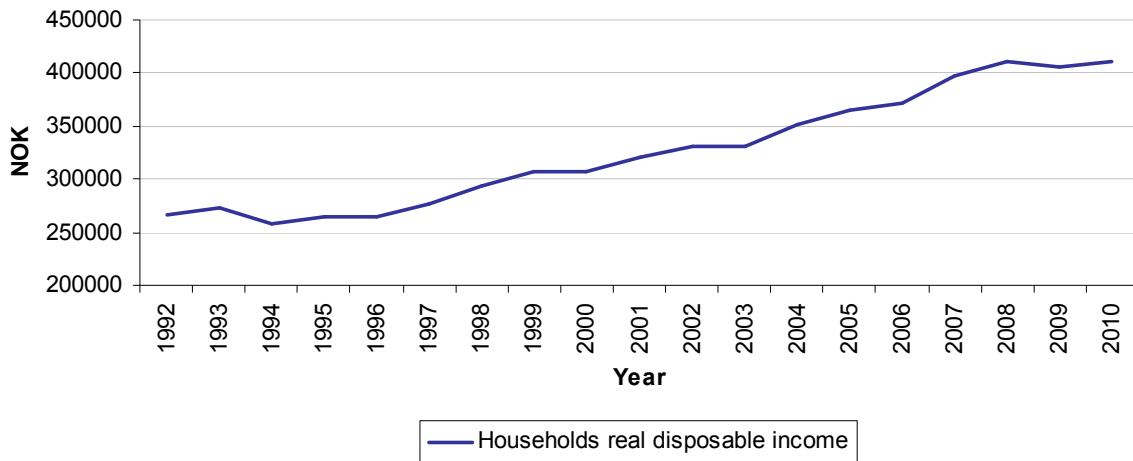
While housing supply predominantly depends on construction costs and regulatory conditions, housing demand mainly depends on income, population, the user cost of housing and financing conditions (Finansdepartementet 2011).

Income

Jacobsen and Naug (2005) show that housing prices rises approximately in the same pace as household income in the long-run but that the ratio of housing prices to income has increased substantially since 1992. Figure 4 illustrates the development in the household's real

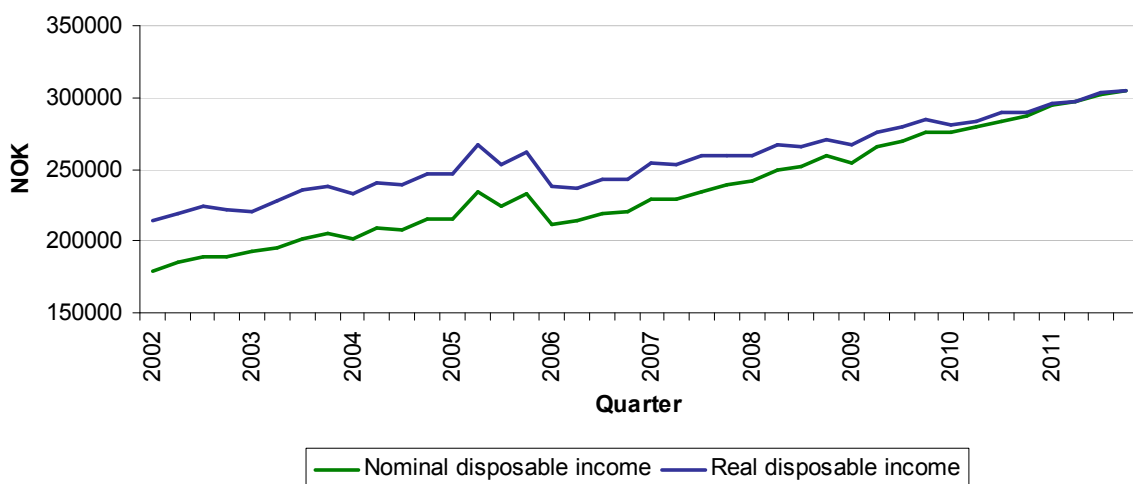
disposable income in 1992-2010 (SSB 2012e), where households' disposable income have grown by 54.3 %.

Figure 4: Households' real disposable income 1992-2010⁷



The quarterly development in households' nominal and real disposable income is in combination with non-profit organizations illustrated in figure 5 (SSB 2012j). During the quarters 2002-2011⁸, the households' and non-profit organizations nominal growth in disposable income was 70 % while the real growth was 42 %.

Figure 5: Households and non-profit organisations nominal and real disposable income 2002-2011



⁷ SSB (2012j) have converted the households' income into fixed prices by the using the Consumer Price Index (CPI). All households are included except student households.

⁸ The disposable income is converted to real prices (2011 prices) by deflating nominal prices by the CPI (SSB 2012g).

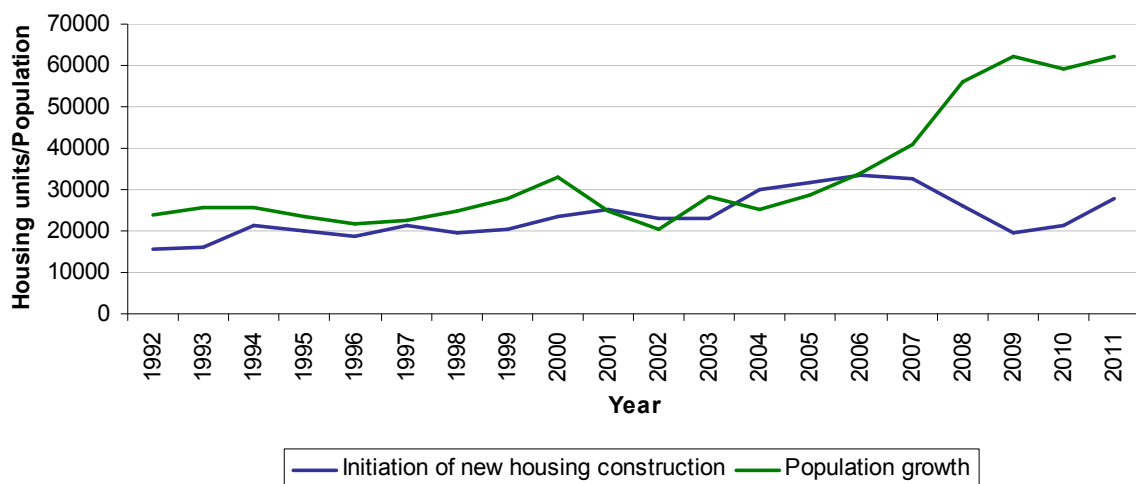
Population

In addition to income, housing demand depends on population size, population movements and the number of individuals in the start-up phase (Finansdepartementet 2011 and Jacobsen and Naug 2005).

Population Size

The annual growth in population size is illustrated by the green line in figure 6 (SSB 2012c). From 1992, the population size has increased by 13 %, where the growth has been particularly high during the years 2006-2011. SSB observes immigration as the main growth driver and that urban areas have accounted for most of the growth. When population increases in a faster pace than the initiation of new housing construction this leads to demand pressure in the housing market. Figure 6 illustrates that the annual initiation of new housing construction follows the approximate same pace as the annual growth in population until 2005 (SSB 2012n). After 2005, the initiation of new housing construction decreases while the population size increases. Thus population growth may contribute to explain why housing prices have increased during the period 2006-2011.

Figure 6: Population growth and initiation of new housing construction 1992-2011

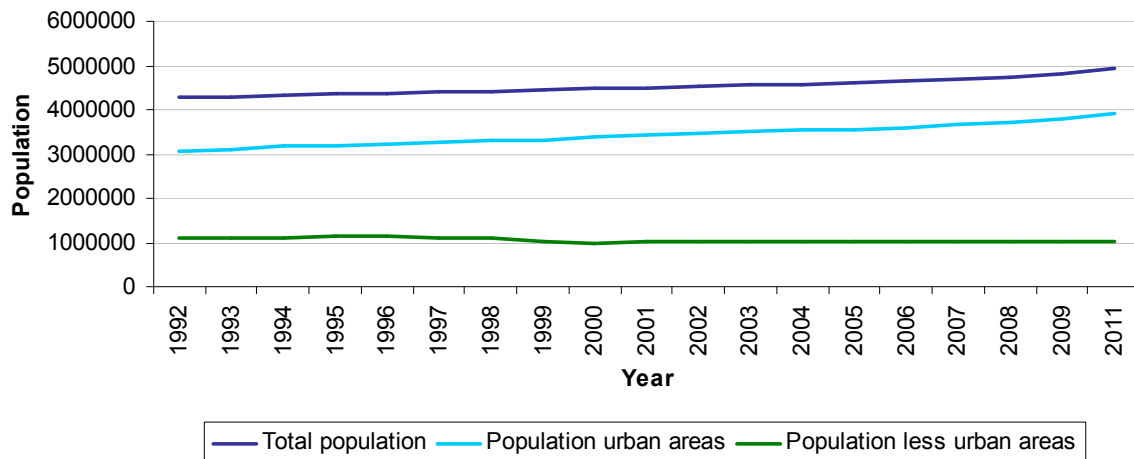


Population Movements

Housing demand in different parts of the country depends on population movements and net migration to urban areas has been positive during the recent years (Jacobsen and Naug 2005). This indicates an increasing demand for urban housing which may be defined as a demand for urban living, including employment, urban amenities and consumption opportunities (Sinai 2008). This development is shown in figure 7 (SSB 2012b), where the

population in sparsely populated areas is slowly decreasing while the population in urban areas is increasing. In 2010, Oslo and the municipalities closest to Oslo accounted for 35 % of the total population in Norway (Høydahl 2010).

Figure 7: Trends in urban and less urban population 1992-2011⁹

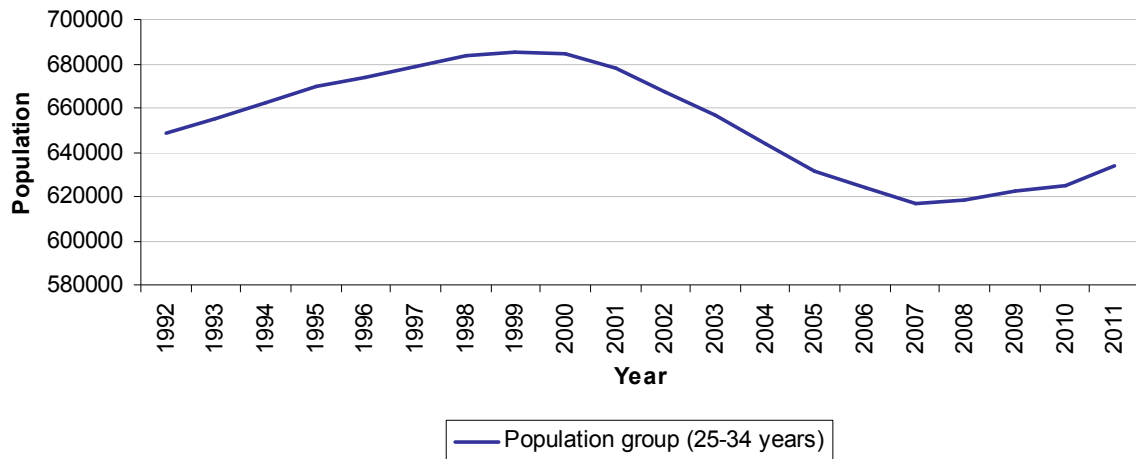


The Number of Individuals in the Start Up Phase

The number of individuals in the start up phase may be defined as the age group 25-34 years in SSB's (2012d) population database. Intuitively this may be reasonable since most people enter the housing market when they have completed their studies and have started to work. This interval assumes a five year higher education and that the individuals wait a year after high school before commencing their studies. In addition, individuals differ in terms of income and savings, which implies that they enter the housing market at different ages. The number of individuals in the start-up phase is illustrated in figure 8 which shows that this population group differs in size throughout the period. The size of the individuals in the start up phase is steadily increasing from 1992 until 1999, but after this period the population group is decreasing in size until 2007. From 2007 until 2011, the population group is increasing again. Since the number of individuals in the start up phase is lower during the latest decade than during the 1990s, this may imply that the number of individuals in the start up phase may not be a main explanatory variable for the increasing housing prices.

⁹ 2010 is not excluded in the dataset and the slope from 2009 to 2011 should therefore be less steep (SSB 2012b).

Figure 8: Number of individuals in the age group 25-34 years 1992-2011



The User Cost of Housing

In addition to income and population, housing demand depends on the user cost of housing, which is defined by Poterba (1992) as the cost of owning a house compared to renting a house¹⁰. According to the Ministry of Finance (Finansdepartementet 2011), the user cost of housing in Norway depends on the real interest rate after taxes, expectations about future price increases and taxation rules for housing and housing services¹¹.

The Real Interest Rate

The real interest rate r , is the rate that the households would receive if they sold their house and saved the proceeds (Romer 2001). Jacobsen and Naug (2005) and Baug and Dyvi (2008) observe that housing prices react quickly and strongly to changes in interest rates. Shiller (2005:12) on the other hand recognizes that low interest rates have contributed to the increasing housing prices since the 1990s but states that ‘central banks have cut interest rates many times in history, and such actions have never produced such concerted booms’.

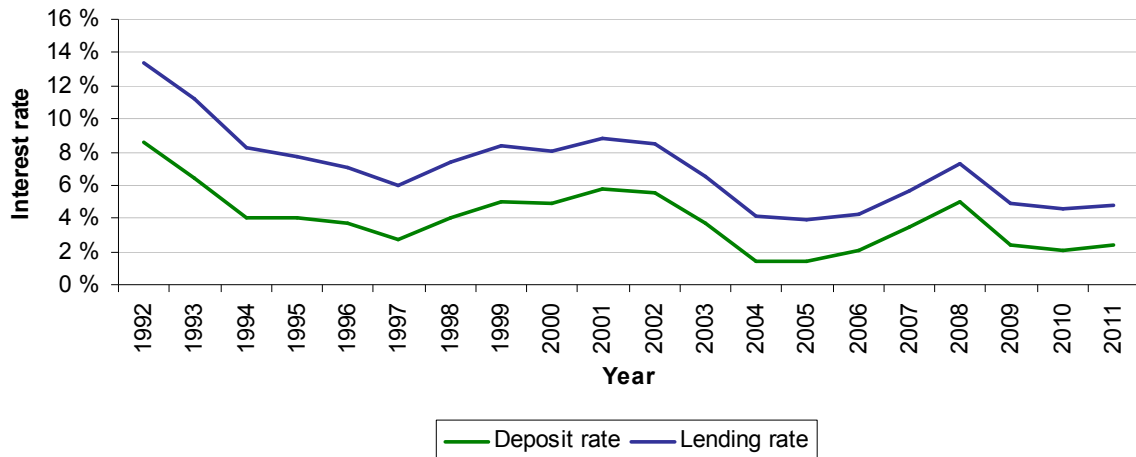
The developments in the annual average of banks lending and deposit rates from 1992-2011 are illustrated in figure 9 (SSB 2012p). The interest rates correlate and the development is

¹⁰ The user cost of housing is derived by Poterba (1992) as $R=P(i^a + \tau + f - \pi)$. i^a is the after tax interest rate and is adjusted to include the offsetting benefit of tax deduction, τ is the property tax rate on owner occupied housing, f is the recurring holding costs of depreciation, maintenance, and the risk premium on residential property, and π is the expected capital gain (or loss). P is the housing price index and R is the cost of renting a house. In equilibrium, the ratio of the imputed rental value to house price, R/P , should equal the term in the brackets known as the user cost of owner-occupied housing, which implies that the expected cost of owning a house should equal the cost of renting a house.

¹¹ The Ministry of Finance (Finansdepartementet 2011) states that the user cost of Norwegian housing also depends on depreciation. For simplicity, depreciation is not included in the analysis for analytical purposes and thus depreciation will not be discussed in this section. The argument for treating depreciation in this way is discussed further in section 3.1.2.

cyclical with peaks in 1992, 2001 and 2008, and troughs in 1997, 2005 and 2009. In addition, the long-run trend is decreasing. The cyclical variation in the interest rates implies that there have been frequent movements in the interest rates during the period.

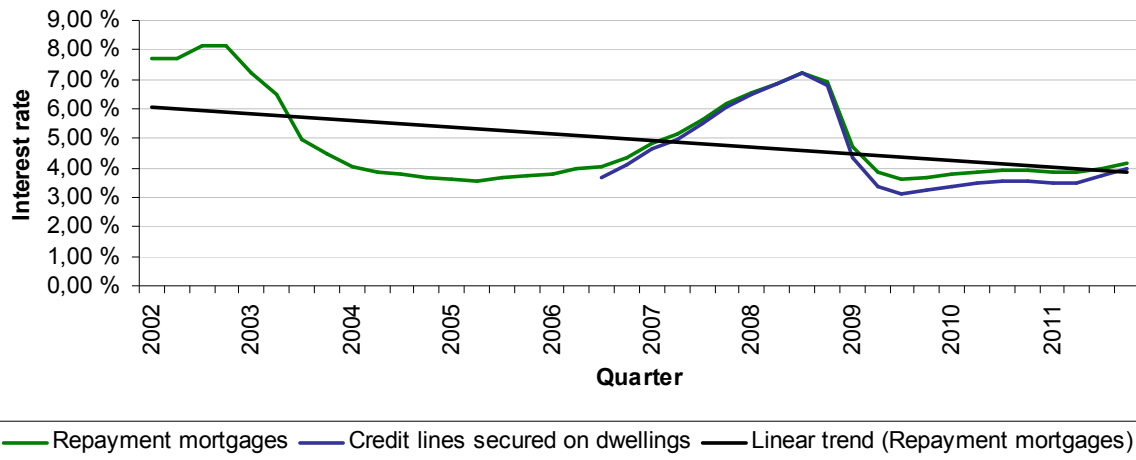
Figure 9: Banks' lending and deposit rates 1992-2011



A similar cyclical development in interest rates is seen in figure 10, which illustrate the quarterly interest rates households pay financial institutions on mortgage backed loans in the period 2002-2011 (SSB 2012o). Two types of loans are represented, 'repayment loans' and 'home equity loans'¹². The interest rates are quite high in the beginning of the period, with rates soaring above 8 % in both the third and the fourth quarter of 2002. From 2003 the rates decline, with a minimum point of 3.55 % in the second quarter of 2005. Until the Financial Crisis hits the economy, the interest rates increase with a peaking of 7.23 % in the third quarter of 2008. Due to government stimulus the interest rates fell in 2009 and have been on a low level since then.

¹² 'Repayment loans' are instalment loans while 'home equity loans' are loans secured on houses where a certain credit ceiling is issued, usually within 60-80 percent of the housing value in which the loan is secured. There are no restrictions to how or what the credit is used for and interests are only paid for the amount of the credit that the customer has used at the given time. 'Home equity loans' can be characterized as a 'financial innovation' and was broadly introduced to the public January 2006 (SSB 2012o).

Figure 10: Weighted average lending rates including provisions 2002-2011¹³



Price Expectations

Since expectations about future price increases is included in the user cost of housing, expectations about higher housing prices in the future can easily result in strong growth in housing prices today. If these expectations are retrospective, expectations in themselves may create long-lasting and strong cycles in the housing prices (Finansdepartementet 2011). Optimistic price expectations may cause housing prices to deviate from long-term trends particularly if housing supply is inelastic in the short-run (IMF 2012) and are stated as one of the main drivers behind the increase in housing prices during the recent years (Finanstilsynet 2012). Optimistic price expectations are closely related to high consumer confidence in the economy. Thus a further explanation of the role of consumer confidence is provided.

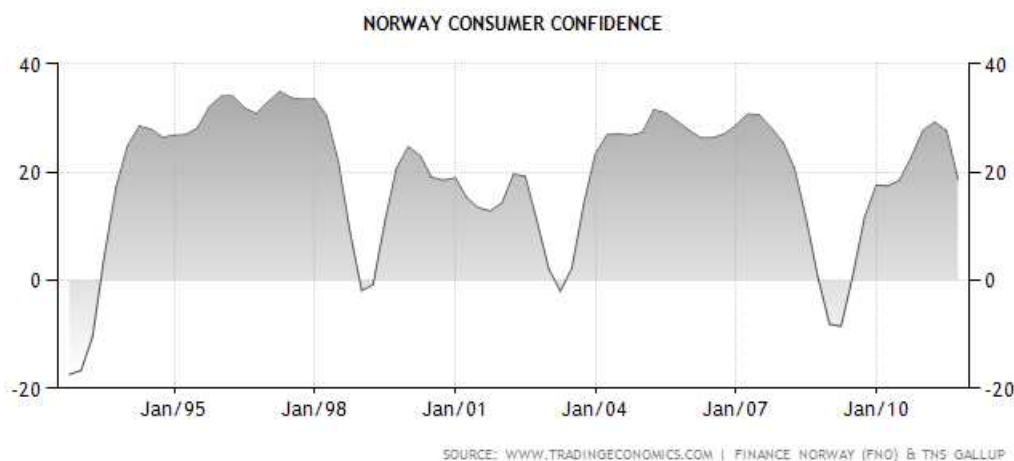
Consumer Confidence

Consumer confidence is the degree of optimism that consumers feel about the overall state of economy and their personal financial situation (Trading Economics 2012). If consumer confidence is high, consumers are making more purchases, boosting economic expansion. When confidence is low, consumers tend to save more than they spend, prompting the contraction of the economy. In Norway, the Finance Norway and TNS Gallup consumer confidence survey measures the level of optimism that consumers have about the performance of the economy. Trading Economics (2012) have illustrated these survey results in figure 11. The Norwegian economy is mostly characterized by positive consumer

¹³ The financial institutions in this figure include banks, credit institutions, life insurance companies and state lending institutions like Husbanken (SSB 2012o).

confidence, but consumer confidence is negative from January 1992 to April 1993, the last quarter of 1998, January 2003 and from October 2008 to April 2009. The figure implies that consumer confidence was particularly low during the troughs in the early 1990s and the Financial Crisis in 2008-2009.

Figure 11: Consumer confidence 1992-2011



Taxation Rules

Housing taxation in Norway is beneficial compared to many other countries, other investment goods and the rental market. It seems obvious that the favourable housing taxation leads to higher housing stock and higher housing prices (Finansdepartementet 2011). Housing in Norway is subject to the following preferential taxation rules (IMF 2012):

- Taxes on imputed rent were abolished in 2005.
- Gains from sale of owner occupied housing is exempt from taxation under certain conditions. The same applies to rental income when a part of the house is rented out.
- Mortgage interests are tax deductible.¹⁴
- Housing is valued low for the purpose of wealth taxation (around 25 % of market value).

On the other hand, freehold housing is subject to 2.5 % stamp duties on sale and many municipalities impose property taxes on housing (Finansdepartementet 2011). The IMF (2012) states however that the effective rates of property taxation are amongst the lowest in

¹⁴ Before the tax reform in 1992, Norwegian households had full deductibility of mortgage interests. Full deductibility combined with high marginal taxes gave incentives to take out a mortgage. After the tax reform, the link between marginal taxes and interest deductibility was abolished and a flat deduction at 28 % was implemented. As a result mortgages became less taxable lucrative for most households (Sommervoll 2007).

the OECD and that these taxes do not outweigh the preferential tax treatment of housing compared to other capital goods.

The IMF (2012) highlights the abolition on imputed rents in 2005 as one of the main contributors to the current boom in housing prices. Even though the authorities have made efforts to reduce the implicit tax subsidies for owner-occupied housing during the recent years (including steps in 2010 to raise property valuations for tax purposes), these changes are most likely outweighed by the change in 2005. In addition, the IMF (2012) suggests that the tax system's promotion of high household leverage, due to the deductibility of mortgage interest and the asymmetric valuation of housing assets and mortgages for wealth tax purposes, may have amplified the effect of the boom on household balance sheets.

Financial Conditions

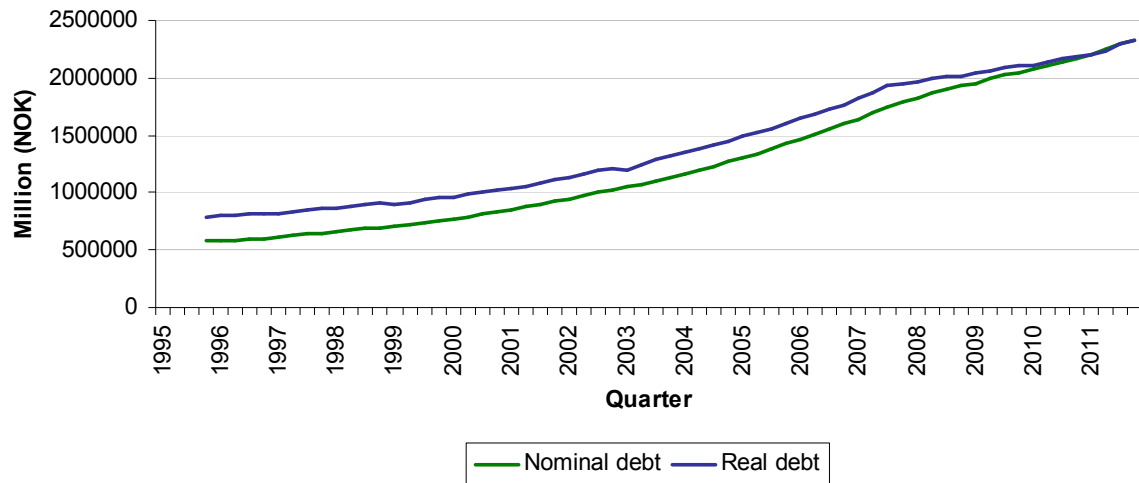
Financial conditions depend on banks' profitability, government regulations, households' expected ability to repay debt and the collateral values of households' houses (Jacobsen and Naug 2005). In this section this thesis mainly focuses on the development in household debt, the presence of the financial accelerator and the newly imposed credit requirements.

Household Debt

Norwegian households mainly take on debt to buy a house (Sommervoll 2007) and in 2009, 61.3 % of the population lived in an owner-occupied house with an outstanding loan or mortgage (Eurostat 2012). Figure 12 illustrates that the size of households and non-profit organizations real debt¹⁵ increased by 194 % from the last quarter in 1995 to 2011 (SSB 2012k).

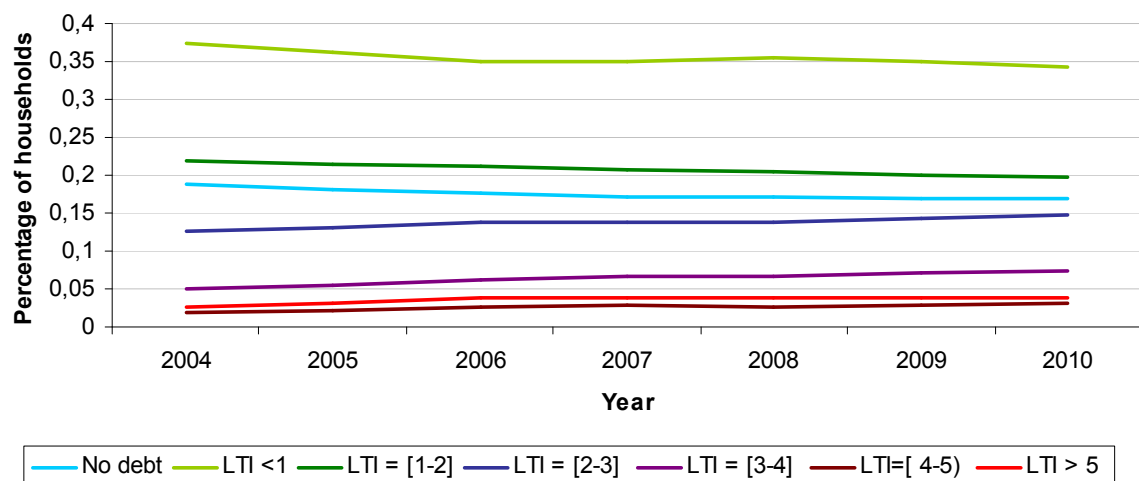
¹⁵ The debt is converted into real terms by deflating the nominal prices by the CPI (SSB 2012g).

Figure 12: Households and non-profit organizations nominal and real debt 1995 (fourth quarter)-2011



Since households' expected ability to repay debt increase when disposable income increases, some of the increase in the households' debt can be attributed to the increase in disposable income. Thus it is interesting to study the households' loan to income (LTI) ratios, which are illustrated in figure 13 (SSB 2012f). As noted by the IMF (2012), the number of households with LTI ratios excess 500 % is increasing. This also applies to the number of households with LTI ratios in the range of 200 % - 500 %, while the number of households with lower LTI ratios is decreasing.

Figure 13: Households' LTI ratios 2004-2010



The Financial Accelerator

Anundsen and Jansen (2011) show that there exists self-reinforcing effects between housing prices and debt in the long-run. Higher housing prices result in higher credit growth due to

collateral effects, which again spurs housing price growth, showing that there is a financial accelerator at work.

In the long-run, high household debt and rising housing prices represent a challenge for the financial system. Norges Bank (2011) explains this as a risk that many households adapt in a manner that makes them vulnerable when interest rates rise or economic prospects weakens. In such situations, it may become difficult for households to repay debt and they would have to reduce consumption. When household demand declines, this may reduce corporate earnings, which in the long-run can lead to increased losses on corporate loans.

Credit Requirements

The authorities are taking steps to reduce financial stability risks related to high household debt and housing prices. In March 2010, the Financial Supervisory Authority (FSA) instituted new guidelines for residential mortgage lending. These guidelines recommended that loan-to-value (LTV) ratios on mortgages should generally not exceed 90 %, LTVs on home equity loans should not exceed 75 % and LTI ratios on mortgages should generally not exceed 300 %. In December 2011, the FSA tightened these guidelines further, including lowering LTV on mortgages to 85 %, lowering the maximum LTV on home equity loans to 70 %, and recommending that banks allow for an interest rate increase of 5 % when assessing a borrower's ability to repay debt (IMF 2012).

There is disagreement about how effective these credit requirements are, and there is a wide opinion that the credit requirements make it more difficult for individuals in the start up phase to enter the housing market. IMF (2012) states that these actions are welcome, but need to be more tightly enforced to be sufficiently effective.

In this section, the historical development and the main determinants of the housing market were described. It was first explained that the historical development in housing prices depends on the state of the economy, where it was shown that housing prices particularly fell during the troughs in the early 1990s and the Financial Crisis 2008-2009. In the second part of this section, construction costs and regulations were identified as the main forces of housing supply, while income, population, the user cost of housing, and financial conditions were identified as the main forces of housing demand.

3. A q Theory Model of Housing

‘Housing is a durable good: it is not consumed once and disposed of, but yields housing services for many years. Hence, the decision to invest in housing can be analysed in a similar way to a company’s decision to invest in machinery or other capital’ (Corder and Roberts 2008: 394). In this section this thesis presents a model of investment with adjustment costs, where it is focused on a household’s decision to invest in housing¹⁶. The theoretical framework for the model is developed by Abel (1982), Hayashi (1982) and Summers (1981) and the discussion in this thesis closely follows the presentation of the q theory model in the Advanced Macroeconomics textbook by David Romer (Romer 2001).

In order to apply the model presented in Romer’s textbook to the housing market, some adjustments are needed. The main difference from the model presented in Romer’s textbook is that this thesis interprets housing as a type of capital and that firms are replaced by households, which is consistent with Corder and Robert’s definition of housing.

3.1 Assumptions

This section presents the underlying assumptions of the q theory model of housing. First, the household’s preferences are discussed, followed by an explanation of the housing accumulation constraint and finally this thesis introduce adjustment costs associated with housing investment.

3.1.1 The Household’s Preferences

First, this thesis considers an economy with N identical households and a finite number of commodities. The representative household wants to maximize utility over time, where the utility function includes all consumer goods such as housing, food and clothes. For simplicity, this thesis will focus on housing utility in the analysis, and thus some assumptions must be made in order to analyze the representative household’s housing utility. First, it is assumed that the household’s preferences take the Gorman form, second, preferences are additively separable, third, subutilities are time separable and fourth, boundary (Inada) conditions is imposed in order to ensure interior solutions.

¹⁶ For the purpose of this thesis, ‘housing’ will refer to owner-occupied housing and housing rented out to other households.

The Gorman Aggregation Theorem

In order to analyze the behaviour of a representative household, the households' preferences are assumed to take the Gorman form¹⁷. This enables the aggregation of individual preferences and the modelling of the economy as if the demand side was generated by a representative household¹⁸. Gorman's Aggregation Theorem implies that when preferences admit a quasi-linear form, aggregate behaviour may be represented as if it resulted from the maximization of a single household (Acemoglu 2009).

In practice, household's preferences may violate the Gorman form since preferences are heterogeneous. Kaplow (2008) finds that 'heterogeneous preferences undoubtedly exist' while Acemoglu (2009) state that 'it is not true that most models with heterogeneity lead to a behaviour that can be represented as if it were generated by a representative household'. This is because, if the indirect utility functions of some households do not take the Gorman form, there will exist some distribution of income such that aggregate behaviour cannot be represented as if it resulted from the maximization problem of a single representative household (Acemoglu 2009). As a result, the assumption that the household's preferences follow the Gorman form may not be a completely satisfactory method, but it is useful for analytical purposes since it enables aggregation of household preferences in a simple way.

Another problem with Gorman Preferences is related to homothetic and quasi-homothetic preferences¹⁹, where the quasi-linear form of the Gorman Preferences is a special case of quasi-homotheticity (Acemoglu 2009 and Miller 2006). Deaton discusses homotheticity and states that 'the supposition that there are neither luxuries nor necessities contradicts both common sense and more than a hundred years of empirical research' (Deaton 1992: 9). Quasi-homotheticity on the other hand, retains much of the mathematical convenience of

¹⁷ To illustrate the Gorman Preferences, the preferences of household $i \in N$ can be represented by an indirect utility function by the form $v^i(p, y^i) = a^i(p) + b(p)y^i$ where p is a price vector and y is the household's income. These preferences can be aggregated and represented by those of a representative household, with indirect utility $v(p, y) = \int_{i \in N} a^i(p) di + b(p)y$ where $y = \int_{i \in N} y^i di$ is aggregate income (Acemoglu 2009).

¹⁸ An attractive feature of the Gorman Preferences is that they contain the constant elasticity of substitution (CES) preferences, which plays a role in aggregation and ensuring balanced growth in neoclassical growth models. In addition, Gorman Preferences imply the existence of a normative representative household which enables welfare comparisons (Acemoglu, 2009).

¹⁹ The main difference between homothetic and quasi homothetic preferences concerns the within Engel curves for goods. Homothetic subutility implies that the within-period Engel curves for goods are straight lines through the origin, so that all goods have identical unit elasticities (Deaton 1992) while quasi-homothetic subutility implies that the Engel curves do not need to go through the origin (Deaton and Muellbauer 1980).

homotheticity and is considered a more fruitful assumption empirically²⁰ (Deaton and Muellbauer 1980). Thus the assumption of quasi-homothetic preferences may not be unrealistic. However, in order to analyze housing utility separately from the utility of other goods, it is assumed that preferences are homothetic in the next chapter. This may represent a problem since the preferences are not in the same form in both cases, and since homothetic preferences contradicts common sense and empirical research. For the purpose of the analysis it is assumed that assuming homothetic and quasi-homothetic preferences will not represent any major problems, since households' preferences are assumed to be given.

Intertemporal Preferences and Components of Consumption

Deaton (1992:7) states that 'consumption can be defined as an aggregate set of commodities'²¹. In order to derive the household's utility function, it is assumed that intraperiod preferences $\phi_t(\bullet)$ are separable between two groups of goods, so that

$$v_t(q_t) = u_t(\phi_{1t}(q_{1t}), \phi_{2t}(q_{2t})) \quad 3.1$$

where $v_t(\bullet)$ is the individual period 'subutility' function, and q is a vector representing the consumption aggregates (c_{1t} and c_{2t}). In a two-goods-economy, the intertemporal choices for either of these aggregates depend on the choices for the other one. The most straightforward empirical procedure is to recognize this dependence explicitly. If intraperiod separability is strengthened to intraperiod additivity²², if intertemporal preferences are *additively separable*²³, and if both commodity groups are homotethic, the intertemporal utility function takes the form

$$u = \sum_1^T u_t(v_{1t}(c_{1t}) + v_{2t}(c_{2t})) \quad 3.2$$

²⁰On aggregate time-series data for broad groups of goods it is not obvious that empirical evidence contradicts linear Engel curves (Deaton and Muellbauer 1980).

²¹ The treatment of consumption as a real aggregate is not a completely satisfactory method (Deaton 1992), but this is not believed to be a major problem in the following analysis.

²² Intra-period additivity rules out inferior goods and complementary goods and forces an approximate proportionality between income and own-price elasticities (Deaton 1992). Deaton (1992:11) states that 'this assumption is typically rejected on the evidence', but this thesis finds the assumption of intra-period additivity useful for analytical purposes.

²³ Choice is governed by a set of intertemporal preferences, which in their most general form can be written as $u = V(c_1, c_2, c_3, \dots, c_T)$. The assumption that intertemporal preferences are additively separable implies that the previous function may be written as $u = v_1(c_1) + v_2(c_2) + \dots + v_T(c_T)$, where the individual period 'subutility' functions $v_i(c_i)$ are increasing and concave in their single arguments (Deaton 1992).

This problem may only be split into two separate problems if the u_t functions are identity functions so that intertemporal utility becomes a double sum over both goods and period

$$u = \sum_{t=1}^T \sum_{i=1}^n v_{it}(c_{it}) \quad 3.3$$

where Deaton (1992) generalizes to allow n aggregates in each period. If (3.3) is correct, the consequences of additivity are extended to all goods in all periods and the behaviour²⁴ of each good is controlled by the curvature of each subutility function.

The Utility Function and the Housing Market

Assuming a two-goods-economy, equation (3.3) can be applied to the housing market. The goods are represented by housing, h , and all other goods, a . The representative household's utility u at time t can be therefore be written as

$$u = v_{ht}(c_{ht}) + v_{at}(c_{at}) \quad 3.4$$

where c_{ht} is the consumption of housing and c_{at} is the consumption of all other goods, and v_{ht} and v_{at} are the two goods' respective subutility functions.

Inada Conditions

Provided that there exists an interior solution, it is assumed that the utility function satisfies the Inada conditions (Inada 1963) in order to ensure an interior solution.

$$\lim_{h \rightarrow 0} u'(h) = \lim_{a \rightarrow 0} u'(a) = \infty \quad 3.5$$

$$\lim_{h \rightarrow \infty} u'(h) = \lim_{a \rightarrow \infty} u'(a) = 0 \quad 3.6$$

The Inada conditions state that the marginal utility of housing (or other goods) approaches infinity as housing (or other goods) goes to zero and approaches zero as housing(or other goods) goes to infinity (Barro and Sala-I-Martin 1995). Intuitively, the Inada conditions will ensure that housing demand is bounded away from extreme values (zero and infinity). These conditions will therefore ensure an interior solution, provided it exists.

²⁴ The behaviour of each good includes income elasticities, price elasticities, and intertemporal elasticities.

Separability of Utility

Assuming intraperiod separability and additivity, additively separable intertemporal preferences, homothetic goods and identity utility functions it is possible to split the representative household's utility into two separate problems; housing utility and the utility of all other goods. Thus, the representative household's housing utility at time t can be written as

$$u_{ht} = v_{ht}(c_{ht}) \quad 3.7$$

where v_{ht} takes the Gorman form and c_{ht} is the consumption of housing.

A representative household's real flow of housing utility at time t , neglecting any costs of acquiring housing, are proportional to its housing stock $h(t)$, and decreasing in the aggregate housing stock $H(t)$, and can be written as $\pi(H(t))h(t)$, where $\pi'(\bullet) < 0$ (Romer 2001). In relation to equation (3.7), π may be interpreted as the household's preferences, where the consumption of housing is given by $(H(t))h(t)$. $\pi(H(t))$ represents marginal utility per housing unit and since $\pi'(\bullet) < 0$, marginal housing utility is decreasing in the aggregate housing stock assuming that other factors such as productivity and technology are constant.

That marginal housing utility decrease in the aggregate housing stock may be appropriate if it is assumed that households do not like to live too crowded due to lower quality of life²⁵. This may be the case since the flow of people into cities will not necessarily improve the quality of life of the people already living in there (Glaeser 2011). Intuitively, this makes sense since crowdedness leads to more insight from strangers, more pollution and less space. Another argument that may support the assumption of decreasing marginal housing utility in the aggregate housing stock is that households want to 'keep up with the Joneses'²⁶.

²⁵ This assumes that the negative effects of an increase in the aggregate housing stock outweigh the positive effects. In the past, urbanization has been viewed as a trade-off between higher wages and lower quality of life. Since the early 20th century this began to change as many major cities have experienced sharp improvements in quality of life (Haines 2001) and demand for urban housing has been rising for many countries including Norway (Jacobsen and Naug 2005 and Rosenthal and Strange 2003). Despite the fact that urban housing involves benefits like employment, urban amenities and consumption, it may be assumed that households' utility decrease when the city grows. When an extra person moves to a big city from a smaller city, this migration causes net social damage due to extra congestion and pollution (Kahn 2008). There is a range of empirical evidence supporting this argument. Tolley (1974) finds that the biggest cities suffered more quality-of-life degradation as they expanded and Glaeser (1998) and Henderson (2002) has documented that urban challenges such as crime, polluting and congestion are all greater in big cities than in smaller cities. Thus, new housing units built to keep up with migration decrease the housing utility to households already living there.

²⁶ Agents have preferences defined on their own consumption, as well as average consumption in the economy. This allows for the idea that households care about their relative standard of living or, as the saying goes, they want to 'keep up with the Joneses' (Gali 1994). By for example looking at housing renovation, researchers have observed 'clustering' of renovation activity that cannot be explained by exogenous neighbourhood characteristics alone, and they have identified a variety of incentives, both social and financial, that motivate households to 'keep up with the Joneses' (Helms 2012).

Intuitively, when a neighbour builds a bigger house, the representative household's housing utility decreases since the household wants the same utility level as its neighbour but cannot achieve it due to liquidity constraints.

Theoretically, the representative household's housing stock, h , and consumption of other goods, a , depend on the choices for the other one (Deaton 1992). The dependence is particularly important in deriving the transversality condition in section 3.2 since households' consumption of other goods than housing is compromised if the households' are continuously attaching high value to housing consumption as time approaches infinity.

Empirically, the relationship between housing and the consumption of other goods is more ambiguous. Several commentators have expressed that rising housing prices have kept consumption high throughout the 1990s. For the US, Case et al. (2003) find long-run elasticities of consumption to house prices around 0.06 using panel data on individual US states. Davis and Palumbo (2001) estimate a long-run elasticity of consumption to housing wealth of 0.08. In addition, Iacoviello (2004) finds that if liquidity-constrained households value current consumption a great deal, they may be able to increase their borrowing and consumption more than proportionally when housing prices rise, so that increase in prices might have positive effects on aggregate demand.

3.1.2 The Housing Accumulation Constraint

The housing accumulation constraint is given by $\dot{h}(t) = I(t) - \delta(t)h(t)$, where I is the household's investment and \dot{h} is the change in the household's housing stock. For simplicity, it is assumed that the depreciation rate is zero ($\delta = 0$), which implies that the housing accumulation equation is given by $\dot{h}(t) = I(t)$. It can be argued that the assumption of zero depreciation is reasonable since housing depreciation is much slower than for other capital goods (see Davis and Heathcote 2005 and Jin and Zeng 2004). Housing depreciation in Norway is in addition relatively stable at approximately 2 % which is 3 % lower than for other capital goods (SSB 2012). Thus it may be assumed that the exclusion of depreciation will not have any major impact for the analysis.

3.1.3 Adjustment Costs

A key assumption of the q theory model of housing is that the representative household faces adjustment costs when altering the housing stock (Romer 2001). Grossman and Laroque (1990) defines adjustment costs as 'in selling the old durable, a transactions cost must be

paid which is proportional to the value of the durable being sold (e.g., a commission to a real estate broker)'. The adjustment costs are a convex function of the rate of change of the household's housing stock, \dot{h} and specifically, the adjustment costs $C(\dot{h})$, satisfy $C(0)=0$, $C'(0)=0$, and $C''(\bullet)>0$. These assumptions imply that it is costly for a household to increase or decrease its housing stock, and that the marginal adjustment cost is increasing in the size of the adjustment (Romer 2001). 'Adjustment costs prevent the capital stock moving immediately to a new equilibrium. So the short-run supply response of the stock to a change in returns is less than the long-run response' (Corder and Roberts 2008: 394). Thus, the presence of adjustment costs means that the housing stock acts sluggishly to demand shifts.

3.1.4 The Household's Problem

The assumptions imply that the household's flow of housing utility at a point of time are $\pi(H)\dot{h}-I-C(I)$. The household maximizes the present value of this flow of housing utility,

$$\Pi = \int_{t=0}^{\infty} e^{-rt} [\pi(H(t))\dot{h}(t) - I(t) - C(I(t))] dt \quad 3.8$$

For simplicity, it is assumed that the real interest rate, r , is constant. Each household takes the path of the aggregate housing stock, H , as given, and chooses its investment over time to maximize its life time flow of housing utility given this path.

3.2 A Discrete-time Version of the Household's Problem

In the analysis, this thesis uses a continuous-time version of the household's problem, but in order to provide intuition, a discrete-time version of the household's problem is first derived. The reason for this is that it is easier to analyze the discrete-time model in equilibrium, but the continuous-time model allows easier analysis of the dynamic adjustment using the phase diagram. The method used to solve the household's maximization problem is called the calculus of variations. The evolution of the household's housing stock is given by the households accumulation constraint²⁷, $h_{t+1}=h_t+I_t$, and the adjustment costs are given by $C(I_t)$. The household's objective function is therefore

²⁷ Depreciation is excluded for analytical purposes. As argued in section 3.1.2 it is assumed that this will not have any major impacts on the analysis.

$$\tilde{\Pi} = \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi(H_t)h_t - I_t - C(I_t)] \quad 3.9$$

The household chooses its investment and housing stock each period subject to the housing accumulation constraint, $h_{t+1} = h_t + I_t$. Since there are infinitely many periods, there are infinitely many constraints. The Lagrangian for the household's maximization problem is

$$L = \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi(H_t)h_t - I_t - C(I_t)] + \sum_{t=0}^{\infty} \lambda_t (h_t + I_t - h_{t+1}) \quad 3.10$$

λ_t is the Lagrange multiplier associated with relaxing the constraint relating h_{t+1} and h_t . It gives the marginal impact of an exogenous increase in h_{t+1} on the lifetime value of the household's flow of housing utility discounted to time 0. If it is defined that $q_t = (1+r)^t \lambda_t$, it follows that q_t shows the value to a household of an additional unit of housing at time $t+1$ in time- t goods. With this definition the Lagrangian can be rewritten as

$$L' = \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi(H_t)h_t - I_t - C(I_t) + q_t (h_t + I_t - h_{t+1})] \quad 3.11$$

The first-order condition for the household's investment in period t is therefore

$$\frac{1}{(1+r)^t} [-1 - C'(I_t) + q_t] = 0 \quad 3.12$$

Multiplying both sides by $(1+r)^t$, obtains

$$1 + C'(I_t) = q_t \quad 3.13$$

Equation (3.13) states that the cost of acquiring a housing unit equals the purchase price (which is fixed at 1) plus the marginal adjustment costs. This condition can be interpreted as that the household invests to the point where the costs of acquiring housing equals the value of housing.

This thesis now considers the first-order condition for housing in period t . The term for period t in the Lagrangian, (3.11), involves both h_t and h_{t+1} . Thus the housing stock in period t , h_t , appears both in the term for period t and the term for period $t-1$. The first-order condition for h_t is therefore

$$\frac{1}{(1+r)^t} [\pi(H_t) + q_t] - \frac{1}{(1+r)^{t-1}} q_{t-1} = 0 \quad 3.14$$

Multiplying this expression by $(1+r)^t$ and rearranging yields

$$\pi(H_t) = (1+r)q_{t-1} - q_t \quad 3.15$$

If this thesis defines $\Delta q_t = q_t - q_{t-1}$, the right-hand side of (3.15) can be rewritten as

$$\pi(H_t) = rq_t - \Delta q_t - r\Delta q_t \quad 3.16$$

The left-hand side of (3.16) is the marginal housing utility, while the right-hand side is the opportunity cost of a housing unit. Owning a housing unit for a period requires forgoing rq_t of real interest and involves offsetting housing gains of Δq_t . Equation (3.16) states that for the household to be optimizing, the returns to housing must be equal to this opportunity cost.

The final condition is called the *transversality condition* and characterizes the household's behaviour concerning what happens as t approaches infinity (Romer 2001). The intuition is that households do not have any valuable assets left at the end. Utility would increase if the assets, which are effectively being wasted, were used instead to raise consumption at some dates over time (Barro and Sala-I-Martin 1995). In this case, the utility function including housing and all other goods kicks in (see equation [3.4]). For an optimizing household with an infinite horizon, the transversality condition is given by

$$\lim_{t \rightarrow \infty} \frac{1}{(1+r)^t} q_t h_t = 0 \quad 3.17$$

The transversality condition states that the household's value of housing discounted to time 0 must approach zero as time approaches infinity, where the value of housing may be defined as the quantity $h(t)$ times the shadow price $q(t)$. If this condition fails, the household is holding valuable housing forever, and so it can increase the present value of its flow of housing utility by reducing its housing stock.

3.3 A Continuous-time Version of the Household's Problem

This thesis now considers the case when time is continuous. The household's problem is now to maximize the continuous-time objective function (3.8) instead of the discrete-time objective function, (3.9). To analyze the problem it useful to set up the current-value Hamiltonian:

$$B(h(t), I(t)) = \pi(H(t))h(t) - I(t) - C(I(t)) + q(t)I(t) \quad 3.18$$

This expression is analogous to the discrete-time case (3.11). The variable that can be controlled freely (I) is the control variable, the variable which at any time is determined by past decisions (h) is the state variable, and the shadow value of the state variable (q) is the costate variable.

The first condition characterizing the optimum is that the derivative of the Hamiltonian with respect to the control variable at each point in time is zero.

$$1 + C'(I(t)) = q(t) \quad 3.19$$

This condition is analogous to (3.13) in the discrete time case.

The second condition is that the derivative of the Hamiltonian with respect to the state variable equals the discount rate times the costate variable minus the derivative of the costate variable with respect to time. In this case, this condition is

$$\pi(H(t)) = r q(t) - \dot{q}(t) \quad 3.20$$

which is analogous to (3.16) in the discrete-time case.

The final condition is the continuous-time version of the *transversality condition*, which is

$$\lim_{t \rightarrow \infty} e^{-rt} q(t) h(t) = 0 \quad 3.21$$

The equations (3.19), (3.20) and (3.21) characterize the household's behaviour and equation (3.20) implies

$$q(t) = \int_{\tau=t}^T e^{-r(\tau-t)} \pi(H(\tau)) d\tau + e^{-r(\tau-t)} q(T) \quad 3.22$$

This equation expresses q , the value of housing, in terms of future marginal housing utility for any $T > t$. The transversality condition implies that the second term approaches zero as T approaches infinity. Thus, the *fundamental value of the housing stock* is given by:

$$q(t) = \int_{\tau=t}^{\infty} e^{-r(\tau-t)} \pi(H(\tau)) d\tau \quad 3.23$$

This expression states that the value of a housing unit at a given time equals the discounted value of the household's future marginal housing utility.

3.4 Tobin's q

The household's problem implies that q summarizes all information about the future that is relevant to a household's investment decision. q shows how an additional unit of housing affects the present value of the flow of housing utility. Thus the household wants to increase its housing stock if q is high and reduce it if q is low. The household does not need to know anything about the future other than the information summarized in q in order to make this decision.

The ratio of the market value to the replacement cost of capital is known as Tobin's q (Tobin, 1969). The analysis of the household's problem implies that what is relevant to investment is *marginal* q , which is the ratio of the market value of a marginal unit of housing to its replacement cost. The *average* q is defined as the market value of the household's housing stock to the replacement costs of its housing stock. Marginal q is likely to be harder to measure than average q , and thus it is important to know how they are related.

In the model, marginal q is less than average q . This is because when it was assumed that adjustment costs only depend on \dot{h} , this thesis implicitly assumed diminishing returns to scale in adjustment costs. In this case, households' lifetime flow of housing utility, Π , rise less than proportionally with their housing stocks, and so marginal q is less than average q .

If this thesis assumes that the model has constant returns to scale in the adjustment costs, average q and marginal q are equal (Hayashi, 1982). The source of this result is that constant returns in the adjustment costs imply that q determines the growth rate of the household's housing stock. As a result, all households choose the same growth rate of their housing stocks. In the rest of the thesis it is therefore assumed that the model has constant returns to scale in the adjustment costs. This means that marginal and average q can be equated.

3.5 Analyzing the Model

The q theory model of housing can be analysed using a phase diagram, where it is focused on the value of housing, q and the aggregate housing stock, H . The economy inherits the quantity of housing from the past, but the prices adjust freely in the market.

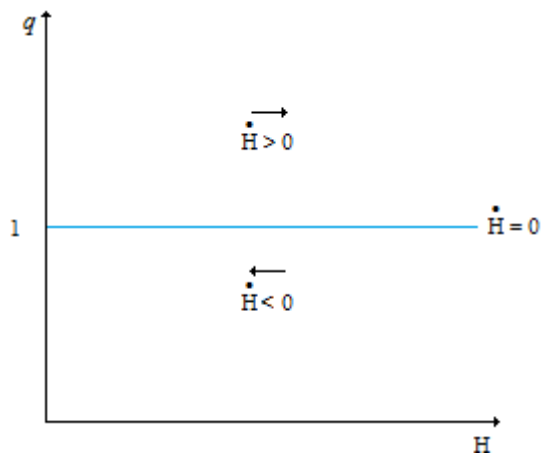
Equation (3.19) states that each household invests to the point where the purchase price of housing plus the marginal adjustment costs equal the value of housing, $I + C'(I) = q$. Since $C'(I)$ is increasing in I , this condition implies that I is increasing in q . Because $C'(0)$ is 0 , it

also implies that I is 0 when q is 1. Due to the fact that q is equal for all households, all households choose the same value of I . This means that the rate of change in the aggregate housing stock, \dot{H} , is given by the number of households times the value of I that satisfies (3.19). Assembling this information gives

$$\dot{H}(t) = f(q(t)), \quad f(1) = 0, \quad f'(\bullet) > 0, \quad 3.24$$

where $f(q) = NC^{-1}(q-1)$ and N is the number of identical households. Equation (3.24) implies that H is increasing when $q > 1$, decreasing when $q < 1$, and constant when $q = 1$. Intuitively, if $q > 1$, the market value of new investment in housing exceeds the replacement value and the household has an incentive to invest in housing. In contrast, the household has an incentive to disinvest in housing if $q < 1$, since the replacement value of new investment in housing exceeds the market value. When $q = 1$, the household neither has an incentive to invest nor disinvest in housing since the market value of new investment in housing is equal to the replacement value. This information can be illustrated in figure 14, where the arrows describe the dynamics in equation (3.24). The arrow above the line where $q = 1$, points to the right to illustrate that the aggregate housing stock increases when $q > 1$, while the arrow below the line, points to the left to illustrate that the aggregate housing stock decrease when $q < 1$. When $q = 1$ the economy is located on the line and the aggregate housing stock is constant.

Figure 14: The dynamics of H

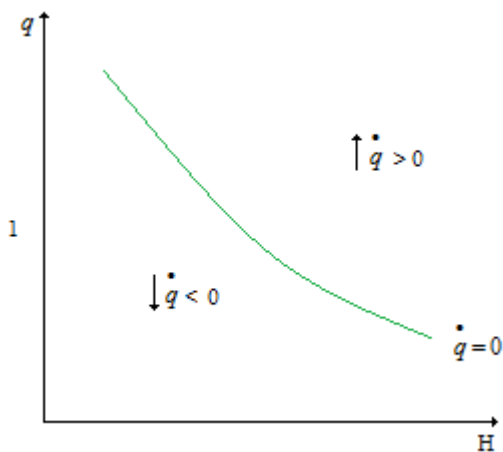


Rewriting equation (3.20) as an equation for \dot{q} gives

$$\dot{q}(t) = rq(t) - \pi(H(t)) \quad 3.25$$

Equation (3.25) implies that q is constant when $rq=\pi(H)$, or $q=\pi(H)/r$. Since $\pi(H)$ is decreasing in H , the set of points satisfying this condition is downward-sloping in (H,q) space. In addition, (3.25) implies that \dot{q} is increasing in H ; thus \dot{q} is positive to the right of the $\dot{q}=0$ locus and negative to the left. This information can be illustrated in figure 15.

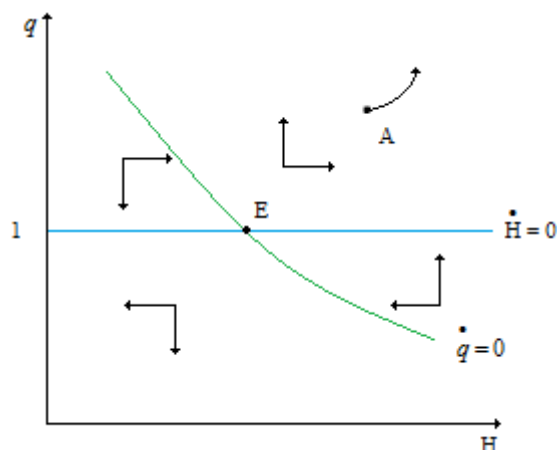
Figure 15: The dynamics of q



3.5.1 The Phase Diagram

Figure 14 and 15 can be combined in figure 16. This diagram shows how H and q must behave to satisfy (3.24) and (3.25) at every point in time given their initial values.

Figure 16: The phase diagram



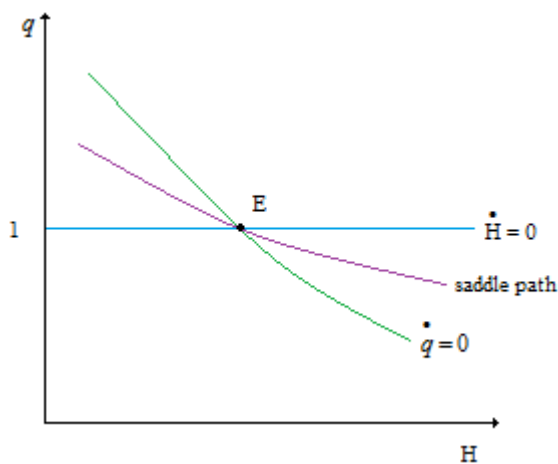
For a given level of H there is a unique level of q that produces a stable path. Specifically, there is a unique level of q such that H and q converge to the point where they are stable (point E in the diagram). If q starts below this level, the economy crosses into the region where both H and q are falling, and they continue to fall indefinitely. Similarly, if q starts too

high, the economy eventually moves to the region where both H and q are rising and remains there. One can show that the transversality condition fails for these paths, and thus they can be ruled out.

Along the path starting at A , the representative household is continually building up housing stock because the value it attaches to the housing stock is always high. This high value is not justified by large marginal housing utility, but by further increases in the value the household attaches to the housing stock. That is equation (3.20) holds with a high value of q not because $\pi(H)$ is high, but because \dot{q} is high. Attaching this high and rising value to housing only makes sense if at some point the housing stock actually makes large contributions to the household's flow of housing utility. On the path starting at A , this time never comes. As a result, one can show that the household can raise the present value of its lifetime flow of housing utility by lowering the path of its housing stock. An analogous argument applies to paths where H and q are continually falling.

The unique equilibrium, given the initial value of H , is for q to equal the value that puts the economy on the saddle path, and for H and q to then move along this saddle path to E . This saddle path is shown in figure 17. Note that the saddle path is not necessarily linear.

Figure 17: The saddle path



The long-run equilibrium, Point E , is characterized by $q=1$ (which implies $\dot{H}=0$) and $\dot{q}=0$. The fact that q equals 1 means that the market and replacement values of housing are equal; thus households have no incentive to increase or decrease their housing stocks. Equation (3.20) implies that, for \dot{q} to equal 0 when q is 1 , the marginal housing utility must equal r . This means that the flow of housing utility from holding a housing unit just offset the

forgone interest, and thus that households are satisfied to hold housing without the prospect of either housing gains or losses.

3.6 Implications

The model outline of the q theory of housing can be used to address many issues. It can for example be used to analyze the effects of changes in housing utility, interest rates and taxes. For concreteness, it is assumed that the economy initially is in long-run equilibrium.

3.6.1 The Effects of Utility Movements

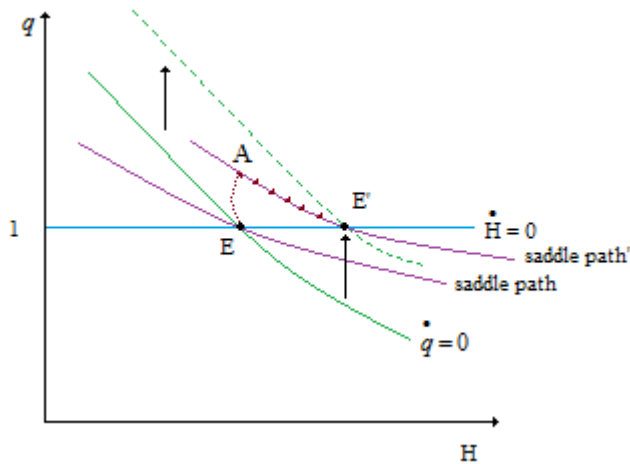
An increase in the household's housing utility function raises the demand for the aggregate housing stock, and thus raises marginal utility for a given housing stock. This may be modelled as an upward shift of the $\pi(\bullet)$ function. Such a shift can for example be a result of an increase in the household's disposable income, easier access to credit or a decrease in the aggregate housing stock.

The effects of an unexpected permanent upward shift of the $\pi(\bullet)$ function are shown in figure 18. The upward shift of the $\pi(\bullet)$ function shifts the $\dot{q}=0$ locus up. Since the flow of housing utility is higher for a given housing stock, smaller housing gains are needed for households to invest in housing (see equation [3.25]). The effects of this change may be analyzed in a phase diagram like the one illustrated in figure 16. First, q jumps immediately to the point on the new saddle path for the given housing stock. After this, H and q then move down that path to the new long-run equilibrium point E' . Because the rate of change in the housing stock is an increasing function of q , this implies that \dot{H} jumps at the time of the change and then gradually returns to zero. Thus a permanent increase in housing utility leads to a temporary increase in investment.

Since the presence of adjustment costs means that the housing stock acts sluggishly to demand shifts, the housing stock cannot instantly adjust when demand for the aggregate housing stock increase. This implies that existing housing in the economy earns rents which leads to an increase in market value. The higher market value of housing attracts investment and so the housing stock begins to rise. As the housing stock is rising, the housing utility in the economy rises, and thus the relative price of the aggregate housing stock declines and the flow of the household's housing utility and the value of housing fall. This process continues

until the value of the housing returns to normal. At this point of time there are no incentives for further investment.

Figure 18: The effects of a permanent increase in housing utility

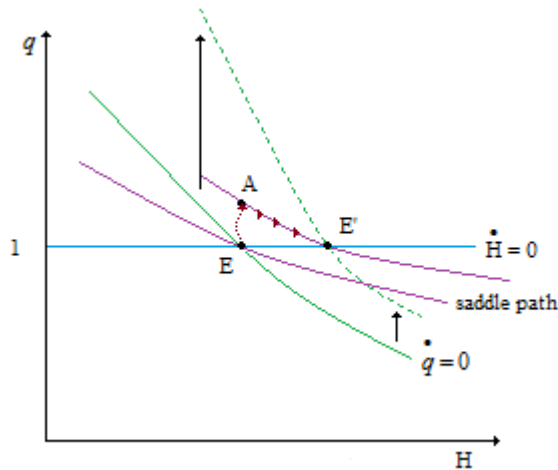


An increase in the household's utility function may also be temporary, where it is known that the utility function will return to its initial position at some later time, T . The key insight needed to find the effects of this change is that there cannot be an anticipated jump in q . At time T , H and q must be on the saddle path leading back to the initial long-run equilibrium. If they were not, q would have to jump for the economy to get back to its initial long-run equilibrium. Between the time of the upward shift in the household's utility function and T , the dynamics of H and q are determined by the temporary high housing utility. The initial value of H is given but since the upward shift in the household's utility function is unexpected, q can change discretely at the time of the initial shock.

In the economy at the time of the change, q jumps to the point such that H and q reach the old saddle path at exactly time T . This is shown in figure 19, where q jumps from point E to Point A at the time of the shock and q and H then gradually move to point B , arriving there at time T . Finally, they move up to the old saddle path to E .

movements. A permanent decline in the interest rate, for example, shifts the $\dot{q} = 0$ locus up. In addition, since r multiples q in the equation for \dot{q} , the decline makes the locus steeper. This is shown in figure 20.

Figure 20: The effects of a permanent decrease in the interest rate



The figure can be used to analyze the effects of permanent and temporary changes in interest rates along the lines of the analysis of the effects of housing utility movements. A permanent fall in the interest rate for example causes q to jump to the point on the new saddle path (Point A). H and q then move down to the new long-run equilibrium (Point E'). Thus the permanent decline in the interest rate produces a temporary boom in investment as the economy moves to a permanently higher housing stock. As with utility movements, both past and expected future interest rates affect investment.

3.6.3 The Effects of Taxes

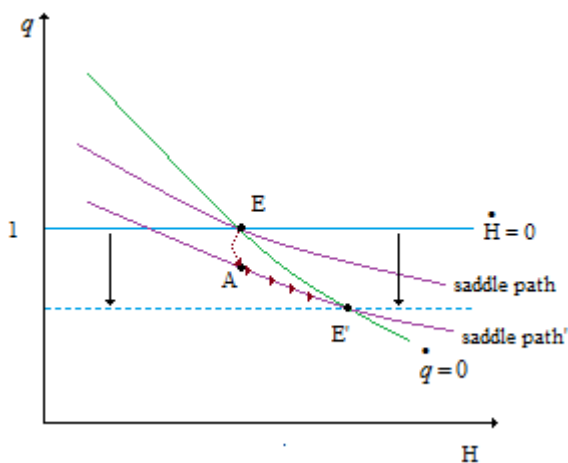
‘A temporary investment tax credit is often proposed as a way to stimulate aggregate demand during recessions’ (Romer 2001: 395). This is because a temporary investment tax credit gives households strong incentive to invest while the credit is in effect. The q theory model of housing may be used to examine this argument.

For simplicity, this thesis assumes that the investment tax credit takes the form of a direct rebate to the household of fraction θ of the price of housing and that the rebate applies to the purchase price but not to the adjustment costs. When such a credit is in effect, the household invests as long as the value of housing plus the rebate exceeds the cost of housing. Thus the first order condition for current investment, (3.19), becomes

$$q(t) + \theta(t) = 1 + C'(I(t)) \quad 3.26$$

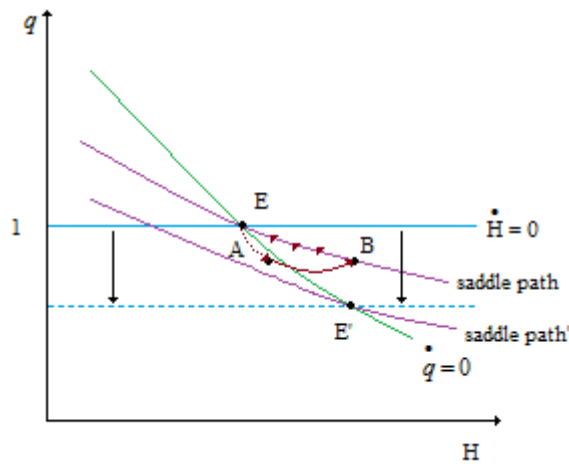
where $\theta(t)$ is the credit at time t and the equation for \dot{q} , (3.25) is unchanged. Equation (3.26) implies that the housing stock is constant when $q + \theta = 1$. An investment tax credit of θ therefore shifts the $\dot{H}=0$ locus down by θ . This is illustrated in figure 21. If the credit is permanent, q jumps down to the new saddle path at the time it's announced. Intuitively, since the credit increases investment, it means that the economy's flow of housing utility (neglecting the credit) will be lower, and thus that existing housing is less valuable. H and q then move along the saddle path to the new long-run equilibrium, which involves higher H and lower q .

Figure 21: The effects of a permanent investment tax credit



In the case of a temporary tax credit, the announcement of the credit causes q to fall to the point where the dynamics of H and q , given the credit, bring them to the old saddle path just as the credit expires. They then move up that saddle path back to the initial long-run equilibrium. This is illustrated in figure 22.

Figure 22: The effects of a temporary investment tax credit



As illustrated in figure 22, q does not fall all the way to its value on the new saddle path which means that the temporary credit reduces q less than a comparable permanent credit. The argument is that, since the temporary credit does not lead to a permanent increase in the housing stock, it causes a smaller reduction in the value of existing housing. Because the change in the housing stock \dot{H} , depends on $q + \theta$ (see equation [3.26]), q is higher under the temporary credit than under the permanent credit, and thus the temporary credit has a larger effect on investment than the permanent credit. Figure 22 also shows that under the temporary credit, q is rising in the later part of the period that the credit is in effect. This means that after a point, the temporary credit leads to a growing investment boom as households try to invest just before the credit goes out of effect. Under the permanent credit, in contrast, the rate of change in the housing stock declines steadily as the economy moves towards its new long-run equilibrium.

4. Housing Bubbles

In order to discuss the possible presence of bubbles in the Norwegian housing market, it is useful to apply theory about housing bubbles. This section first defines housing bubbles and then presents a method that can be used to measure housing bubbles.

4.1 Definitions

The value of housing may be split into fundamental and non-fundamental values where a significant presence of non-fundamental values may indicate bubble tendencies. In order to define housing bubbles, this section first explains the difference between fundamental and non-fundamental values and then introduces some bubble definitions from existing literature.

4.1.1 Fundamental Value

In the model, the fundamental value of a housing unit at a given time equals the discounted value of the household's future marginal housing utility as derived in equation (3.23). Thus the fundamental value of house is related to the dynamics of q and H as described in equations (3.25) and (3.24) respectively. In addition, the transversality condition in equation (3.21) imposes restrictions on the limiting behaviour of the model stating that the household cannot continuously attach high value to housing when time approaches infinity. Another way to identify housing's fundamental value is to look at the forces of housing supply and demand as presented in section 2. These forces were identified as construction costs, regulatory conditions, income, population, the user cost of housing, and financing conditions. However, price expectations, which are included in the user cost of housing, may be a non-fundamental value since the IMF (2012) states that optimistic price expectations can be unsustainable and change quickly.

4.1.2 Animal Spirits and Irrational Exuberance

As defined above, price expectations may be a non-fundamental value in the housing market. This may be because expectations are not always rational where evidence from Behavioural Finance suggests that 'animal spirits' (Akerlof and Shiller 2009) and 'irrational exuberance' (Shiller 2005) may be at work in the asset markets.

Animal spirits is defined by Akerlof and Shiller (2009) as confidence, fairness, corruption and bad faith, money illusion and storytelling. Of the five spirits, confidence and storytelling may be particularly evident in the housing market. Economists suggest that confidence is rational, but Shiller and Akerlof (2009) state that the very meaning with trust is that we go beyond what is rational. As described in section 2, the level of consumer confidence is related to the development in housing prices. In storytelling, epidemics of confidence/pessimism may mysteriously arise because there is a change in the contagion rate of certain modes of thinking. In housing markets, there may be expectations about future price increases because the media and people emphasize stories about successful housing sales.

Irrational exuberance is defined by Shiller (2005: xvii) as ‘wishful thinking on the part of investors that blinds us the truth of our situation’. A Ponzi process may be among the mechanisms that takes place during irrational exuberance, and can be defined as a feedback loop. Investors, their confidence and expectations buoyed by past price increases, bid up prices further, thereby enticing more investors to do the same, so that the cycle repeats, resulting in an amplified response to the original precipitating factors (Shiller 2005). Ponzi processes may take place in housing markets since housing sales are characterized by bids.

4.1.3 Bubbles

A *bubble* occurs when the current price of an asset deviates from its *fundamental value* and may be difficult to detect because fundamental value is fundamentally unobservable. No one knows for sure what future dividends are going to be, or what discount rates investors will require on assets (Krainer and Wei 2004).

Jacobsen and Naug (2005) explain housing bubbles as situations when many individuals want to purchase a house today because they expect housing prices to rise in the future and when these expectations are not based on fundamentals. Shiller (2005: xviii) describes a speculative bubble as ‘a situations in which temporarily high prices are sustained largely by investors’ enthusiasm rather than consistent estimation of real value’. During a housing bubble, households think that a house that they would normally consider too expensive is now an acceptable purchase because they will be compensated by further price increases (Case and Shiller 2004). In addition, households do not need to save as much as they otherwise might, because they expect that the increased value of housing will do the saving for them. During a housing bubble, first-time homebuyers may also worry that if they do not

buy now, they will not be able to afford a house later. Furthermore, the expectations of significant price increases may have a strong impact on demand if people think that housing prices are very unlikely to fall, and certainly not likely to fall for long, so that there is little perceived risk associated with housing investment.

4.2 Price/Earnings Analysis

Bubbles can be measured using different methods but are as mentioned difficult to detect. A common way to measure bubbles is by performing a variance analysis (Grytten 2010). This can be done by either measuring variance from trend or variance from fundamental values. A price/earnings (P/E) analysis measures variance from fundamental values and can be useful in analyzing if housing prices are following a sustainable growth path. The P/E ratio shows the market value, measured by price P compared to the fundamental value, measured by earnings E .

In a P/E analysis it is relevant to look at the relative sizes and changes in the P/E -values. If price is higher than earnings, this may signal a bubble. A variant of the P/E analysis can be applied to the housing market by using housing prices as the market value and the replacement costs as the fundamental value and is in practice the same as Tobin's q defined in section 3. One way to define a housing bubble is to calculate the path of prices that is not consistent with the fundamental value of the housing stock as in equation (3.23). When q shows a strong upward trend over time, Grytten (2009) suggests that this can indicate that market prices are about to blow up compared to the fundamental value of housing.

5. Data Processing

This section presents the data processing methods used in the analysis. In order to convert nominal prices to real prices, the difference between deflating by gross domestic product and the consumer price index is first explained. Then follows theory about how the relationship between two variables may be estimated through regression analysis.

5.1 The Gross Domestic Product Deflator Versus the Consumer Price Index

In order to convert nominal numbers into real terms it is possible to deflate by either the gross domestic product (GDP) deflator or the consumer price index (CPI). The GDP deflator may be defined as ‘the current level of prices relative to the level of prices in the base-year’ (Mankiw 2012: 520), whereas the CPI may be defined as ‘a measure of the overall cost of goods and services bought by a typical consumer’ (Mankiw 2012: 514). Economists and policymakers monitor both the GDP deflator and the CPI to gauge how quickly prices are rising. The main difference between these two statistics is that the GDP deflator reflects the prices of all goods and services *produced domestically*, whereas the CPI reflects the prices of all goods and services *bought by consumers* (Mankiw 2012).

5.2 Regression Analysis

Regression analysis is used to predict the value of one variable on the basis of other variables (Keller 2009). This technique involves developing a mathematical equation that describes the relationship between the variables to be forecast, the dependent variable Y , and the variables believed to be related to the dependent variable, the independent variables denoted as X_1, X_2, \dots, X_k (where k is the number of independent variables). A linear model with one independent variable may be written as

$$y = \beta_0 + \beta_1 x + \varepsilon \tag{5.1}$$

where y is the dependent variable, x is the independent variable, β_0 is the y-intercept, β_1 is the slope of the line and ε is the error variable. To define the relationship between x and y , it is necessary to know the value of the coefficients β_0 and β_1 , where their estimators are based on drawing a straight line through the sample data.

An objective method to draw the straight line is by applying the *ordinary least squares method*. The ordinary least squares method produces a straight line drawn through the points so that the sum of squared deviations between the points in the line is minimized. This line is represented by

$$\hat{y} = b_0 + b_1x \quad 5.2$$

where b_0 is the y -intercept (where the line intercepts the y -axis), b_1 is the slope, and \hat{y} is the value of y determined by the line (Keller 2009). The size of the slope, b_1 , may be calculated by applying the formula $b_1 = (y_2 - y_1)/(x_2 - x_1)$ (Sydsæter 2000).

It can be measured how well the data fits the line by computing the value of the minimized sum of square deviations. The deviations between the actual data points and the line are called *residuals*, denoted e_i . That is

$$e_i = y_i - \hat{y}_i \quad 5.3$$

The residuals are the observations of the error variable. Consequently, the minimized sum of square deviations is called the *sum of squares for error*, denoted *SSE*.

5.2.1 Scatter Diagrams

A scatter diagram may be used to describe the relationship between two variables, where the two most important characteristics are the *strength* and the *direction* of the linear relationship (Keller 2009).

To determine the strength of the linear relationship, the ordinary least squares method is applied to draw a straight line through the data points. If most of the points fall close to the line there is a linear relationship. When one variable increases and the other also does so, there is a positive linear relationship and when two variables tend to move in opposite directions, the nature of their association is described as a negative linear relationship. The direction of the linear relationship may be observed by looking at the value of the coefficients.

6. The model ingredients

In order to apply the q theory model of housing in practice, the first step in the analysis is to define and analyze the model ingredients which consist of the value of housing, q , and the housing stock, H .

6.1 The Value of Housing, q

This section defines the value of housing, q , by identifying its components and developing an index. When an index for q is constructed, the development in q can be analyzed by studying how its dynamics relate to the model.

6.1.1 The Components of q

The average value of housing, q , is defined as the market value of housing deflated by the replacement costs of housing (Tobin 1969). The housing price index is interpreted as the market value of housing, but it is not as straightforward to interpret the replacement costs of housing. Corder and Roberts (2008) suggests that replacement costs can consist of construction costs, land prices, planning costs and other costs such as financing costs, while Madsen (2011) estimates that housing prices are predominantly driven by land prices and construction costs in the very long run. Although reports on how to construct an official land price index for Norway have been developed, reliable data on land prices does not exist (Bærug et al 2005). As a result, the construction cost index is for simplicity interpreted as the replacement costs of housing.

Since the housing price index and the construction cost index are available from SSB it is possible to calculate the average q ratio on a national basis. In the calculation of the average q , the two indexes must be comparable. As a result, both time series are converted to indexes where 1992 (the starting year) has a value of 1. Hence it is assumed that 1992 is the year where the economy is initially in steady state. In addition, the construction cost index is converted to quarterly figures since the housing price index is quarterly. This is done by calculating the average of each set of three months that constitutes a quarter. The adjusted housing price index is illustrated in figure 23 while the adjusted construction cost index is illustrated in figure 24.

Figure 23: Nominal housing price index (1992=1) 1992-2011

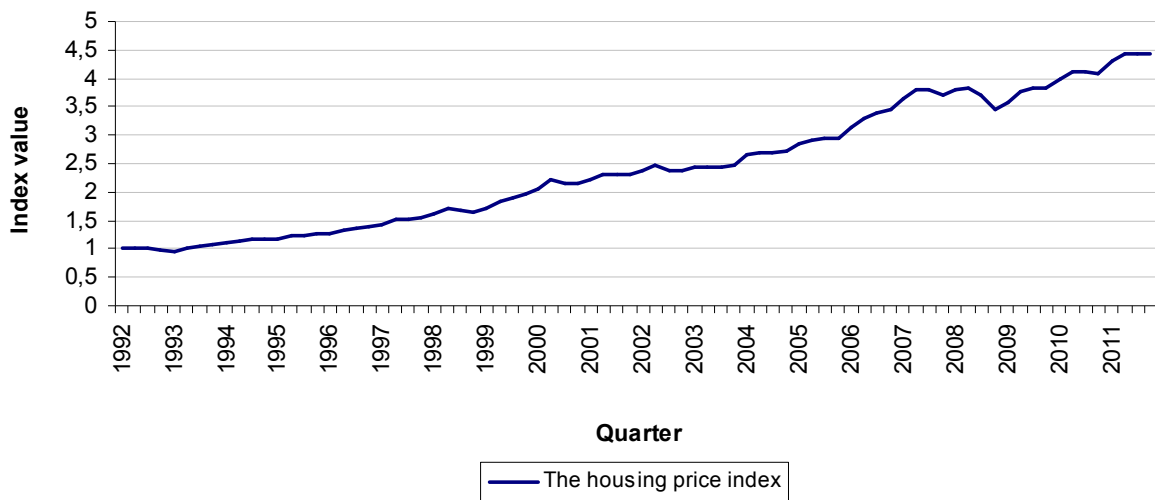
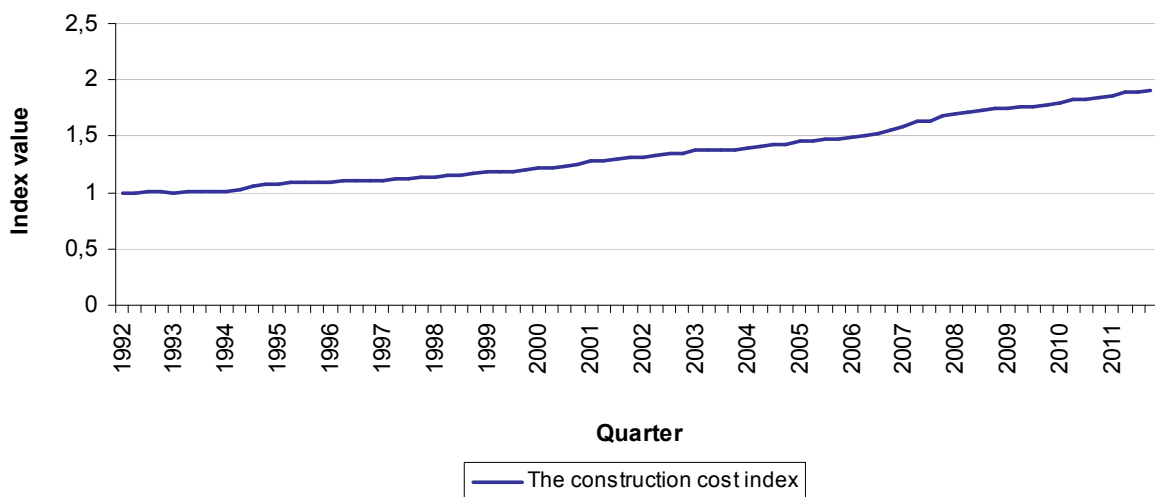


Figure 24: Nominal construction cost index (1992=1) 1992-2011

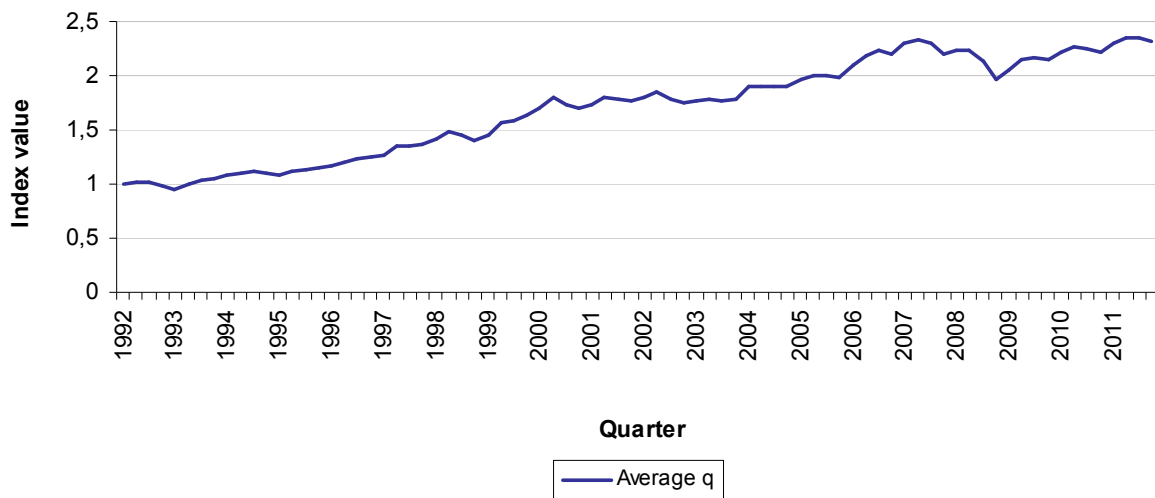


6.1.2 Analyzing q

An index for average q is constructed by dividing the adjusted housing price index by the adjusted construction cost index²⁸. This index is shown in figure 25 where 1992 is the index year with a value of 1, where inflation is cancelled out since both the numerator and denominator are nominal.

²⁸ It should be noted that this index compares market prices for new and used houses with construction costs for new houses and that this may be a potential source of error since the actual construction costs for used housing are not included.

Figure 25: Average q as defined in equation (3.23) (1992=1) 1992-2011



From 1992 to 2011 the average q^{29} has increased by 232 %. During this period, the nominal change in housing prices and construction costs were respectively 442 % and 191 %³⁰ implying that housing prices have grown by more than twice as much as construction costs. The increasing gap between housing prices and construction costs indicates that q has a strong upward sloping trend. According to Grytten (2009) this may indicate that market prices are about to blow up compared to fundamental values.

Before concluding that housing prices may be overvalued it is important to recall that the housing prices in 1992 were historically low. Thus, the first part of the increasing q may be due the fact that housing prices are returning to a more reasonable level compared to construction costs (Sommervoll 2007). In addition, other fundamentals than construction costs must be taken into account. The result may be quite different if other replacement costs such as land prices were included in the calculation of q . According to theory about P/E analysis it is relevant to look at the relative changes in q in order to determine if the housing prices are overvalued and thus the changes in q may be analyzed along the lines of figure 15.

The Dynamics of q

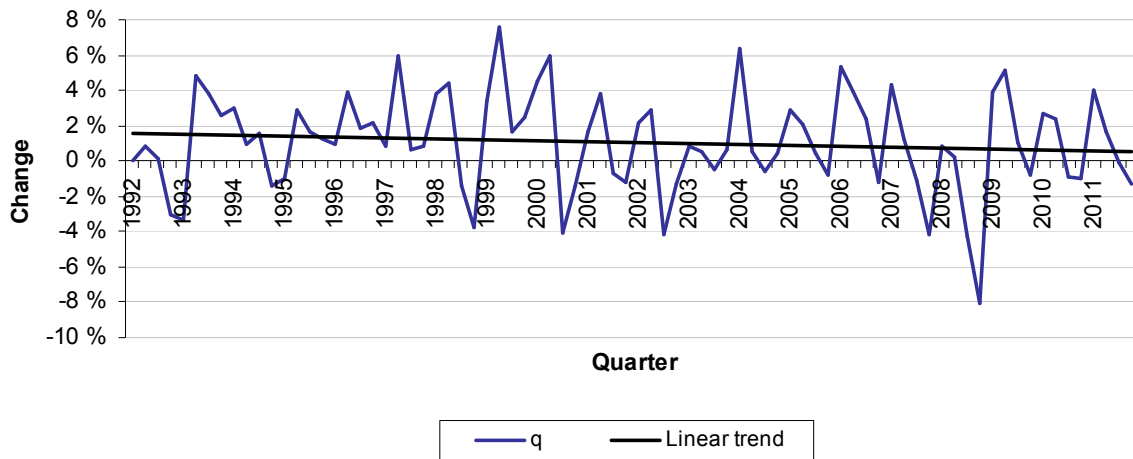
In order to analyze the dynamics of q , it is relevant to look at the changes in q since both q and \dot{q} is included in equation (3.25). The change in q is illustrated in figure 26 and can be

²⁹ From now on, average q is for simplicity referred to as q .

³⁰ See figure 23 and 24.

interpreted along the lines of figure 15 with the exception that the x-axis denotes time instead of housing. The change in q is fluctuating and slightly downward sloping. The maximum point is 7.63 % in the first quarter of 1999, and the minimum point is - 8.01% in the last quarter of 2008 which may be due to the setback in the housing prices associated with the Financial Crisis.

Figure 26: The change in q as defined by equation (3.25) 1992-2011



The slightly downward sloping trend indicates that q is stagnating towards the end of the period and the fluctuating trend may imply that the $\dot{q}=0$ locus is changing. To investigate the implications of the changing $\dot{q}=0$ locus in relation to the model, it is necessary to study how the value of housing is related to the housing stock.

6.2 The Housing Stock, H

Housing is interpreted as a type of capital (Corder and Roberts 2008) and data on fixed real capital associated with housing is published by SSB (2012m)³¹. The aggregate housing stock is defined by SSB as cumulative investment minus depreciation and modifies the housing stock based on a price index for gross investment in housing³².

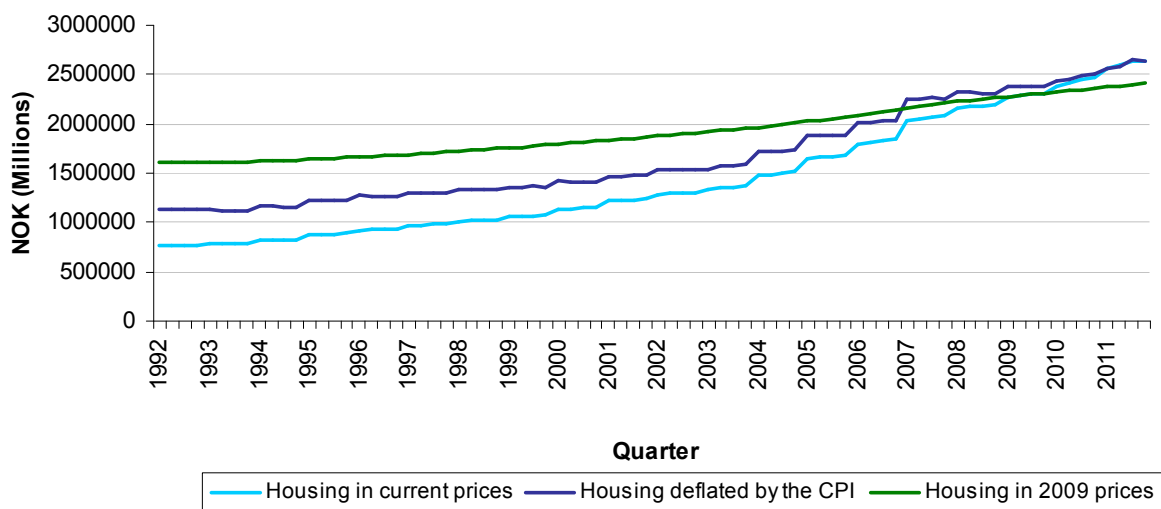
³¹ The housing stock is primarily published in annual numbers, but through personal correspondence with SSB estimated quarterly numbers were obtained (see table 24 in the Appendix). This includes owner-occupied housing and housing rented out to other households, but excludes commercial activity. Holiday homes and garages are also included in the calculation of housing.

³² This is in practice the same as the housing accumulation constraint, $\dot{h}(t)=I(t)-\delta(t)h(t)$, as defined in section 3.1.2. As argued in this section, the depreciation rate in this thesis is assumed to be zero.

6.2.1 Analyzing H

The housing stock is published in both current (nominal) prices and 2009 prices (SSB 2012m). Since inflation is cancelled out in the calculation of q , housing must also be given in real terms. In addition to 2009 prices, housing can be converted to real terms by deflating current prices by GDP or the CPI as explained in section 5. Of the two deflators, it may be more accurate to deflate housing by the CPI since housing constitutes a larger part of all goods and services bought by consumers than of all goods and services produced domestically. Thus, housing in current prices, 2009 prices and current prices deflated by the CPI are illustrated in figure 27.

Figure 27: Nominal and real housing 1992-2011

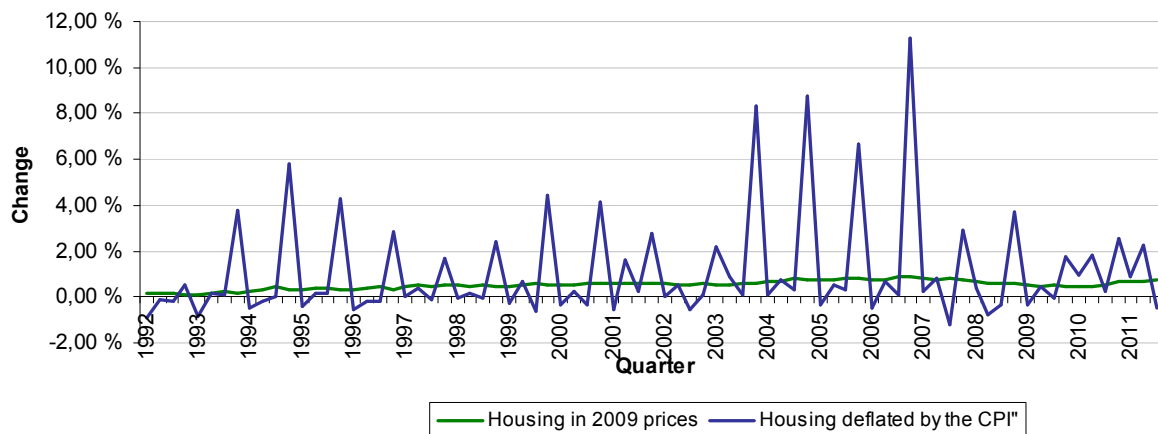


The figure shows that the housing measurements are upward sloping, but differ in terms of level and variation. Current prices are following the lowest path in the diagram, followed by current prices deflated by the CPI in a similar slope, whereas housing in 2009 prices is following the smoothest path.

The Dynamics of H

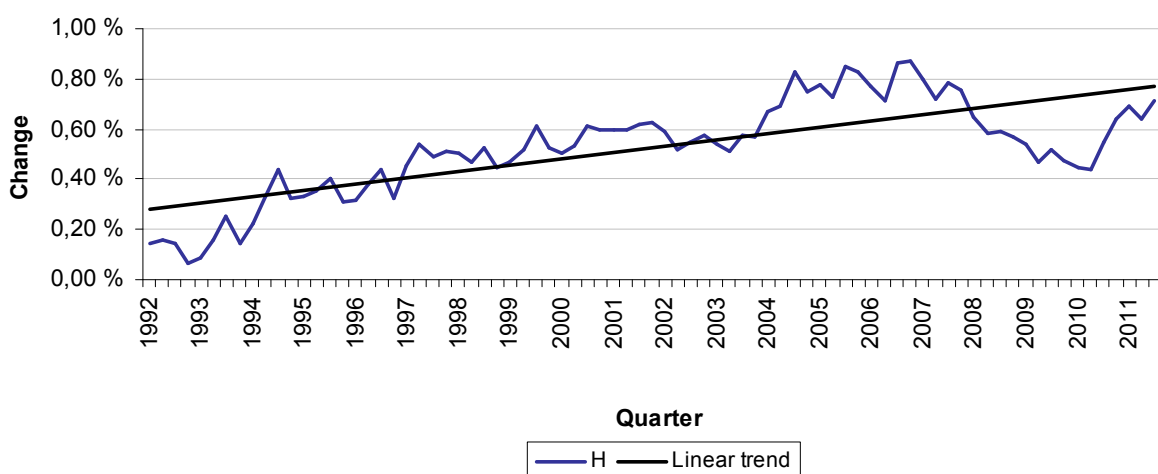
In order to analyze the dynamics of H , it is necessary to look at the change in the housing stock according to equation (3.24). The change in the real housing stock is illustrated in figure 28 and can be analyzed along the lines of figure 14 with the exception that the x-axis denotes time instead of housing.

Figure 28: Change in real housing as defined by equation (3.24) 1992-2011



This figure illustrates that the change in housing deflated the CPI is fluctuating significantly more than the change in housing in 2009 prices where the development is relatively smooth in the interval of 0-1 %. In order for the model to satisfy the steady state conditions, housing in 2009 prices may be the best choice since this housing measurement is the closest to $\dot{H}=0$ (see equation [3.24]) and hence housing in 2009 prices will primarily be used in the rest of the analysis. To add robustness to the analysis, housing deflated by the CPI is considered in the regression analyzes in section 7 and 8. The percentage change in H in 2009 prices may be analyzed in more detail in figure 29.

Figure 29: Change in H in 2009 prices



During the period analyzed, the change in housing is positive for all quarters, which implies that $\dot{H}>0$. This violates the steady state condition (3.24), where $q=1$ implies that the change in housing should be constant ($\dot{H}=0$). It is particularly observed that \dot{H} is highest during the years before the Financial Crisis, which may be caused by the high level of initiation of new housing construction during that period (SSB 2012n).

In this section, an index for q was calculated by deflating the housing price index by the construction price index. During the period analyzed, q showed a strong upward sloping trend, which may indicate bubble tendencies according to P/E analysis. The variation in \dot{q} suggests that the $\dot{q}=0$ locus may be changing and the downward sloping trend implies that \dot{q} is stagnating towards the end of the period. The housing stock was primarily defined as housing in 2009 prices, which similar to q showed an increasing trend. \dot{H} fluctuated less than \dot{q} and was positive for the whole period. The behaviour of q and H in relation to each other may be analyzed by applying the phase diagram introduced in section 3. This will be the core of the second part of the analysis.

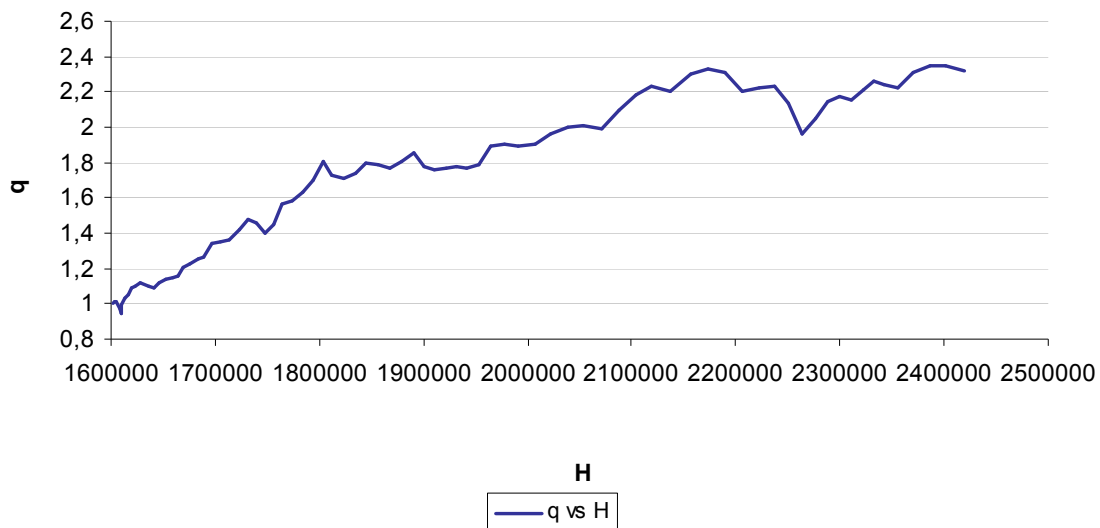
7. Analyzing the Behaviour of q and H

In this part of the analysis, the behaviour of q and H is analyzed in relation to each in a phase diagram like the one introduced in section 3. This includes an analysis of how the path of q and H may relate to historical development. Second, the relationship between the levels of q and H and the changes in q and H is estimated in a regression analysis. In order to add robustness to the analysis, linear regression is applied on both the relationship between q and housing in 2009 prices and the relationship between q and housing deflated by the CPI. Finally, this thesis discusses the model implications of the behaviour of q and H .

7.1 The Phase Diagram

Summarizing the information about q and H from section 6, their behaviour can be illustrated in a phase diagram similar to figure 16 in figure 30. The dependent variable is q and the independent variable is H . Since H is increasing for the whole period, the x-axis may also be interpreted as a time axis. Assuming no shocks, this path of q and H may be interpreted as the saddle path as shown in figure 17.

Figure 30: The relationship between q and H in relation to figure 16



The path of q and H starts in the first quarter of 1992, where the economy is assumed to be in steady state, satisfying the steady state conditions derived in equation (3.24) and (3.25), $q=1$, $\dot{q}=0$ and $\dot{H}=0$. Even if the economy is not initially in steady state, the relative

movements are informative. In particular, the stable saddle path dynamics illustrated in figure 17 imply that there should be a negative relationship between q and H .

Consistent with the separate analyzes of H and q , figure 30 shows a positive relationship between the two variables. This is in line with the q theory model of housing which states that investment should increase when the value of housing is above one. In the absence of shocks, it is however observed that the path of q and H is not consistent with the stable saddle path which should be downward sloping. This suggests that there might be a bubble in the housing market. This implication will be investigated further in the rest of the analysis.

7.1.1 Path Developments

The saddle path defined in figure 30 may be analyzed in the light of the historical development during the period. In order to relate the path to historical development, the saddle path may be split into separate paths with different slopes. This is done by finding the points of time where q is highest and stretching a ‘path indicator’ between the lowest and the highest value of q .

The maximum points of q are located in the second quarter of 2007, and in the second and third quarter of 2011. By identifying three paths³³, the first path is defined as the period from the first quarter of 1992 to q ’s first maximum point in 2007. The second path is the period from the maximum point in 2007 to the fourth quarter of 2008, where q reaches its lowest point since the first quarter of 2005. The third path starts in the fourth quarter of 2008 and continues until the second quarter of 2011. The size of the slopes is quantified in table 1³⁴.

Table 1: The size of the slopes

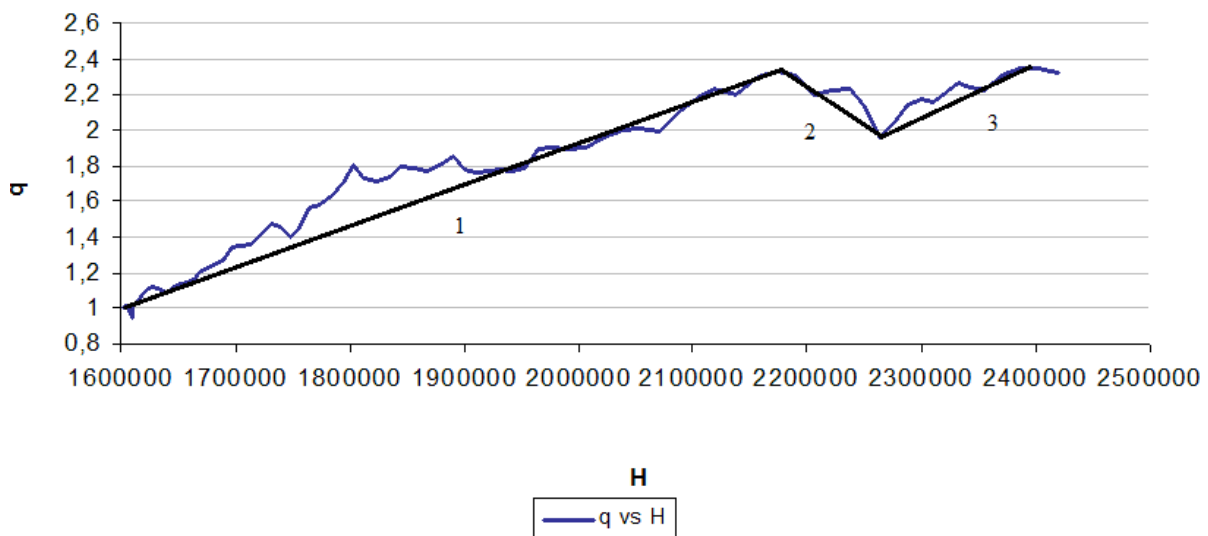
Path	Period	Slope
1	1992:1-2007:2	2,32401E-06
2	2007:2-2008:4	-4,03396E-06
3	2008:4-2011:2	9,6008E-07

Table 1 illustrates that the slopes during the three periods strongly differ, where the paths in the first and third period has the most similar slopes. These paths are shown in figure 31.

³³ The paths displayed in the figure can be split down further to add more detail, but this will not alter the main points of this analysis.

³⁴ The size of the slopes is calculated by applying the formula $b_1 = (y_2 - y_1) / (x_2 - x_1)$ presented in section 5.

Figure 31: The slopes of the development in q and H



The first path of H and q starts in steady state where $H=1600902$ and $q=1$, and is upward sloping until q reaches 2.33. During this period, H has increased by 35.7 % while q has increased by 133 %. After this, q then falls until it reaches 1.97 where H has increased by 4.2 % and q has decreased by 18.3 %. Thereafter, q increases until it reaches its maximum point of 2.35 in the second quarter of 2011 implying a 5.5 % increase in H and a 19.3 % increase in q . During last two quarters of 2011, q slightly decreases.

The behaviour of the three paths yields a puzzling observation. The model predicts that there should be a unique level of q for a given level of H that produces a stable path, but some of the observations of q and H deviate from this. For instance, q is approximately equal in the second quarter of 2005 ($q=2$) and in the fourth quarter of 2008 ($q=1.97 \approx 2$) while H differ by 11 %. A similar picture arises when H is compared for two of the top values of q , where q is 2.33 and 2.35 in the second quarter of 2007 and 2011 respectively, but H differs by 10 %. This indicates that there has been a change to one or more of the model's variables during the period, which is consistent with the earlier finding that the $\dot{q} = 0$ locus may be changing. The dynamics of the second path is of particular interest since this path is the longest downward sloping path in the figure. This suggests that the Financial Crisis that hits the economy during this period have had a particularly negative effect on q .

7.2 Regression Analysis

In this section, the relationship between the levels of q and H and the changes in q and H is estimated by applying linear regression. To add robustness to the analysis, linear regression is applied on both the relationship between q and H in 2009 prices and the relationship between q and H deflated by the CPI. Throughout this analysis, a 95 % confidence interval is assumed and the ordinary least squares method is applied.

7.2.1 The Levels of q and H

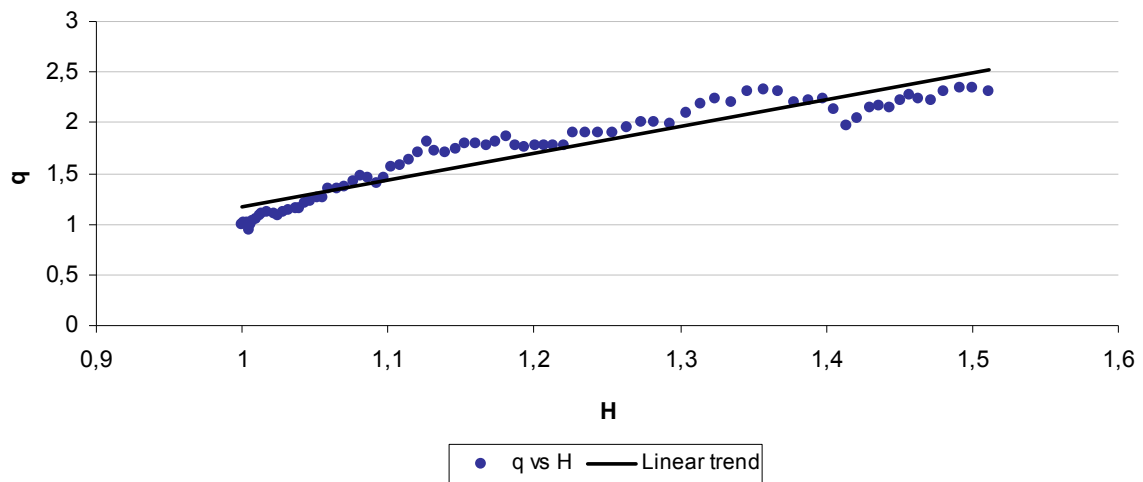
Assuming no shocks in the economy, the model's main prediction is that there should be a negative relationship between the levels of q and H along the stable saddle path defined in figure 30. This section investigates if this is the case by estimating the relationship between the levels of q and H , where both measures of real housing are applied.

Housing in 2009 Prices

In order to compare the relationship between q and H in a regression analysis, q and H must first be converted into the same *levels*. Thus housing is converted into an index similar to q , where 1992 is the index year with a value of 1.

Figure 32 illustrates the linear relationship between the two variables. Since the points are close to the line, this indicates a strong positive linear relationship between q and H . Assuming no shocks, this supports the suggestion that there may be a bubble in the housing market. During the first and last part of the scatter diagram the observations are below the linear trend line. This indicates that the value of housing is influenced by the troughs in 1992-1993 and 2008-2009 as described in section 2.

Figure 32: Linear regression of the levels of q and H in 2009 prices



The regression results are illustrated in table 2. H 's coefficient is positively and significantly related to q which is consistent with existing literature (Corder and Roberts 2008, Berg and Berger 2005, Jud and Winkler 2003 and Madsen 2011). This result is also in line with the model in the sense that there should be a unique q for every given H which produces a stable path. In the absence of shocks, the model however predicts that there should be a negative relationship between q and H which is not consistent with this result. Thus there must be a presence of other variables such as shocks or non-fundamentals in the economy.

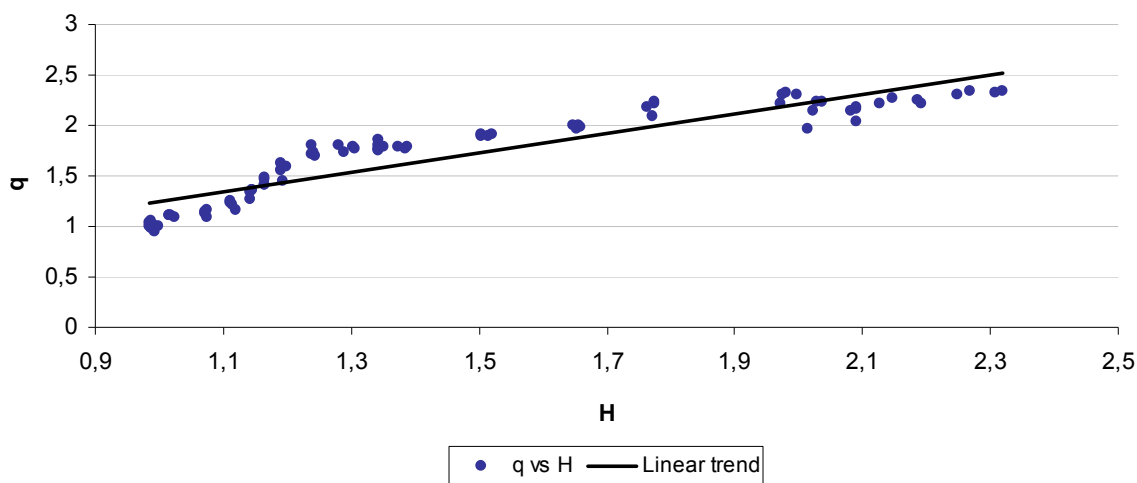
Table 2: Regression results q vs H in 2009 prices

	Coeff.	P-value	Std.Error
H	2,64206	0,000	0,09958
Constant	-1,4878	0,000	0,1207

Housing Deflated by the CPI

The linear relationship between the levels of q and H deflated by the CPI is illustrated in figure 33. Similar to the regression of the levels of q and H in 2009 prices, there is a strong positive linear relationship between q and H and the observations are below the trend line during the first and last part of the scatter diagram. In contrast to figure 32, the points in this figure are more scattered, which may be explained that housing in 2009 prices follows a smoother path in figure 27.

Figure 33: Linear regression of the levels of q and H deflated by the CPI



The results from this regression are illustrated in table 3. Similar to the results in table 2, H is positively and significantly related to q , but exhibits a lower coefficient and standard error.

Table 3: Regression results: q vs H deflated by the CPI

	Coeff.	P-value	Std.Error
H	0,97120	0,000	0,04666
Constant	0,25695	0,001	0,07141

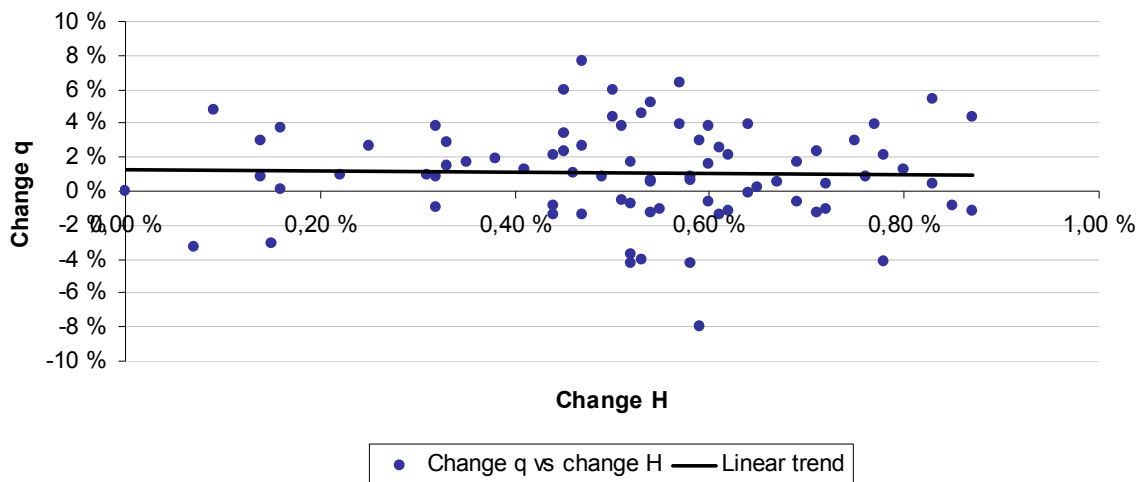
7.2.2 The Change in q and H

The slope of the saddle path may be investigated in a regression analysis by estimating the relationship between the changes in q and H . In the absence of shocks, the model predicts that the saddle path should be downward sloping as in figure 17. This section follows the same procedure as the linear regression of the levels of q and H , where q and H are adjusted to percentage *changes*.

Housing in 2009 Prices

The linear relationship between the change in q and H in 2009 prices is illustrated in figure 34. The points are quite scattered, which implies that there may not be a strong linear relationship between the change in q and H . The linear relationship is slightly downward sloping, which indicates that the change in q may be stagnating for higher changes in H .

Figure 34: Linear regression of the change in q and H in 2009 prices



The regression results are displayed in table 4 and show that none of the coefficients are significant. These results must therefore be interpreted with caution. The change in H has a negative coefficient which suggests that the saddle path is downward sloping which is consistent with the model's prediction when there are no shocks in the economy.

Table 4: Regression results: change in q vs change in H in 2009 prices

	Coeff.	P-value	Std.Error
H	-0,433	0,787	1,593
Constant	0,013181	0,139	0,008829

Housing Deflated by the CPI

The linear relationship between the change in q and H deflated by the CPI is illustrated in figure 35. In contrast to figure 34, the points in this figure are less scattered and the linear trend is upward sloping. Thus there may be a relative strong positive relationship between the change in q and H .

Figure 35: Linear regression of the change in q and H deflated by the CPI

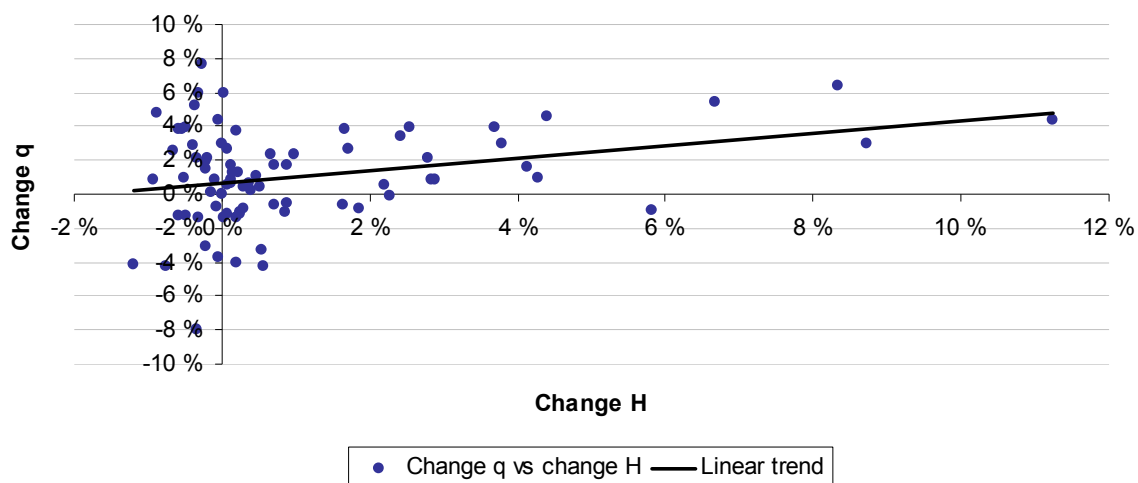


Table 5 illustrates the regression results and shows that H is positively and significantly related to q . Thus, the interpretation of these results is more reliable than the interpretation of the results in table 4 and it can not be concluded that the slope of the saddle path is in line with the model's prediction when there are no shocks in the economy.

Table 5: Regression results: change q vs change H deflated by the CPI

	Coeff.	P-value	Std.Error
H	0,3669	0,007	0,1329
Constant	0,006992	0,039	0,003337

In this regression analysis, the relationship between the levels of q and H and the changes in q and H were estimated. It was found that q is positively and significantly related to H , which is consistent with earlier research (Corder and Roberts 2008, Berg and Berger 2005, Jud and Winkler 2003 and Madsen 2011) and the model prediction that there should be a unique q for every given H which produces a stable path. Assuming no shocks, the model predicts that there should however be a negative relationship between q and H . Thus there may be a presence of shocks or non-fundamentals in the economy.

Since the regression of housing deflated by the CPI yielded the most robust results, this housing measure is used in the regression analysis in section 8. Nevertheless, housing in 2009 prices has been useful for analytical purposes, since this housing measure is closer to the steady state conditions than housing deflated by the CPI.

7.3 Implications for the Behaviour of q and H

The main finding from this analysis is that the value of housing is positively and significantly associated with the housing stock. In the absence of shocks, this deviates from the model predictions which may suggest that the transversality condition is failing and that the fundamental value of the housing stock is not given by equation (3.23). The variation in q may however indicate that there may be a presence of shocks in the economy such as the Financial Crisis as explained in section 7.1.1. In the last part of this section, this thesis discusses the implications of these results for the behaviour of q and H .

7.3.1 Is there a Long-run Equilibrium?

In the analysis it is for simplicity assumed that the economy is initially in steady state in 1992 and that there are no shocks in the economy. Following these assumptions, the path of q and H is moving away from the initial long-run equilibrium in a rising manner. In practice, the presence of a possible long-run equilibrium is more ambiguous. First of all, this assumes that a long-run equilibrium is in fact present during the period. It may be the case that q and H are either moving away from a long-run equilibrium before 1992 or moving towards a long-run equilibrium after 2011. Second, 1992 is set as the economy's initial long-run equilibrium for analytical purposes and thus the long-run equilibrium (provided it exists) may in practice be located anywhere on the path. According to Sommervoll (2007) if a long-run equilibrium exists, it is more likely situated in a later year since housing prices were historically low in 1992. Third, the variation in the value of housing suggests that the dynamics of q and H is influenced by shocks, such as the effects of the Financial Crisis identified in section 7.1.1. The presence of shocks implies that multiple long-run equilibria may exist. Thus it is difficult to determine with certainty whether or not there exists a long-run equilibrium within the observations. In order to investigate if there are multiple long-run equilibria, the effects of shocks may be analyzed.

7.3.2 Is the Transversality Condition Failing?

The transversality condition ensures that in the limit, the model implies that the fundamental equation (3.23) for q is satisfied. However, it is possible that the dynamics of q and H may lead the economy away from the saddle path. The increasing trend of q and H indicates that their path is located in the upper right corner of the phase diagram as illustrated in figure 30. This implies that the dynamics of H and q is following a similar path to the path starting at

Point A in figure 16, where the economy is in the region where both q and H are rising and remains there. If this is driven by shocks, it does not violate the model, but if it is driven by non-fundamental variables such as animal spirits and irrational exuberance it is a bubble and the development in the housing market is not consistent with the model. If the increasing path of q and H is explained by shocks, the high value the household attaches to housing when time approaches infinity satisfies the fundamental equation (3.23) and the transversality derived in equation (3.21) does not fail. If however the dynamics of q and H is driven by non-fundamentals, bubble tendencies in the housing market are possible.

In the third part of the analysis, this thesis investigates if the presence of shocks may explain the dynamics of q and H . If it is true that shocks impact the dynamics of q and H , the transversality condition does not fail in the limit of the model and there may be multiple long-run equilibriums. If the presence of shocks cannot explain all of the dynamics of q and H , non-fundamental variables may be present and there may be bubble tendencies in the housing market.

8. Analyzing Shocks

In the absence of shocks, it was found that the path of q and H is moving away from their initial steady state in 1992. This may imply that q is continually jumping to new saddle paths and that the economy does not have time to adjust to the new shocks. The shocks may be permanent or temporary but in either case, the economy may be continually moving towards new long-run equilibriums. In this part of the analysis, it is investigated how changes in housing utility, interest rates and taxes may have affected the path of q and H . The theoretical background for this analysis is presented in section 3.6 and it is for simplicity assumed that the economy is initially in steady state in 1992.

8.1 The Effects of Utility Movements

As derived in section 3, the household's utility function depends on the household's preferences and the consumption of housing. The marginal housing utility is included in the equation for the motion for q (see equation [3.25]), and thus changes in the household's preferences and the consumption of housing may lead to changes in this equation.

8.1.1 The Effects of Changes in the Household's Preferences, π

Changes to household preferences may depend on households' disposable income and financial conditions. Although housing utility is analyzed separately from all other goods, it is important to have in mind that changes in aggregate consumption may influence marginal housing utility. A change in preferences in favour of housing will for this reason lead to an increase in the household's utility function. Since disposable income and financial conditions are described as two of the forces of housing demand in section 2, these are the variables focused on in the analysis of changes in the household's preferences.

Disposable Income

As derived in section 3, households possess Gorman Preferences where aggregate income, y , plays an important part. As illustrated in figure 4, the households' disposable income has increased significantly during the period. Since disposable income is continually rising, this may indicate that the economy is continuously exposed to new increases in the household's utility function. This raises demand for the aggregate housing stock, and thus raises marginal

utility for a given housing stock. This may be modelled as an upward shift in the $\pi(\bullet)$ function, where the effects can be analyzed along the lines presented in figure 18 and 19.

Financial Conditions

Easy access to credit may be similar to an increase in disposable income, increasing housing demand. In the latest years there has been a sharp increase in loans associated with housing and Anundsen and Jansen (2011) show that there exist self-reinforcing effects between housing prices and debt. Easy access to credit increases the household's ability to take on loans and makes it possible to increase its housing stock in an easier way than if it did not have access to the credit. During the Financial Crisis, it became more difficult to access credit, but this thesis will focus on the effects of the Financial Crisis in the section that analyzes the effects of interest rate movements. Similar to increases in income, easy access to credit may be modelled as an upward shift in the $\pi(\bullet)$ function.

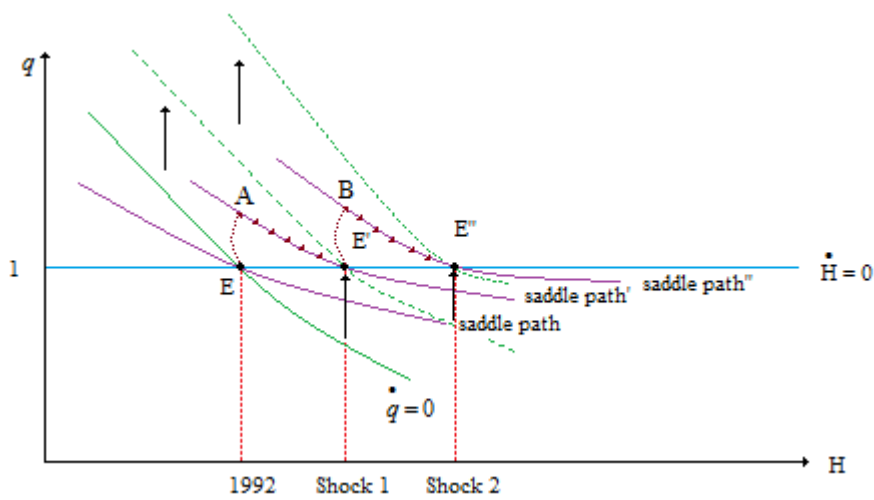
The FSA imposed new guidelines for residential lending in March 2010 and December 2011 which tightened banks' lending policies. This may be modelled as a negative shift in the $\pi(\bullet)$ function, but since these credit requirements are relatively new, it is still too early to investigate if the new guidelines have had any effects on the dynamics in the housing market.

Phase Diagram

Both increases in disposable income and easy access to credit may have contributed to shape the path of q and H in figure 30. This may be analyzed along the lines of figure 18 and 19, adjusting for the fact that the shocks may be happening continuously. For simplicity, this thesis analyzes the effects when the economy is exposed to two shocks right after each other.

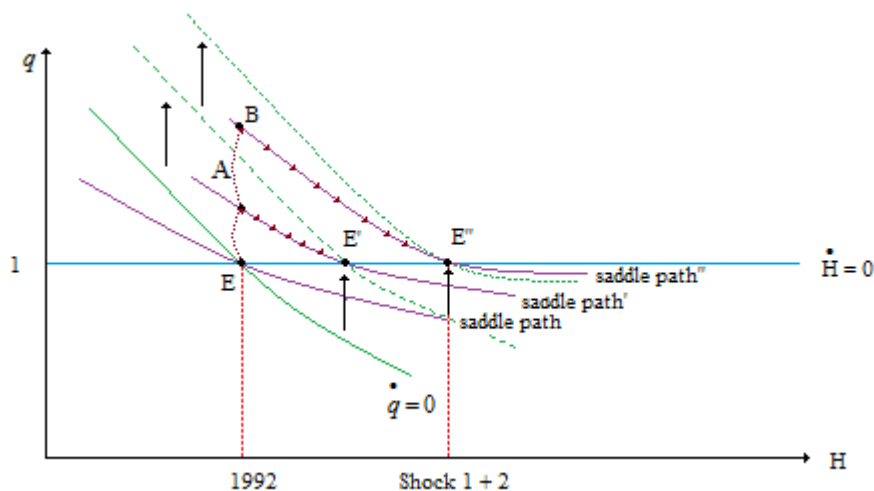
If both shocks are permanent and the economy has time to adjust to the new long-run equilibrium point E' after the first shock, the effects of the two changes to π may be analyzed in figure 36. When the economy reaches the new long-run equilibrium point E' , another increase in π yields an immediate jump in q to point B on the new saddle path for the given housing stock. After this q and H then move down that path to the new long-run equilibrium point E'' . This type of shock may explain why the housing stock is increasing for the whole period, but not why the value of housing is increasing. Thus, some other types of shocks may be at work, suggesting that the economy does not have time to adjust to the new long-run equilibrium point E' after the first shock.

Figure 36: Continuous permanent increases in π



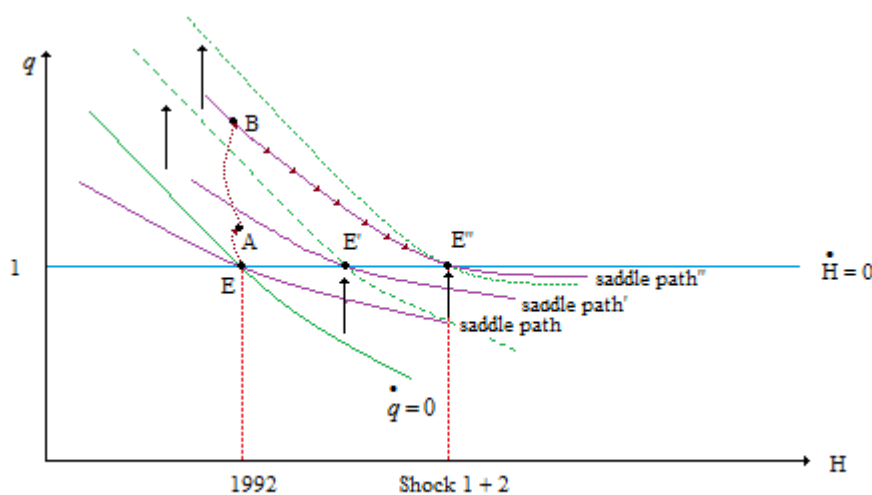
If the economy lacks time to adjust to the new long-run equilibrium point E' after the first shock, the increasing path of q and H may be explained by permanent shocks or a combination of permanent and temporary shocks. Figure 37 illustrates the effects of two permanent shocks, where the economy lacks time to adjust to the new long-run equilibrium path after the first shock. Immediately after the value of housing has reached the new saddle path, a shock increases π which leads to another immediate jump in q , before q and H then move towards the new long-run equilibrium point E'' . The shock might also take place when q and H is located on the saddle path between point A and the long-run equilibrium point E' . This indicates that the *time* the economy needs to adjust is important for the shape of the path of q and H .

Figure 37: Continuous permanent increases in π where the economy lacks time to adjust



The effects of a permanent shock and a temporary shock are illustrated in figure 38, where the economy is first exposed to a temporary increase in π . Before q and H reaches the old saddle path at time T , a permanent shock raises π further and q jumps immediately from point A to point B for the given housing stock. q and H then move gradually to the new long-run equilibrium point E'' . As in the case with two permanent shocks, q may move to point B from a point between point A and point E .

Figure 38: Continuous temporary and continuous increases in π where the economy lacks time to adjust



This analysis indicates that the rising path of q and H may be explained by continuous shocks to π assuming that the economy does not have time to adjust to new long-run equilibria. The figures are examples of shocks that may take place and when the economy is exposed to multiple shocks, the shape of the path of q and H may be a result of a combination of shocks were the economy's time to adjust vary. The assumption that the economy's time to adjust varies, may also apply to other shocks than changes in π .

8.1.2 The Effects of Changes to the Aggregate Housing Stock, H

The growth in the number of households increases the housing stock through N , in equation (3.24) and from 1992-2011, the Norwegian population grew by 13 %. Since it is assumed that marginal housing utility is decreasing in the aggregate housing stock, the increase in population may be modelled as a downward shift in the representative household's utility function. This assumes that the rate of new housing construction follows the same pace as the development in the population. In practice, this is not the case since housing construction takes time and thus the economy will not immediately adjust to the increase in population. In

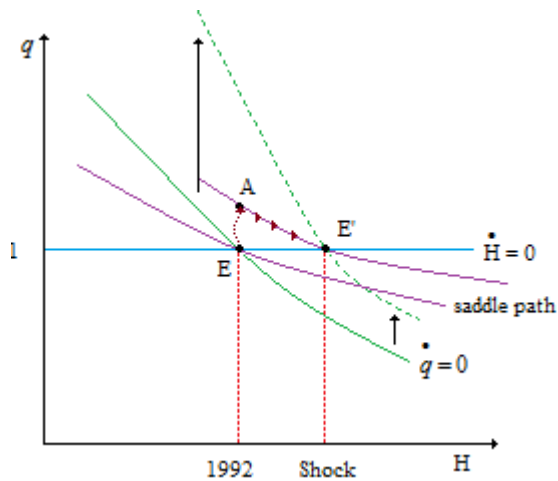
figure 5 it was shown that there is an increasing gap between the population and the initiation of new housing construction during the period 2006-2011. When population grows in a faster pace than new houses supplied there is unsatisfied demand in the housing market which leads to an increase in the household's utility function. Thus, the combination of the increase in population and the decrease in initiation of new housing construction may be modelled as an upward shift in the household's utility function. Thus the growth in population and the low pace of initiation of new housing construction may contribute to explain the rising path of q and H during the period 2006-2011.

Changes in the household's utility function may contribute to explain the rising path of q and H during the period analyzed, but none of the changes analyzed so far seem to explain the brief setback in q during the Financial Crisis.

8.2 The Effects of Interest Rate Movements

In the analysis so far, it is assumed that the real interest rate is constant. As described in section 2, there have however been frequent movements in interest rates. Interest rate movements, like shifts in the housing utility function, affect investment through their impact on the equation for the motion of q (see equation [3.25]). When interest rates decline, the $\dot{q}=0$ locus becomes steeper and is shifted up. When the opposite happens the $\dot{q}=0$ locus becomes less steep and is shifted down. Thus the fluctuating trend in interest rates may contribute to explain why the $\dot{q}=0$ locus might be changing, where the decreasing trend in the interest rates in figure 10 may suggest that the $\dot{q}=0$ locus is more often shifted up than down. The effects of a permanent decrease in interest rates may be analyzed along the lines of figure 20 and is illustrated in figure 39.

Figure 39: Permanent decrease in interest rates

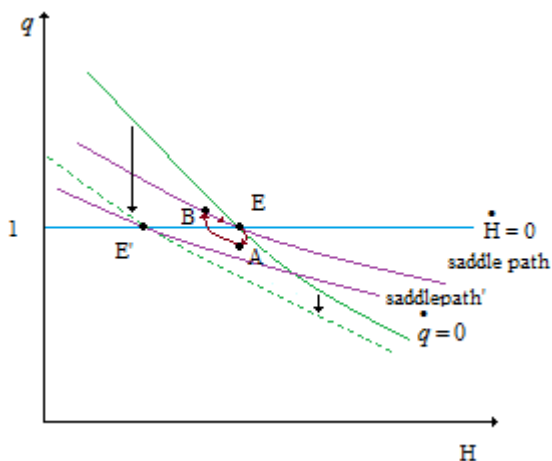


As a result, the decreasing trend in interest rates may contribute to explain why the housing stock is increasing for the whole period. Similar to the analysis of changes in the household's utility function, the effects of interest movements may cause multiple permanent and temporary shocks to the economy. This may contribute to explain the increasing path of q and H during the period.

8.2.1 The Effects of the Financial Crisis

If interest rates increase, a negative demand shock takes place. This was the case during the first phase of the Financial Crisis, where consumer confidence fell, and interest rates soared to above 7 % in the two last quarters of 2008. This effect was however temporary, as the interest rates fell in 2009. Assuming that the economy is initially in steady state before the crisis hits, the effects of the temporary increase in interest rates is illustrated in figure 40.

Figure 40: The effects of the Financial Crisis



When there is an unanticipated temporary increase in interest rates, q jumps immediately to a new lower point A for the given housing stock. Since $q < I$, the housing stock starts to decrease until the path of q and H reaches the old saddle path again on point B , and moves towards the old long-run equilibrium point E . Thus the effects of the Financial Crisis illustrated by an increase in interest rates may explain the brief setback in q , but not why the housing stock is increasing.

8.3 The Effects of Taxes

As described in section 2, housing in Norway is subject to beneficial taxation compared to other countries, other investment goods and the rental market. For simplicity³⁵, the tax subsidies can be thought of as a tax credit that takes the form of a direct rebate to the household of a fraction θ of the housing price. The favourable tax treatment of owner-occupied housing may contribute in determining the underlying level of the housing market, and hence be analyzed along the lines of figure 21 and 22. Two major changes have been made to the taxation of owner-occupied housing during the period analyzed. In 1992, deductibility on interest rates was reduced and in 2005, the taxes on imputed rents were abolished.

8.3.1 The Tax Reform in 1992

The effects of tax deductibility on interest rates work in similar manner as a decrease in interest rates. Before the tax reform in 1992, households had full deductibility on interest rates. The tax reform imposed a flat deduction rate of 28 %, indicating a permanent increase in the real interest rate after taxes. A permanent increase in the real interest rate after taxes may be analyzed along the lines of figure 20. These effects are illustrated in figure 41, where the higher interest rates lead to an immediate drop in q , which leads to a permanently lower housing stock, as q and H moves towards the new long-run equilibrium point E . This shock may explain why the value of housing was low and gradually increasing during the early 1990s, but can not explain why the housing stock is increasing.

³⁵ In practice, the treatment of tax subsidies is more complicated. The households differ in terms of LTV ratios, financing terms, rental income, gains on sale and so on.

construction, interest rates and taxes have affected the path of q and H . In section 8.4, it is estimated how these shocks impact the dynamics of q and H in a regression analysis.

8.4 Regression Analysis

The effects of the shocks analyzed in section 8.1 and 8.2 are in this section estimated in a regression analysis. The effects of taxes are left out since it was difficult to obtain reliable quarterly data on these effects. The housing measurement used is housing deflated by the CPI, since the CPI is used to convert three of the shocks into real terms and this housing measurement produced the most robust results in section 7.2.2.

In this analysis, regressions are performed on levels and changes, using income, debt, population, initiation of new housing construction and interest rates. The effect of each shock is first analyzed separately, followed by the total effect to the household's preferences and the aggregate housing stock respectively, and finally the effect of all the shocks combined. Since the variables' time series differ in length, the shortest time series is applied in the regression of more than one shock. In addition to linear regression, this regression analysis includes a variance analysis and an analysis of the residual correlation between q and H , but first the variables are presented.

8.4.1 The Variables

This section provides a brief description of the variables; income, debt, population, initiation of new housing construction and interest rates. In order to compare the variables, the variables are converted into levels and percentage changes, where their first observations have a value of 1 and 0 respectively. Income, debt and interest rates are converted into real terms by deflating by the CPI.

Disposable Income

To find quarterly data on households' disposable income, the time series illustrated in figure 5 is applied. A weakness with this dataset is that it includes disposable income for non-profit organizations. To cope with this problem it is assumed that the inclusion of non-profit organizations does not have any major impacts for the results. The data is available in the period 2002-2011 and in the presentation of the regression results disposable income is for simplicity denoted as income.

Financial Conditions

Easy access to credit may be analyzed in the same way as the change in households' debt. Thus the data from figure 12 may be applied. Similar to disposable income, this dataset includes non-profit organizations, but it is assumed that this will not have any major impact for the results. The period analyzed is the time period from the fourth quarter of 1995 throughout 2011 and in the presentation of the regression results this variable is denoted as debt.

Population

The quarterly data used to estimate the effects of developments in population is available from the fourth quarter of 1997 throughout 2011 (SSB 2012a).

Initiation of New Housing Construction

Figure 3 illustrates the quarterly data on the level of initiation of new housing construction in the period 1993-2011. In the presentation of the regression results this variable is denoted as construction.

Interest Rates

In order to estimate the effects of interest rates, the repayment rates on mortgage backed loans illustrated in figure 10 is applied. The time period for this dataset is 2002-2011 and in the presentation of the regression results this variable is denoted as interest.

8.4.2 Regression Analysis of Levels

The regression results of the effects of shocks on the levels of q and H are displayed in table 6-13. The effects of changes in household's preferences are first analyzed, followed by changes to the aggregate housing stock and interest rate movements.

The Effects of Changes in Household's Preferences

As analyzed in section 8.1, the effects of changes in household's preferences may be analyzed as an increase in income and debt. In the first regression, the value of housing is regressed against income and housing. Table 6 shows that all the coefficients are significant, where the coefficients of H and the constant are positive and income's coefficient is negative. The reason why this coefficient is negative may be that disposable income is correlated to labour costs which constitute a major part of construction costs (SSB 2012i). This result implies that disposable income may be stronger correlated to construction costs

than housing prices, and thus the value of housing may decrease when income rises. Hence, the level of income has had an effect on the value of housing, but not in the same way as predicted in section 8.1. Since income may be correlating with construction costs, this result does not disprove that income may have contributed in driving the value of housing upwards.

Table 6: Regression results: income (2002-2011)

	Coeff.	P-value	Std.Error
H	0,57051	0,000	0,08149
Income	-0,3409	0,050	0,1686
Constant	0,8042	0,000	0,1096

In the next regression, the value of housing is regressed against housing and debt. Table 7 illustrates the results, and show that all the coefficients are significant, where H 's coefficient is negative and the other coefficients are positive. Thus the level of debt is positively and significantly related to the value of housing, which is consistent with existing literature that state that there may be a financial accelerator in the housing market (Anundsen and Jansen 2011). The fact that the housing stock has a negative coefficient is in line with the model prediction that there should be a negative relationship between q and H .

Table 7: Regression results: debt (1995-2011)

	Coeff.	P-value	Std.Error
H	-1,1887	0,005	0,4068
Debt	1,1521	0,000	0,2390
Constant	1,2797	0,000	0,1728

The combined effect of income and debt is illustrated in table 8, where only income and the constant are significant. Thus, the level of income may have a stronger effect on the value of housing than the level of debt. This result must however be interpreted with caution since income may be correlated with construction costs.

Table 8: Regression results: income and debt (2002-2011)

	Coeff.	P-value	Std.Error
H	0,2213	0,473	0,3048
Income	-0,4237	0,025	0,1816
Debt	0,2835	0,242	0,2386
Constant	0,9398	0,000	0,1578

The Effects of Changes to the Aggregate Housing Stock

The effects of changes to the aggregate housing stock may be analyzed as the effects of population and initiation of new housing construction. Table 9 illustrates the regression results when the value of housing is regressed against housing and population. H 's coefficient is significant and positive, but the other coefficients are not significant and based on this analysis it cannot be concluded that population has contributed to the development in q and H .

Table 9: Regression results: population (1997-2011)

	Coeff.	P-value	Std.Error
H	0,7378	0,000	0,1551
Population	-1,504	0,307	1,458
Constant	1,943	0,145	1,315

Table 10 illustrates the regression results when the value of housing is regressed against housing and the initiation of new housing construction. Both variables have positive and significant coefficients, and thus the initiation of new housing construction may have contributed to explain the development in q .

Table 10: Regression results: construction (1993-2011)

	Coeff.	P-value	Std.Error
H	0,84076	0,000	0,04562
Construction	0,21567	0,000	0,03962
Constant	0,07300	0,357	0,07881

The combined effect of population and initiation of new housing construction is illustrated in table 11, where housing and construction have significant coefficients. This strengthens the argument that the initiation of new housing construction may have influenced q positively.

Table 11: Regression results: population and construction (1997-2011)

	Coeff.	P-value	Std.Error
H	0,4956	0,001	0,1405
Population	0,480	0,713	1,299
Construction	0,19849	0,000	0,04160
Constant	-0,008	0,994	1,183

The Effects of Interest Rate Movements

The regression results from the value of housing regressed against housing and interest rates are illustrated in table 12. Since interest rates are not significant, this analysis implies that it

can not be concluded that this set of interest rates have had an impact on the value of housing.

Table 12: Regression results: interest rates (2002-2011)

	Coeff.	P-value	Std.Error
H	0,44112	0,000	0,03761
Interest	0,05414	0,241	0,04545
Constant	0,53764	0,000	0,06907

The Total Effect of the Shocks

The total effects of the shocks are illustrated in table 13, where only initiation of new housing construction and interest rates has significant coefficients. These coefficients are positive and thus initiation of new housing construction and interest rates may have contributed to explain the development in q . If longer time series were applied, more coefficients may however be significant. Since H only has a negative coefficient in the regression of debt, this may be interpreted as once controlling for all the shocks, the relationship between q and H is not negative as the model predicts.

Table 13: Regression results: all shocks (2002-2011)

	Coeff.	P-value	Std.Error
H	0,2006	0,433	0,2528
Income	-0,0479	0,824	0,2135
Debt	0,3441	0,102	0,2046
Population	-1,590	0,182	1,167
Construction	0,09336	0,004	0,02984
Interest	0,08765	0,047	0,04256
Constant	1,9201	0,059	0,9834

Variance Analysis

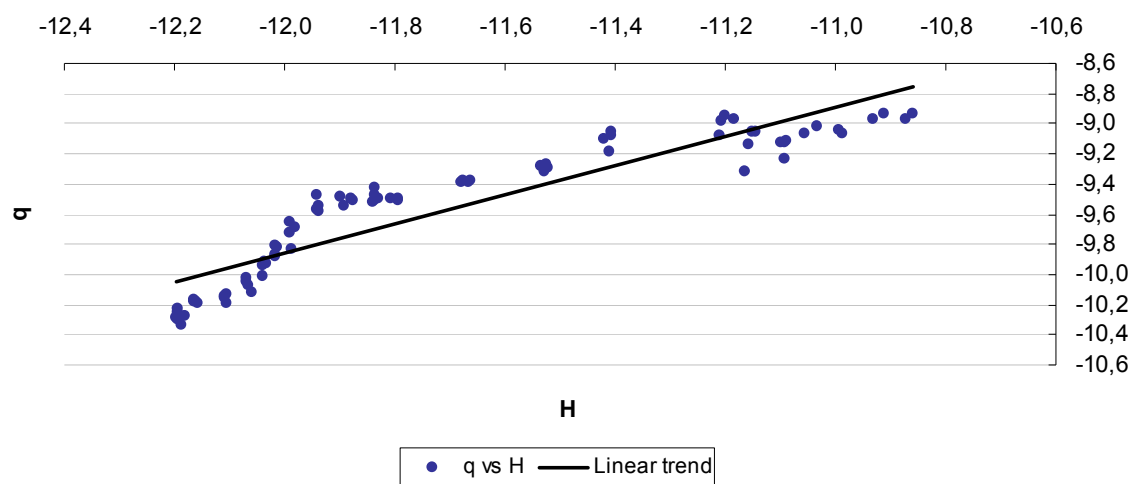
The variance of each shock is decomposed in a variance analysis (ANOVA) in table 14. Since the p-values are significant for all of the shocks, it may be assumed that the variance in the sample is constant. The R^2 expresses how much of the variance in q that can be explained by the shocks, where interest rates in particular has a high explanation degree of 74,46 %. In the regression of all the shocks, the R^2 is also relatively high with a degree of 64,26 % and the third highest R^2 is found in the regression of the combined effects of population and construction, with a degree of 37,56 %. Thus the variance in q may partially be explained by shocks, where interest rates and population are particularly evident.

Table 14: ANOVA results

	Period	DF	SS	MS	F-value	P-value	Pooled Std. Dev	R ²
Income	2002-2011	2	0,7967	0,3984	14,09	0,000	0,1682	19,41 %
Debt	1995-2011	2	3,674	1,837	8,55	0,000	0,4635	8,18 %
Income and debt	2002-2011	3	3,5040	1,1680	24,00	0,000	0,2206	31,58 %
Population	1997-2011	2	5,3845	2,6923	49,78	0,000	0,2325	37,21 %
Construction	1993-2011	2	7,148	3,574	17,55	0,000	0,4513	13,49 %
Population and Construction	1997-2011	3	7,4703	2,4901	44,92	0,000	0,2354	37,56 %
Interest	2002-2011	2	12,6464	6,3232	170,53	0,000	0,1926	74,46 %
All shocks	2002-2011	6	20,9194	3,4866	82,17	0,000	0,2060	64,36 %

Residual Correlation

By regressing both q and H individually on the shocks and saving their residual errors, it is possible to plot their correlation against each other by subtracting the residuals from their initial data. This is illustrated in figure 43. Compared to figure 33, this slope is more upward sloping and thus a positive relationship between q and H still persists after controlling for shocks.

Figure 43: Residual correlation between the levels of q and H 

8.4.3 Regression Analysis of Changes

The regression results of the effects of shocks on the changes of q and H are displayed in table 15-22. The tables illustrates that all of the shocks have a negative effect on the change in q . In tables 18 and 20, which show the change in population and construction respectively, all of the coefficients are significant. In table 21, interest rates are significant if a 90 %

confidence interval is assumed. These results imply that the change in population, construction and interest rates may have a negative effect on q 's slope.

Housing is positively and significantly related to the value of housing in all the tables, except for construction where housing is significant if a 90 % confidence interval is assumed. Thus the relationship between the change in q and H is not negative once controlling for all the shocks which inconsistent with the model predictions.

Table 15: Regression results: changes in income (2002-2011)

	Coeff.	P-value	Std.Error
H	0,5595	0,001	0,1468
Income	-0,0582	0,690	0,1450
Constant	-0,000640	0,893	0,0004515

Table 16: Regression results: changes in debt (1995-2011)

	Coeff.	P-value	Std.Error
H	0,4628	0,003	0,1471
Debt	-0,2993	0,392	0,3473
Constant	0,010639	0,119	0,006731

Table 17: Regression results: changes in income and debt (2002-2011)

	Coeff.	P-value	Std.Error
H	0,5612	0,001	0,1583
Income	-0,0564	0,721	0,1570
Debt	-0,0131	0,975	0,4087
Constant	-0,000443	0,955	0,007816

Table 18: Regression results: changes in population (1997-2011)

	Coeff.	P-value	Std.Error
H	0,4357	0,005	0,1473
Population	-9,576	0,014	3,789
Constant	0,024357	0,011	0,009220

Table 19: Regression results: changes in construction (1993-2011)

	Coeff.	P-value	Std.Error
H	0,2556	0,095	0,1509
Construction	-0,02118	0,194	0,01614
Constant	0,010038	0,008	0,003688

Table 20: Regression results: changes in population and construction (1997-2011)

	Coeff.	P-value	Std.Error
H	0,3012	0,047	0,1482
Population	-8,363	0,025	3,167
Construction	-0,04664	0,010	0,01738
Constant	0,024631	0,007	0,008733

Table 21: Regression results: changes in interest rates (2002-2011)

	Coeff.	P-value	Std.Error
H	0,5804	0,000	0,1373
Interest	-0,08363	0,060	0,04316
Constant	-0,002760	0,519	0,004238

Table 22: Regression results: changes in all shocks (2002-2011)

	Coeff.	P-value	Std.Error
H	0,4418	0,009	0,1599
Income	-0,0280	0,851	0,1481
Debt	-0,1021	0,803	0,4051
Population	-5,83	0,195	4,403
Construction	-0,03037	0,127	0,01939
Interest	-0,05940	0,199	0,04537
Constant	0,01625	0,290	0,01512

Variance Analysis

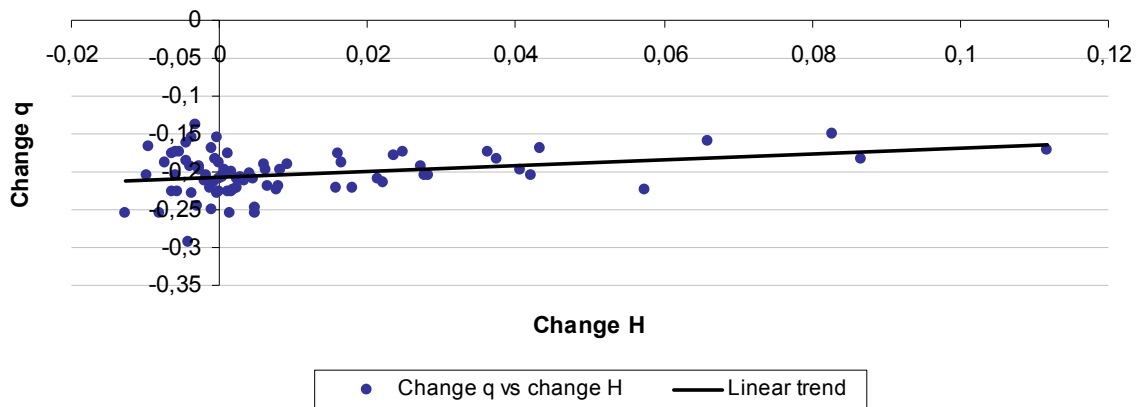
The variances of each shock have been decomposed in a variance analysis (ANOVA) in table 23. In contrast to the variance analysis in table 14, only the variance of the change in interest rates and population are significant. This implies that the variance is not constant for the rest of the variables. Both interest rates and population has the highest explanation degrees of 4.98 % and 3.86 % respectively. Thus the variance in q 's slope may to a small extent be explained by the change in interest rates and population.

Table 23: ANOVA results: changes

	Period	DF	SS	MS	F-value	P-value	Pooled Std. Dev	R ²
Income	2002-2011	2	0,001105	0,000553	0,71	0,494	0,02789	1,20 %
Debt	1995-2011	2	0,001161	0,000581	1,15	0,318	0,02245	1,19 %
Income and debt	2002-2011	3	0,003152	0,001051	1,71	0,166	0,02475	3,19 %
Population	1997-2011	2	0,003399	0,001699	3,37	0,037	0,02244	3,86 %
Construction	1993-2011	2	0,0260	0,013	0,81	0,448	0,1271	0,71 %
Population and Construction	1997-2011	3	0,0140	0,0047	0,42	0,741	0,1058	0,56 %
Interest	2002-2011	2	0,0187	0,00934	3,06	0,05	0,0552	4,98 %
All shocks	2002-2011	6	3,726	0,621	1,68	0,125	0,6074	3,57 %

Residual Correlation

The relationship between the change in q and H adjusted for residual errors is illustrated in figure 44. Compared to figure 36, this figure illustrates a slope which is less upward sloping where q is negative. Since the slope is still upward sloping, the relationship between the change in q and H is still positive and thus the model prediction that the relationship between q and H should be negative is not true for the data.

Figure 44: Residual correlation between the changes in q and H 

8.4.4 Regression Results of Shocks

In this section regressions were performed on the levels and changes in q and H . In the analysis of levels, income, debt and initiation of new housing construction yielded significant results in their separate regressions, but only initiation of new housing construction and interest rates were significant in the regression of all the shocks. In the variance analysis, all the shocks were significant and thus the variance in the value of housing could partially be explained by the shocks, where interest rates and population had particularly high explanation degrees. Thus the effects of shocks have undoubtedly contributed to explain the *levels* of q .

In the analysis of changes, population and interest rates yielded significant results, but none of the shocks were significant in the regression of all the shocks. Population and interest rates were in addition the only variables significant in the variance analysis. These shocks may for this reason explain a small extent of the variance in the change in q . This is consistent with the variance analysis of levels where these variables had the highest explanation degrees. The small explanation degrees and the few significant variables suggest however that the effects of shocks may not have played a major role in determining the *changes* in q .

Once controlling for all the shocks in table 13 and table 22, the relationship between q and H was still positive which is inconsistent with the model predictions. This was also true in the residual plots of q and H in figure 43 and 44. This means that shocks may not explain all of the upward sloping development in q and H and thus other variables not accounted for in this analysis may be at work. The implications of these variables are discussed in the next section, where the possible presence of non-fundamentals is particularly in focus.

9. Discussion

In this section, this thesis discusses the results and the possible presence of bubbles in the Norwegian housing market. Finally, this thesis comments some possible weaknesses with the analysis.

9.1 Results

In section 6 and 7, it was found that the value of housing is positively and significantly associated with housing investment, which is in line with the q theory model of housing and existing literature. Assuming no shocks in the economy, the upward sloping path may however indicate a deviation from fundamental values according to equation (3.23) and P/E analysis. This result is consistent with Grytten (2009), who based on the information summarized in q believe that it is too easy to conclude that there is not a housing bubble in the Norwegian housing market.

Assuming a presence of shocks in section 8, it was found that shocks may contribute in explaining the rising path of q and H . The shocks analyzed were the effects of income, debt, population, initiation of new housing construction, interest rates and taxation rules. Empirical estimates showed that the effects of population and interest rates were particularly evident in explaining the variance in q . Since interest rates were particularly high during the Financial Crisis, this result is in line with the finding that the Financial Crisis has impacted the value of housing. By controlling for each shock in a regression analysis, the residual correlation plots showed that the relationship between q and H was positive. As a result, the presence of bubbles in the housing market may not be denied. The regression analysis in section 8 has however not accounted for other variables such as other replacement costs than construction costs. This weakens the suggestion that there may be a bubble in the housing market and thus it is interesting to discuss the possible presence of bubbles.

9.2 Is There a Bubble in the Housing Market?

In the analysis of q , housing prices were compared to construction costs, where construction costs can be defined as the fundamental value of housing. According to the fundamental equation for q (3.23) and P/E analysis, this comparison indicates that there may be a bubble in the housing market. In section 8, it was analyzed that the effects of shocks have influenced

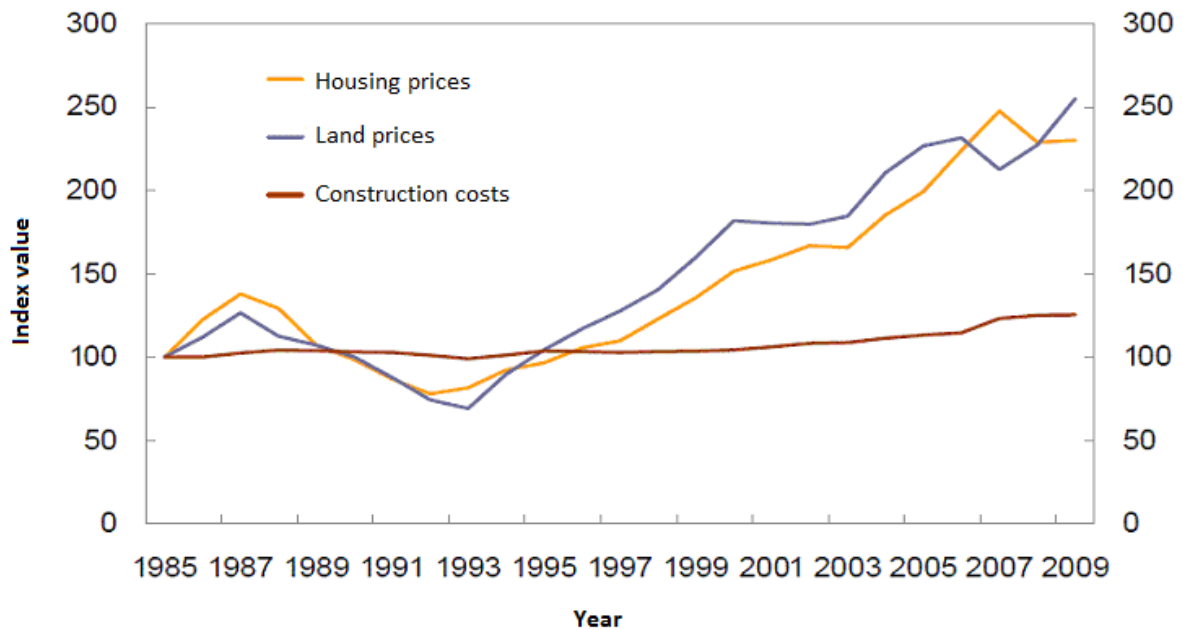
the value of housing, but when controlling for shocks the relationship between q and H was still positive. However, the regression analysis did not estimate the effects of the favourable taxation rules which are suggested as a main driver of the recent boom (IMF 2012). In addition, the full range of the determinants of housing supply and demand is not accounted for. This section discusses the impact of other replacement costs than construction costs that have not been included in the calculation of q and the role of unstable price expectations which may represent a non-fundamental variable in the housing market.

9.2.1 Land Prices

Madsen (2011) use Norwegian agricultural land prices as a proxy for urban land prices, and estimate that urban land prices together with construction costs are the key determinants of housing prices in the very long-run. Thus the increasing gap between construction costs and housing prices may be explained by the fact that urban land prices may be increasing. This may be explained as that when population grows, space becomes limited and the best locations become more expensive. Vikøren (2010) has developed a figure showing housing prices, land prices and construction costs deflated by the CPI in the period 1985-2009 where 1985 is set as the index year with a value of 100³⁶. Vikøren's figure is included below as figure 45 and explains the increasing housing prices with a similar increase in land prices. Since an official land price index does not exist for Norway, there is some uncertainty associated with this figure, but the figure may strengthen the argument of why land prices should be included in the replacement costs to give a more realistic measure of q .

³⁶ Vikøren's calculations are based on sources from SSB, NEF, EFF, ECON Pöyry, Finn.no and Norges Bank. According to the Communications Department in Norges Bank, land prices have most likely been constructed by subtracting the construction costs from the housing prices.

Figure 45: Housing prices, land prices and construction costs (1985=100) 1985-2009



9.2.2 Non-fundamentals

A non-fundamental variable that may affect housing demand is the unstable price expectations included in the user cost of housing. These expectations may be characterized by *animal spirits* in the sense that household's have strong confidence in housing since it is a common perception that housing is good investment since prices 'always' go up. In addition, households may have positive price expectations because the media and people emphasize stories about successful housing sales. Unstable price expectations may also be explained by *irrational exuberance* through the possible presence of Ponzi processes. Since housing sales are characterized by bids, households, their confidence and expectations buoyed by past price increases, bid up prices further, thereby enticing more households to do the same which may result in an amplifying feedback loop. The extent of unstable price expectations in the housing market is however difficult to reveal as these types of data are difficult to obtain. Since no asset market is 100 % efficient, intuitively some of these mechanisms may be at work, but perhaps not so much that they can contribute to explain the rising path in q and H in the analysis. Since the model predicts that eventually all bubbles must burst, the interesting question is how big the contribution of non-fundamentals is in the value of q and how long the existence of non-fundamentals may persist before the potential bubble bursts. This is however a question that goes beyond the scope of this thesis.

9.3 Comments on Possible Weaknesses

In order to adapt the q theory model of housing to the Norwegian housing market, a range of assumptions were taken to simplify the analysis. Concerning the households preferences it was assumed that it is possible to model the housing market as if the demand side is generated by a representative household, that housing utility may be separated from the utility of other goods, and that marginal housing utility is decreasing in the aggregate housing stock. In addition, it was assumed that the depreciation rate is zero in the housing accumulation constraint since it was argued that housing depreciation has been stable and relatively low compared to other capital goods. It is also assumed that the variables presented in this thesis are the main variables of the housing market, but other variables may also be at work.

The data applied in this thesis is subject to some limitations. Most of the data is gathered from SSB and adapted for the purpose of this thesis through own calculations. Thus miscalculations may not be ruled out. The comparisons of data will in addition yield some weaknesses since some of the data measures different things. The housing price index for instance, measures the housing prices for used and new freehold houses and housing cooperatives, while the construction cost index measures the cost of producing new houses. The use of the CPI deflator in the conversion of nominal prices to real prices may also represent some limitations since the actual measures of the variables converted may deviate from the development in the CPI. The replacement cost of housing is in addition simplified for the purpose of this thesis, where ideally more replacement costs such as land prices should be included.

In the analysis, it is focused on the data's raw levels and changes, and thus seasonal effects may not be ruled out. In the process it was however investigated to pursue deseasonalized data, but since the period analyzed is relatively short (20 years) the use of deseasonalized data would alter some of the data's initial meaning. In addition, the variables applied in section 8.4 may not be independent since they may correlate with each other. Income and interest rates may for instance correlate with debt, while initiation of new housing construction may correlate with debt and population.

Due to the various assumptions and the data limitations, the results in this thesis must be interpreted by keeping in mind that the use of the q theory model of housing is a simplified version of the real mechanisms in the housing market.

10. Conclusion

This thesis develops a q theory model of housing which shows that the value of housing, q , in the period 1992-2011 is positively and significantly related to housing investment. This is consistent with the q theory model of housing that predicts that there should be a unique q for every given H and existing literature. Assuming no shocks in the economy, the upward sloping path of q and H is not consistent with the q theory model of housing since the model predicts that there should be a negative relationship between the two variables. This implies that there may be bubble tendencies in the housing market.

Assuming a presence of shocks in the economy, the development in q have undoubtedly been influenced by factors such as changes to income, debt, population, initiation of new housing construction, interest rates and taxes. Empirical estimates show that the developments in population and interest rates in particular can explain the variance in the value of housing. After controlling for shocks, the value of housing is still positively and significantly related to housing investment and thus the presence of shocks does not counter fact the suggestion that there may be a presence of bubbles in the Norwegian housing market. This suggestion must however be interpreted with caution since it is difficult to reveal bubbles before they have burst, and the empirical estimates have not included all of the main drivers of the housing market such as land prices and taxes. Thus it may neither be proved nor disproved that a bubble exists in the Norwegian housing market. Nevertheless, this does not alter the main result in this thesis, that the value of housing is significantly related to housing investment according to the q theory model of housing.

References

- Abel, Andrew B. 1982. *Dynamic effects of permanent and temporary tax policies in a q model of investment*. Journal of Monetary Economics 9 (May). (353-373).
- Acemoglu, Daron. 2009. *Introduction to Modern Economic Growth*. New Jersey: Princeton University Press. (215-226)
- Akerlof, George A. and Robert J. Shiller. 2009. *Animal Spirits. How Human Psychology Drives the Economy and Why It Matters for Global Capitalism*. New Jersey: Princeton University Press.
- Anundsen, André K. and Eilev S. Jansen. 2011. *Self-reinforcing effects between housing prices and credit*. SSB Discussion Paper No. 651.
- Barro, Robert J. and Xavier Sala-I-Martin. 1995. *Economic Growth*. McGraw-Hill. (16, 65, 119-122)
- Berg, Lennart and Tommy Berger. 2005. *The Q theory and the Swedish Housing Market- An Empirical Test*. Uppsala University. Working Paper 2005:19.
- Boug, Pål and Yngvar Dyvi. 2008. *MODAG-En makroøkonomisk modell for norsk økonomi*. SSB: Sosiale og økonomiske studier (SØS 111). (3, 191-199)
- Bærug, Solve, Einar Hegstad and Håvard Steinsholt. 2005. *Prisregister for tomter til utbyggingsformål*. (14.10.05)
<<http://www.regjeringen.no/upload/kilde/krd/tid/2006/0017/ddd/pdfv/284329-tomt.pdf>> (10.06.12)
- Case, Karl E., John M. Quigley and Robert J. Shiller. 2003. *Comparing Wealth Effects: The Stock Market versus the Housing Market*. Cowles Foundation Discussion Paper No. 1335.
- Case, Karl E. and Robert J. Shiller. 2004. *Is there a bubble in the housing market?* Cowles Foundation Discussion Paper No. 1089.
- Corder, Matthew and Nyssa Roberts. 2008. *Understanding dwellings investment*. Bank of England Quarterly Bulletin Q4. (393-403)
- Davis, Morris and Jonathan Heathcote. 2001. *Housing and the Business Cycle*. International Economic Review. (753)
- Davis, Morris and Michael G. Palumbo. 2001. *A Primer on the Economics and Time Series Econometrics of Wealth Effects*. Finance and Economics Discussion Series 2001-09.
- Deaton, Angus. 1992. *Understanding Consumption*. Oxford: Clarendon Press. (1-12)
- Deaton, Angus and Muellbauer. 1980. *Economic and Consumer Behaviour*. Cambridge: Cambridge University Press. (144-145)

-
- Eurostat (2012). *Housing statistics*. Statistics Explained (01.06.12)
<http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Housing_statistics>
(11.06.12)
- Finansdepartementet. 2011. *Bedre rustet mot finanskriser*. Norges offentlige utredninger (NOU) 2011:1. (152-158)
- Finanstilsynet. 2012. *Finansielt utsyn 2012*. (07.03.12)
<http://www.finanstilsynet.no/Global/Venstremeny/Rapport/2012/Finansielt_utsyn_2012.pdf> (10.06.12) (2)
- Gali, Jordi. 1994. *Keeping up with the Joneses: Consumption Externalities, Portfolio Choice, and Asset Prices*. Journal of Money Credit and Banking. Vol 26, No 1. (1-8)
- Glaeser, Edward L. 2011. *Triumph of the City. How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier*. New York: Penguin Press (90)
- Glaeser, Edward L. 1998. *Are Cities Dying?* Journal of Economic Perspectives. Vol 12. No 2. (139-60)
- Grossman, Stanford J. and Guy Laroque. 1988. *Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods*. NBER Working Papers No 2369. (4)
- Grytten, Ola H. 2010. *Tidsserieanalyse*. Lecture FIE431-1 Krakk og Kriser. Bergen: NHH (14.09.10)
- Grytten, Ola H. 2009. *Boligboble? Empiriske indikatorer i et historisk perspektiv*. Magma 0509. <<http://www.magma.no/boligboble>> (10.06.12)
- Haines, Michael R. 2001. *The Urban Mortality Transition in the United States 1800-1940*. Historical Paper 134. Cambridge: NBER.
- Hayashi, Fumio. 1982. *Tobin's Marginal q and Average q: A Neoclassical Interpretation*. North Western University Discussion Paper No 457.
- Helms, Andrew C. 2012. *Keeping up with the Joneses: Neighbourhood Effects in Housing Renovation*. Regional Science and Urban Economics 42. (303-313)
- Henderson, Vernon. 2002. *Urban Primacy, External Costs, and Quality of life*. Resource and Energy Economics 24. (95-106)
- Høydahl, Even. 2010. *Befolkning: Befolkningsvekst rundt Oslo*. SSB: Samfunnsspeilet nr 5-6/2010. (11-19)
- Iacoviello, Matteo. 2005. *House prices, Borrowing Constraints, and Monetary Policy in the business cycle*. The American Economic Review. Vol 95, No. 3. (739-762)

-
- Iacoviello, Matteo. 2004. *Consumption, House prices, and Collateral Constraints: a Structural Econometric Analysis*. Boston College Working Papers in Economics. No 589. (4)
- IMF. 2012. *Norway: 2011 Article IV Consultation-Staff report; Public Information Notice on the Executive Board Discussion; and Statement by the Executive Director for Norway*. IMF Country Report No 12/25.
- Inada, Ken-Ichi. 1963. *On a Two-Sector Model of Economic Growth: Comments and a Generalization*. Review of Economic Studies 30 (June). (119-127)
- Jacobsen, Dag H. and Bjørn E. Naug. 2005. *What drives house prices?* Economic Bulletin 05 Q1. (29-41)
- Jansen, Eilev S. 2012. *Hva driver utviklingen i boligprisene?* SSB: Samfunnsspeilet nr 5-6/2011. (89-95)
- Jin, Yi and Zhixiong Zeng. 2004. *Residential Investment and House Prices in a Multi-Sector Monetary Business Cycle Model*. Journal of Housing Economics. Vol 13, No 4. (277-278)
- Jud, G. Donald and Daniel T. Winkler. 2003. *The Q Theory of Housing Investment*. Journal of Real Estate Finance and Economics. Vol. 23, No. 3. (379-392)
- Kahn, Matthew E. 2008. *Urban environment and quality of life*. The New Palgrave Dictionary of Economics. Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan, 2008.
- Kaplow, Louis. 2008. *Optimal Policy with Heterogeneous Preferences*. NBER Working Papers No. 14170. (21)
- Keller, Gerald. 2009. *Managerial Statistics*. Eight Edition. Ohio: South-Western Cengage Learning. (65-69, 616-621)
- Krainer, John and Chisen Wei. 2004. *House Prices and Fundamental Value*. NBER Working Papers No. 14170. (21)
- Madsen, Jakob B. 2011. *A q Model of House Prices*. Monash University. Discussion Paper 03/11.
- Mankiw, Nicholas G. 2012. *Principles of Economics*. Sixth Edition. Ohio: South-Western Cengage Learning. (514-520)
- Miljøverndepartementet. 2008. *Plan og bygningsloven: Kapittel 12. Reguleringsplan*. (08.06.12) <<http://www.lovdatab.no/all/tl-20080627-071-018.html>> (10.06.12)
- Miller, Nolan. 2006. *Notes on Microeconomic Theory*. <<http://www.hks.harvard.edu/nhm/notes2006/firsthalf.pdf>> (10.06.12) (87-88)
- Norges Bank. 2011. *Finansiell Stabilitet*. Norges Banks rapportserie nr 5-2011.

-
- Poterba, James M. 1992. *Taxation and Housing: Old Questions, New Answers*. NBER Working Paper No. 3963. (2)
- Romer, David. 2001. *Advanced Macroeconomics*. Second Edition. New York: McGraw-Hill. (367-387)
- Rosenthal, Stuart S. and William S. Strange. 2003. *Evidence on the Nature and Sources of Agglomeration Economies*. Handbook of Urban and Regional Economics Vol 4, 2004. (2119-71)
- Sandø, Toralf. 2012. Likner en boligboble i Norge. (11.01.12)
<<http://www.aftenbladet.no/nyheter/okonomi/Likner-en-boligboble-i-Norge-2917023.html#.T9TiXdVgJEI>> (10.06.12)
- Shiller, Robert J. 2005. *Irrational Exuberance*. Second Edition. New Jersey: Princeton University Press. (56)
- Sinai, Todd M. 2008. *Urban Housing Demand*. The New Palgrave Dictionary of Economics. Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan, 2008.
- Sommervoll, Dag E. 2007. *Gjeldsrenter og Skatt: Skattereformen av 1992 uten effekt på husholdningenes gjeld?* SSB: Økonomiske Analyser 5/2007
- SSB. 2012a. *Emne: 02 Befolkning. Tabell: 01222: Befolkningsutvikling (K)*. (16.05.11)
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=folkendrkv> (05.06.12)
- SSB. 2012b. *Emne: 02 Befolkning. Tabell: 05212: Folkemengde, etter kjønn og tettbygd/spredtbygd strøk (K)*. (17.06.11)
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?Productid=02.01&PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/MenuSelP.asp&SubjectCode=02> (05.06.12)
- SSB. 2012c. *Emne: 02 Befolkning. Tabell: 06913: Folkemengde 1. januar og endringer i kalenderåret (K)*. (22.03.12)
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=folkendrhst> (05.06.12)
- SSB. 2012d. *Emne: 02 Befolkning. Tabell: 07459: Folkemengde, etter kjønn og ettårig alder. 1. januar (K)*. (14.03.12)
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=folkemengde> (05.06.12)
- SSB. 2012e. *Emne: 05 Personlig økonomi og boforhold. Tabell: 04751: Inntekt etter skatt for hushald, etter hushaldstype. Median i faste kroner og indeks for faste priser (1990=100)*. (08.03.12)

-
- <http://statbank.ssb.no/statistikkbanken/Default_FR.asp?Productid=05.01&PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/MenuSelP.asp&SubjectCode=05>
(05.06.12)
- SSB. 2012f. *Emne: 05 Personlig økonomi og boforhold. Tabell: 06468: Hushald, etter hushaldstype og storleiken på gjelda (prosent). (12.04.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=iformue>
(05.06.12)
- SSB. 2012g. *Emne: 08 Priser, prisindekser og konjunkturindikatorer. Tabell: 03013: Konsumprisindeks. (10.05.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=kpi> (05.06.12)
- SSB. 2012h. *Emne: 08 Priser, prisindekser og konjunkturindikatorer. Tabell: 07221: Boligprisindeksen, etter boligtype og region (2005=100). (20.04.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=bpi> (05.06.12)
- SSB. 2012i. *Emne: 08 Priser, prisindekser og konjunkturindikatorer. Tabell: 08651: Byggjekostnadsindeks for bustader i alt, etter arbeidstype (2000=100). (10.05.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=bkibol> (05.06.12)
- SSB. 2012j. *Emne: 09 Nasjonalregnskap og utenrikshandel. Tabell:05622: Kvartalsvis institusjonelt sektorregnskap. Inntekter, utgifter og sparing. (23.05.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?Productid=09.01&PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/MenuSelP.asp&SubjectCode=09>
(05.06.12)
- SSB. 2012k. *Emne: 09 Nasjonalregnskap og utenrikshandel. Tabell: 06754: Finansielle sektorregnskaper. Fordringer og gjeld, etter institusjonell sektor og finansobjekt (mill. kr). (29.03.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selectvarval/define.asp&Tabellid=06754> (05.06.12)
- SSB. 2012l. *Emne: 09 Nasjonalregnskap og utenrikshandel. Tabell: 09181: Investeringer og kapitalbeholdninger, etter art og næring. Kapitalslit. (22.11.11)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=nr> (05.06.12)
- SSB. 2012m. *Emne: 09 Nasjonalregnskap og utenrikshandel. Tabell: 09181: Investeringer og kapitalbeholdninger, etter art og næring. Fast realkapital. (22.11.11)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=nr> (05.06.12)
- SSB. 2012n. *Emne: 10 Næringsvirksomhet. Tabell:03723: Byggeareal. Boliger og bruksareal til bolig. Foreløpige tall (F). (31.05.12)*
<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=nr> (05.06.12)

[uage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=byggeareal](http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=byggeareal) >
(05.06.12)

SSB. 2012o. *Emne: 11 Finansmarkeder og konkurser. Tabell: 07200: Gjennomsnittlige veide rentesatser inklusive provisjoner på utlån til publikum, etter utlånsart og sektor (prosent).* (31.05.12)

<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=orbofrent>
(05.06.12)

SSB. 2012p. *Emne: 11 Finansmarkeder og konkurser. Tabell: 08175: Bankenes årlige utlåns- og innskuddsrenter (prosent).* (31.05.12)

<http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=orbofrent>
(05.06.12)

Steigum, Erling. 2010. *Norsk Økonomi fra 1980 - Fra Krise til Suksess.* CME/BI Working Paper Series 4/10.

Summers, Lawrence H. 1981. *Taxation and Corporate Investment: A q-Theory Approach.* Brookings Papers on Economic Activity. No. 1. (67-127)

Sydsæter, Knut. 2000. *Matematisk analyse. Bind 1.* Oslo: Gyldendal Akademisk. (91)

Tobin, James. 1969. *A General Equilibrium Approach to Monetary Theory.* Journal of Money, Credit, and Banking. Vol. 1, No.1. (15-29)

Tolley, George S. 1974. *The Welfare Economics of City Bigness.* Journal of Urban Economics 1. (324-45)

Trading Economics. 2012. *Norway Consumer Confidence.*

<<http://www.tradingeconomics.com/norway/consumer-confidence>> (05.06.12)

Vikøren, Birger. 2010. *Finansiell stabilitet og boligmarkedet.*

(05.05.10)<http://filer.boligkonferansen.no/02_NorgesBank.pdf> (10.06.12) (13)

Appendix

Table 24: Quarterly real and nominal housing in millions (obtained from SSB personally) 1992-2011

Quarter	H in 2009 prices	H in nominal prices	Quarter	H in 2009 prices	H in nominal prices
92:1	1600902	766139	02:1	1879627	1282705
92:2	1603172	767175	02:2	1890692	1289813
92:3	1605718	768414	02:3	1900532	1296628
92:4	1608076	769532	02:4	1910877	1304013
93:1	1609160	780137	03:1	1921922	1342322
93:2	1610550	780755	03:2	1932255	1349070
93:3	1613052	781937	03:3	1942114	1356016
93:4	1617148	783910	03:4	1953307	1364139
94:1	1619476	814612	04:1	1964376	1479977
94:2	1623076	816354	04:2	1977566	1489766
94:3	1628499	819043	04:3	1991215	1499991
94:4	1635677	822620	04:4	2007750	1512435
95:1	1640946	878908	05:1	2022753	1642901
95:2	1646421	881753	05:2	2038454	1655637
95:3	1652242	884828	05:3	2053204	1667665
95:4	1658951	888377	05:4	2070633	1681940
96:1	1664081	923349	06:1	2087758	1800177
96:2	1669407	926218	06:2	2103895	1814094
96:3	1675823	929742	06:3	2118930	1827184
96:4	1683210	933759	06:4	2137282	1843368
97:1	1688633	970234	07:1	2155935	2028340
97:2	1696254	974518	07:2	2173190	2044637
97:3	1705399	979694	07:3	2188882	2059624
97:4	1713721	984414	07:4	2206007	2076230
98:1	1722521	1010392	08:1	2222689	2158051
98:2	1731200	1015371	08:2	2237139	2172062
98:3	1739312	1020059	08:3	2250100	2184734
98:4	1748439	1025368	08:4	2263393	2197643
99:1	1756246	1059274	09:1	2276239	2276098
99:2	1764468	1064112	09:2	2288546	2288345
99:3	1773573	1069529	09:3	2299171	2299046
99:4	1784454	1076019	09:4	2311065	2311065
00:1	1793875	1134869	10:1	2322014	2384348
00:2	1802901	1140428	10:2	2332379	2421708
00:3	1812495	1146406	10:3	2342679	2448900
00:4	1823600	1153343	10:4	2355486	2478131
01:1	1834551	1219127	11:1	2370540	2556784
01:2	1845494	1226239	11:2	2386848	2594852
01:3	1856517	1233475	11:3	2402196	2636249
01:4	1867964	1241001	11:4	2419346	2632810