House Price Uncertainty in the Dutch Owner-Occupied Housing Market

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ISBN 978-90-816238-3-4
Tjalling C. Koopmans Dissertation Series
USE 004
Printed by Ridderprint, Ridderkerk

House Price Uncertainty in the Dutch Owner-Occupied Housing Market

De onzekerheid in huizenprijzen voor huiseigenaren op de Nederlandse woningmarkt

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor
aan de Universiteit Utrecht
op gezag van de rector magnificus,
prof.dr. G.J. van der Zwaan,
ingevolge het besluit van het college voor promoties
in het openbaar te verdedigen op
maandag 30 mei 2011 des middags te 2.30 uur

door

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geboren op 19 september 1983
te Utrecht

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Dit proefschrift werd (mede) mogelijk gemaakt met financiële steun van de expertisegroep Innovation and Environment van TNO.

Voor mijn ouders

Acknowledgements

When I started this journey, I thought that writing a dissertation would be easy. It is not. Therefore, it only seems appropriate to thank those who made this dissertation possible.

First, and foremost, I would like to thank my supervisor, Wolter Hassink. Without his expertise and guidance this dissertation would probably not have been written. Wolter once told me that PhD students are the intellectual children of their supervisor. Although I am still relatively young, I do understand that children can give you a terrible headache, but in the end, they are worth it. I admire his passion for research and his organizational talent. I sincerely hope we continue to work together for many years to come.

A second important person in my academic and personal live has been Walter Manshanden. When I was a simple master student, he decided to take a gamble: he hired me for an internship at TNO. After this internship, Wolter and Walter, two names I have used interchangeably for about a year, helped me to become a PhD student. Walter's insights into economics (data) have been fundamental to my personal development. His economic "fingerspitzengefühl" is unravelled. The opportunities both Wolter and Walter provided me with will never be forgotten.

Of course, my two other promotores, Rob Alessie and Harry Garretsen, also contributed substantially to my dissertation. To this day, I am still baffled by the sheer knowledge of Rob. I remember asking him a question about some page in a book on consumer behavior by Deaton and Muellbauer. With a single look he understood the problem and solved it. Usually, half of what he says I do not understand. It is exactly this half that inspires me to learn more. Harry is one of the best economists I have ever met. Admittedly, I still have to learn a lot with regard to pure economic reasoning. Presenting issues in a simple and comprehensible manner is not as easy as it sounds. This is exactly the strength of Harry. Even though Harry is a busy man, he always had time to talk. Of those few meetings I have had with Harry, the "train station meeting" was one of the most memorable (and efficient).

I would also like to express my gratitude to the members of the reading committee, Jaap Bikker, Piet Eichholtz, Jos van Ommeren, Frank van Oort, and Arno van der Vlist for reading and commenting on my dissertation. These persons are all experts in their respective fields and they are highly regarded by me and my supervisors.

Although all of my colleagues, both at USE and TNO, made my live as a PhD student more enjoyable, there are several colleagues I would like to mention explicitly. First, I would like to thank the PhD students in my office, Lu Zhang, Seçil Hülya Danakol, Joras Ferwerda, Ryan van Lamoen, and Yi Zhang. Thank you for all the talks, laughs, and food. I hope the girls in my office liked the flowers I send to them for Valentine's day. Yi, I admire your "Spartan" work ethics. Are you from Mars? Second, I would like to express my gratitude to Evgueni Poliakov and Mark Kattenberg for commenting on my dissertation. Third, I valued the conversations with the other members of the applied econometrics chair, Suzanne Heijnen, Mark Kattenberg, Adriaan Kalwij, and Yolanda Grift.

Special thanks go to Ryan van Lamoen. I sincerely believe that without his companionship I would not have finished my dissertation. I regard him as one of my closest friends. I have the uttermost respect for his research and drinking skills. Sleeping under a doggy blanket on his floor after a hard night's work is probably one of my most cherished memories. I suppose it is simply comforting to know that someone is as equally "enjoying" PhD life as you do. Finally, I also enjoyed talking to his supervisor, Jaap Bos. Every time I see Jaap I think: "That guy is crazy, in a brilliant kind of way".

I would also like to take this opportunity to express my gratitude to my family and friends. I would especially like to thank my parents for my upbringing: my mother, Sonja, for her colorful personality, she is one of the most independent women I know, and my father, Marc, for his entrepreneurial spirit, may he rest in peace. Of course, my two brothers also contributed to my upbringing. Thank you for all the joy, and fights, we had.

I suppose this final paragraph should contain some final thoughts. Although I am a man of many words, at this point there is little to say. Words cannot describe what I feel. For about ten years now, my girlfriend Jolanda van Beurten has been by my side. She has supported me throughout my PhD, even though I have not been an easy person to live with. Economists usually do not give much about the constant in their regression models. She is, however, the constant that gives my life meaning.

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Chapter 4: House Price Risk and the Hedging Benefits of Homeownership

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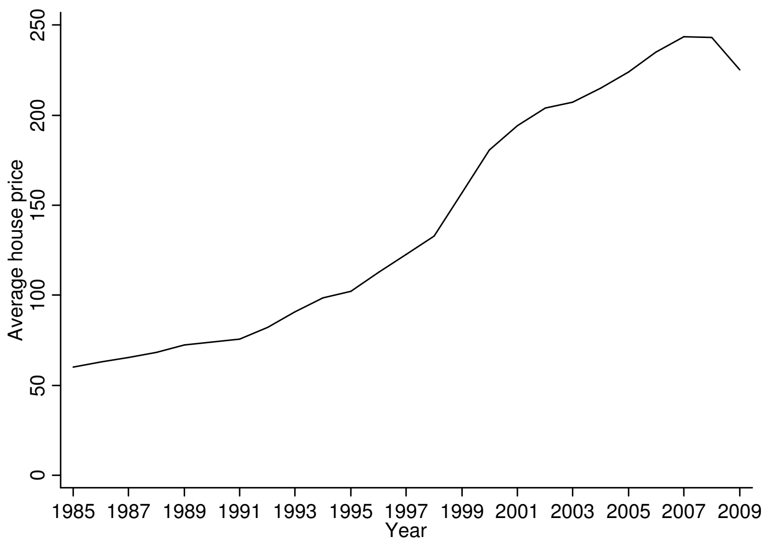
Chapter 1

Introduction

1.1 Background

A simple figure of house prices in the Netherlands suggests that house prices increased substantially in recent decades, although prices have declined somewhat in 2008 and 2009 due to the financial crisis.

Figure 1.1: House prices in the Netherlands (euros, in thousands)



Source: Dutch Association of Realtors (NVM)

In particular, the house price index of the Dutch Association of Realtors (NVM) indicates that the average house price increase between 1985 and 2009 has been approximately 6 percent per annum or about 7,000 euros per year (see Figure 1.1). These housing capital gains made owning a home, besides being a consumption good, a profitable investment.

The average increase in house prices, however, masks two important facts. First, house prices may be uncertain. A homeowner does for instance not know with certainty how much he can sell his house for in the future. Second, there may be substantial heterogeneity in housing capital gains across homeowners. Both of these issues are discussed in further detail in this dissertation.

1.2 Aim of the thesis

The aim of this dissertation is *to provide an analysis of the uncertainty in house prices in the Netherlands from a homeowner's perspective.* This dissertation focuses on two topics that are directly related to house price uncertainty.

This dissertation first investigates the homeowner's sale price expectations. In particular, since house prices are uncertain, individuals have expectations about them. This part of the dissertation examines how such expectations are formed and how they influence the decisions of homeowners. This dissertation focuses on the role of the decision to move, mortgage commitment, and the Dutch institutional setting on sale price expectations. This part provides some insight into why there may be heterogeneity in housing capital gains across homeowners.

The second topic is to examine the magnitude (patterns) of house price volatility (house price uncertainty) in the Netherlands. Hence, this dissertation emphasizes that owning a home is not only profitable, but that it may also be risky. This part also discusses whether it is possible to reduce this risk. The key interesting feature of this second part is that it is based on an unusually rich source of individual-level house price data. Since the heterogeneity in house price changes plays an important role in the risk of owning a home, this dissertation investigates in detail the differences in house price changes across locations, time periods, and types of houses in the Netherlands.

1.3 Sale price expectations of homeowners

The first part of this dissertation (Chapters 2 and 3) focuses on the sale price expectations of homeowners. By now, there is consensus in the economic literature that house price expectations of individuals play a crucial role in the creation of house price bubbles and housing market booms, but that it can also explain the sudden price declines in some housing markets (e.g. see Shiller, 1990). As a result, it is of fundamental concern to policy makers and economists to understand the formation of such expectations and the role of these expectations in the household decision-making process.

The literature on this topic has mainly focused on the sale price expectations of homeowners (Kish and Lansing, 1954; Kain and Quigley, 1972; Robins and West, 1977; Follain and Malpezzi, 1981; Ihlanfeldt and Martinez-Vazquez, 1986; Goodman and Ittner, 1992; Kiel and Zabel, 1999). Empirical work has primarily investigated whether such expectations can be used to accurately estimate the price of the hedonic characteristics of a house (e.g. the price of an additional square meter, room, etc.) using the classical hedonic approach of Rosen (1974). These studies argue that the hedonic estimates will be biased if homeowners inaccurately predict the market price of the home in a systematic way.

This literature has predominately examined the sale price expectations of homeowners in the US. However, the price expectations of homeowners under a different institutional setup than the US setup could provide us with invaluable insights about how the expectations of homeowners are formed. In addition, some researchers have suggested that, in contrast to the aforementioned studies on sale price expectations, homeowners may actively decide what they want the sale price of the house to be (Stein, 1995; Genesove and Mayer, 1997, 2001; Harding et al., 2003, among others). Nevertheless, these studies are mainly based on list/transaction prices. For instance, Genesove and Mayer (1997) find that down-payment requirements on a new home (a relatively high mortgage loan) may explain why homeowners in the US list their houses for a higher price. As a result, a natural extension would be to combine both the literature on sale price expectations and the literature on the price setting behavior of homeowners by investigating whether this price setting behavior also plays a role in the sale price expectations of homeowners.

The specific question of Chapter 2 is whether mortgage commitment also influences the sale price expectations of Dutch homeowners. As a result, this dissertation connects both aforementioned strands of literature. In addition, since there are no minimum down-payment requirements in the Netherlands (i.e. mortgage qualification is mainly based on income), this dissertation also provides evidence about the formation of sale price expectations under a different institutional setup than that of the US.

As mentioned, a further issue is that sale price expectations may affect the homeowner's housing decisions. One of the key housing decisions that characterize the main allocation mechanism in the housing market is the decision to move (residential mobility). However, research on the effect of sale price expectations on residential mobility/housing demand is scarce (e.g. Dusanski and Koç, 2007; Enghelhardt, 2003). In addition, the literature on the influence of house prices, housing capital gains, on residential mobility has mainly suggested that price increases have a positive effect on the propensity to move since it allows homeowners to afford the down payment on a new home (e.g. Stein, 1995; Chan, 2001; Lee and Ong, 2005; Ortalo-Magné and Rady, 2006). As mentioned, such an explanation may not directly apply to the Dutch institutional setup (e.g. no down-payment requirements).

The specific question of Chapter 3 is whether higher (expected) housing capital gains also increase residential mobility in a setting without down-payment constraints. I formulate a simple microeconomic model that suggests that the answer to this question crucially depends on the homeowner's decision to trade up or down the property ladder.

1.4 House price volatility

The second part of this dissertation (Chapters 4 and 5) investigates the volatility of house prices in the Netherlands. The recent decline in house prices in the Netherlands, but also in other countries such as the US and the UK, emphasizes that the uncertainty in house prices may be substantial. That is, house prices may be quite volatile. Specifically, while house prices in the Netherlands increased by about 15 percent during the economic upturn in 2000, they fell by approximately 7 percent at the beginning of the financial crisis in the Netherlands in 2009. Since households hold a sizable proportion of their wealth in housing – in the Netherlands about 56 percent of the household's total net worth is in net housing equity (Jäntti and Sierminska, 2007) –, the volatility in house prices, amplified by the recent financial crisis, has generated renewed interest worldwide in the size of the uncertainty in house prices (Sinai and Souleles, 2009), its implications for the decisions of homeowners (Sinai and Souleles, 2005, 2009; Han 2010), and ways to reduce this uncertainty (Case et al., 1991; Caplin et al., 2003; Sinai and Souleles, 2005, 2009; Quigley, 2006; Shiller, 2008; De Jong et al., 2008).

Most of this literature, however, is based on highly aggregate regional house price indices, while there is especially a need to understand how the volatility in house prices differs across localities, time periods, and types of houses. In addition, most of these studies are US-based. Hence, there is still a need to examine house price risk outside the US.

As a result, the research question of Chapter 4 is whether, and the extent to which, house price risk differs across types of houses, years, and municipalities in the Netherlands. Since sudden house price changes may have a considerable impact on the wealth and, consequently, welfare of homeowners, information on this risk may be invaluable to those homeowners, but also to mortgage lenders and governments.

A further issue is that the literature on ways to reduce house price risk has mainly focused on insurance products, the natural hedging benefits of homeownership, and house price derivates. However, these studies have largely ignored the reason why house price risk may be high for households to begin with. In particular, this risk is especially high for households since the typical household invests a large sum of money at a single location.

Consequently, the specific question of Chapter 5 is whether house price risk could be reduced if homeowners could diversify the housing investment across locations by investing in each other's property. Specifically, this dissertation investigates the diversification benefits of free trade in the value of the house among homeowners. These diversification benefits could, for instance, be obtained through a financial stock market based on the value of the house. Since house price risk may be substantial, it is of fundamental importance to examine whether this risk could be reduced.

1.5 Place in the Dutch literature

Although this dissertation is mainly embedded in the international literature, its place in the Dutch literature emphasizes some other important aspects of the Dutch housing market. In particular, this dissertation contributes to the Dutch housing market literature since there has been virtually no scientific economic research on the sale price expectations of homeowners and house price risk in the Netherlands, but it largely ignores other aspects of the housing market such as housing supply, the rental market, the land market, the commercial real estate, and the social role of housing corporations. In addition, although the current financial crisis may have increased the salience of this dissertation, the goal of this dissertation is not to provide a full analysis of the impact of the financial crisis on the Dutch housing market (house price risk). In particular, the financial crisis is an event that may have increased house price risk. However, house price risk was there before the financial crisis and will still be there after it. The following overview shortly discusses these aspects, but is not meant to be exhaustive.

The Dutch literature has mainly focused on several problems in the Dutch housing market (see REA, 2006; SER, 2010; CPB, 2010). In part, these problems are reflected in the increase in house prices depicted in Figure 1.1. The increase in house prices in the Netherlands in the past decades can, to some extent, be explained by market factors like relatively low mortgage interest rates and increases in the income of households. Both of these factors have increased the demand for housing and, consequently, house prices. However, housing demand has also been stimulated by the government mainly through the deductibility of mortgage rents, which has led to over-consumption of owner-occupied housing. In addition, the inelasticity of housing supply, which is partly the result of the government's regulation of land use, has further increased house prices (see Vermeulen and Rouwendal, 2007). In part, these zoning regulations reflect the Dutch government's aim to preserve open space (see Rouwendal and Van der Straaten, 2008). Moreover, these supply restrictions have also affected internal migration and labor market outcomes (see Vermeulen and Van Ommeren, 2009), especially since job mobility and the residence relocation decision may be highly related (see Van Ommeren et al., 1999).

The increase in house prices has contributed to the fact that first time home buyers have found it difficult to buy a house even though the recent price declines may have increased the opportunity for starters to own a house (see Brounen and Neuteboom, 2009). Especially in the Randstad there has been a scarcity premium on housing due to insufficient housing supply and the accumulation of labor and work in this area (Van Oort et al., 2008). Instead, the periphery of the Netherlands has been characterized by relatively low price increases, or even price declines, which is related to the demographic decline in those regions (see Eichholtz and Lindenthal, 2009).

A further issue is that rents in a large part of the rental sector are highly regulated. This regulation reflects the Dutch government's policy that every household should be able to afford a home. As a result, the regulated rents have been far below the market rents (see Romijn and Besseling, 2008). Consequently, there are many households who have been consuming housing for a price that has been too low in relation to their income. Since rents have been relatively low and buying a house may be expensive, many households have been reluctant to move house, which has contributed to long waiting lists in this sector. In the owner-occupied housing sector, residential mobility has also been hampered by transaction costs, such as transfer taxation. For instance, Van Ommeren and Van Leuvesteijn (2005) have found that a one percent decrease in transaction costs in the Dutch housing market would increase the number of residential moves by about 8 percent.

Finally, the housing corporations play an important role in the supply of social housing in the Netherlands. In particular, since the housing corporations own a substantial part of the houses in the Netherlands, there have been some concerns about the considerable housing wealth of these corporations. Specifically, this wealth has not always been used to provide social housing (i.e. the social goal of the housing corporations).

Many solutions have been proposed to deal with these problems in the Dutch housing market (see REA, 2006; SER, 2010; CPB, 2010). This overview only discusses a few of these solutions. In particular, some economists have suggested that the rents in the rental housing sector need to be liberalized to reduce the gap between the regulated rent and the market rent. Most of these proposals also argue for a reduction in the building/zoning regulations. Moreover, a reduction in the transaction costs (transfer taxation) could improve the allocation in the housing market. In addition, many economists have suggested that the deductibility of mortgage rents should be reduced to mitigate the misallocation of housing consumption in the

Dutch housing market. Furthermore, some of the proposals have also recommended that the housing corporations should only own housing (invest in housing) in accordance with their social goals (for a discussion see Conijn, 2005; Koning and Van Leuvensteijn, 2010). Moreover, the SER (2010) has proposed that the financial risks faced by households (i.e. due to excessive lending) should be reduced. Finally, most economists agree that these housing market reforms should be gradual to avoid a “shock effect” in the housing market.

There are some additional important topics in the Dutch housing market literature. In particular, the current financial crisis has amplified many of the aforementioned problems in the Dutch housing market. This has also created renewed interest in the fundamental and non-fundamental factors that determine the developments in the (commercial) real estate market (for a discussion see Van der Vlist, 2009). In addition, the current global warming problem has raised interest in the cost and benefits of green buildings (see Eichholtz et al., 2010). Moreover, there has been some research on the effect of negative attitudes towards ethnic minorities on house prices (Gautier et al., 2009). Furthermore, part of the Dutch housing market literature has focused on the accessibility of cities and local amenities to explain why land prices are relatively high in cities (De Groot et al., 2010). Finally, there is also some recent literature on house price risk in the Netherlands (Kramer, 2010). However, in accordance with the international literature, the study of Kramer (2010) only focuses on the variability in house prices at a highly aggregated level. As mentioned, this dissertation examines the heterogeneity in house price changes in more detail.

1.6 Thesis outline

Each of the chapters in this dissertation investigates house price uncertainty in the Netherlands from a different point of view.

Chapter 2 discusses the homeowner’s expectations regarding the sale price of the home in relation to mortgage commitment. In a seminal paper, Genesove and Mayer (1997) find that homeowners in the Boston condominium market who face a down-payment constraint list their house for a higher price, receive higher transaction prices, and have a longer expected time on the market. Stein (1995) argues that this result can be explained by the low opportunity cost of “fishing” for a relatively high selling price for those homeowners who cannot move due to the down-payment constraint. That is, homeowners who find it difficult to move house due to a high mortgage loan may try to compensate for this fact by requiring a higher sale price of the house. Instead, borrowers in the Netherlands mainly face an income constraint in loan qualification, which is measured by the mortgage loan payment to income ratio. As a result, Chapter 2 adapts Stein's model for the Dutch institutional setting. In particular, this chapter reformulates Stein's fishing hypothesis in terms of the mortgage loan payment to income ratio and sale price expectations of homeowners. Subsequently, Chapter 2 investigates the fishing hypothesis empirically by examining whether homeowners who have a relatively high mortgage loan payment are less likely to move and expect a mark-up of the sale price over the assessed value of the house. Since taxes and subsidies on housing (mortgage rent deductibility) affect the mortgage loan payments, this chapter also investigates the effect of removing the favorable tax treatment of owner-occupied housing on sale price expectations and residential mobility. Finally, the implications for the hedonic approach based on sale price expectations are discussed.

Chapter 3 examines the effect of expected housing capital gains on future owner-occupied housing demand. As mentioned, it is usually argued that housing capital gains have a positive effect on housing demand due to the existence of minimum down-payment requirements. Based on a bare-bones framework without down-payment constraints, it is argued that an increase in housing capital gains does not necessarily have a positive effect on housing demand. In particular, an increase in the price of the current home increases capital gains, but it also implies that the homeowner may need to pay more for a new home. This cost effect of a price increase may outweigh the capital gains effect of such an increase, especially for those homeowners who decide to trade up. Instead, housing demand may well be upward sloping for homeowners who want to trade down the property ladder. In a setup with uncertainty in house prices, Dusanski and Koç (2007) also find that housing demand may be upward sloping. In essence, Chapter 3 shows similar results in a standard microeconomic setup with transaction costs, but without uncertainty in housing consumption and down-payment constraints. Subsequently, this chapter studies these issues empirically based on the variation in whether homeowners want to move within two years, the price paid for the house, the expected sale price of the house, and an indicator of the homeowner's decision to trade up or down.

Chapter 4 investigates the extent and development of house price risk and the natural hedging benefits of homeownership across types of houses, years, and municipalities in the Netherlands. In particular, although the volatility in house prices may be substantial, a homeowner who sells his current home and buys a new home may be hedged against house price risk since the price changes in the current home may cancel out against the price changes in the new home. This chapter quantifies these hedging benefits. In an important study, Sinai and Souleles (2009) have also examined the hedging benefits of homeownership in the US based on highly aggregated house price return series per Metropolitan Statistical Area (MSA). Instead, Chapter 4 provides a more detailed analysis of the volatility of house price changes based on a dataset consisting of all transaction prices of existing homes that were sold in the Netherlands between 1995 and 2008.

Chapter 5 examines the diversification benefits of free trade in house value. In particular, homeowners could reduce (share) house price risk if they could invest in each other's property. They could diversify the housing investment if a financial stock market based on house value would exist, but these diversification benefits could also be obtained if homeowners would jointly buy houses or if they would sell their houses to, for instance, housing corporations. Currently, homeowners cannot adequately diversify against house price risk due to high transaction costs in the housing market and the indivisibility of the housing investment. Based on simple CAPM estimates, Chapter 5 tries to quantify the extent to which house price risk could be reduced if Dutch homeowners could invest in a market portfolio of houses. Subsequently, the diversification benefits of free trade in house value are compared with an alternative risk-reducing strategy, hedging with house price futures.

Finally, Chapter 6 summarizes the main findings of this thesis. The implications of the results for policy and the housing market literature are also considered. In addition, this chapter discusses the limitations of this study and directions for future research.

PART I
SALE PRICE EXPECTATIONS

Chapter 2

Sale Price Expectations and Mortgage Commitment

2.1 Introduction

The homeowner's expectations regarding the sale price of the house is not always equal to the market price (see Kish and Lansing, 1954; Kain and Quigley, 1972; Robins and West, 1977; Follain and Malpezzi, 1981; Ihlanfeldt and Martinez-Vazquez, 1986; Goodman and Ittner, 1992; Kiel and Zabel, 1999). Harding et al. (2003) explain why such a difference might exist. As a good becomes more heterogeneous, the "true" market value of that good becomes less well known since markets become increasingly thin. A house is a typical example of a heterogeneous good. In the housing market, arbitrage may be further hampered by substantial search and transaction costs. In addition, the characteristics of a seller may be private information relative to the market. Under these conditions, bargaining and market power play an important role in the determination of prices. Specifically, the homeowner may act as a price setter in the housing market.

In a seminal paper, Genesove and Mayer (1997) investigate price-setting behavior of homeowners in relation to down-payment requirements. Their findings suggest that homeowners in the Boston condominium market with a high mortgage loan to assessed value (loan-to-value ratio) have a higher list price mark-up over the assessed value of the home since these homeowners have higher reservation prices.[1] Stein (1995) provides a rationale for this result. Stein shows that homeowners with a higher level of mortgage debt are less likely to move since they cannot afford the down payment to buy a new home. In addition, he argues that "non-movers" have a low opportunity cost of "fishing" for a relatively high selling price. The findings of Genesove and Mayer (1997) are consistent with this fishing hypothesis. However, this explanation may not directly apply to homeowners in a country without down-payment requirements, such as the Netherlands and various other European countries. Instead, borrowers in the Netherlands mainly face an income constraint in loan qualification.

The aim of Chapter 2 is to investigate the effect of mortgage commitment on sale price expectations of Dutch homeowners. As mentioned in the introduction of this

[1] The homeowner with a higher loan-to-value ratio also had a longer expected time on the market. In general, the homeowner trades off the possibility of a higher selling price versus the (opportunity) costs associated with a longer time on the market (see Anglin et al., 2003; Genesove and Mayer, 1997; Glower et al., 1998; Horowitz, 1992; Herrin et al., 2004).

dissertation, if homeowners base their decisions on expectations, it is of fundamental importance to understand what determines those expectations. In this chapter, sale price expectations are measured by self-reported home values. The results in this chapter are interesting since previous studies on owner-reported home values have mainly focussed on the US (for an overview, see Kiel and Zabel, 1999). Since homeowners in the Netherlands do not face down-payment constraints, we adapt Stein's model for the Dutch institutional setting. In particular, the income constraint in loan qualification is captured by the mortgage payment-to-income ratio (LTI ratio). Moreover, we formally include the homeowner's fishing behavior in Stein's model. In accordance with the fishing hypothesis, we find that homeowners with a higher LTI ratio are less likely to move and, consequently, have more incentive to fish for a relatively high selling price.

In this chapter, we use a unique dataset of about 30,000 homeowners from the Dutch Housing Demand Survey (WoON) of 2006 that is merged with both the officially assessed value of the house and official taxable income records. We will utilize the owner-stated value as a mark-up over the officially assessed value to investigate the price-setting behavior of homeowners (the fishing hypothesis) in further detail.[2]

The remainder of this chapter is organized as follows. Section 2.2 discusses the institutional setting. Section 2.3 presents the underlying theory. Section 2.4 puts forward the methodology and empirical model. Section 2.5 discusses the data. Section 2.6 shows the main results. Section 2.7 concludes.

2.2 Institutional Setting

Dutch homeowners are not required to make a minimum down payment to buy a new home. In particular, the *average* ratio of the mortgage loan to the value of the home at the time of purchase is 90 percent, but this ratio can be as high as 115 percent. This average loan-to-value ratio is one of the highest in the world. For instance, in the US the typical loan-to-value ratio is 75 percent, with a maximum of 95 percent (see Green and Wachter, 2005). In the US, a loan-to-value ratio above 80 percent is considered to be an "excessive" mortgage commitment (see Genesove and Mayer, 1997; Lamont and Stein, 1999).

Although down payments in a country without minimum down-payment requirements may be the result of informal constraints imposed by banks (Chiuri and Jappelli, 2003), the

[2] Studies that focus on the price-setting behavior of homeowners are usually based on list/transaction prices (e.g. Horowitz, 1992; Genesove and Mayer, 1997; Glower et al., 1998; Genesove and Mayer, 2001; Anglin et al., 2003; Herrin et al., 2004). This chapter relates to those studies since sale price expectations may be interpreted as a proxy for list prices.

high average loan-to-value ratio in the Netherlands suggests that down-payment constraints may not be binding for homeowners in the Netherlands.[3] Instead, mortgage qualification is mainly based on household income.[4] As of August 2006, the code of good conduct with respect to home mortgages stipulates that the mortgage should not be higher than 4.5 times the gross yearly income of the homeowner. In addition, the (monthly) loan payments should not be higher than 35 percent of gross income.[5]

Transaction costs can be financed by the mortgage. In addition, mortgage payments are tax deductible.[6] There are several mortgage types available for households to finance a home. One of the most popular mortgage types is the no pay-off mortgage. This type of mortgage is an interest-only mortgage. In particular, the principal balance of the loan has to be repaid in full at maturity. In the Netherlands, mortgages are predominately fixed rate mortgages. In addition, sub-prime mortgages are rare.

As of 1995, Dutch law ("Wet WOZ") stipulates that each municipality has to estimate the market value of every real estate object in the municipality. This officially assessed value is denoted by the acronym WOZ. The assessed value has to reflect the market price (at the 1st of January 1995, 1999, 2003, 2005, and 2007). As of 2007, the valuation occurs on a yearly basis. The assessed value is used for tax purposes.[7] The municipality (assessor) bases the assessed value on the recent sale price of the house, the transaction prices of nearby comparable houses, and market information. Most assessed values are based on hedonic type of models. The outstanding mortgage of a household is not used in the assessment. By law, there is a separate organization ("de Waarderingskamer") that monitors, inspects, and approves the assessed values.

2.3 Theory

The theoretical discussion in this chapter proceeds as follows. First, we reformulate the model of Stein (1995) to include mortgage qualification based on income. In addition, we show that the loan payment-to-income ratio is negatively related to the probability of moving. Second,

[3] Nevertheless, investing own equity in the house does lead to more favorable borrowing conditions.
[4] As of 1993, mortgage qualification is also based on the income of the spouse.
[5] As of 1995, the homeowner can participate, for a small premium, in the national insurance scheme (NHG). The national insurance scheme provides insurance in case of default of the homeowner. As a result, homeowners can obtain a lower mortgage interest rate.
[6] As of 2004, mortgage rents are only fully tax deductible if the net housing equity after the sale of the house is invested in the new home.
[7] Property tax ("OZB"), income tax ("Eigen Woning Forfait"), and tax to manage (the level of) water in the Netherlands.

we discuss the expected sale price in relation to the fishing behavior of movers versus non-movers.

In a seminal paper, Stein (1995) discusses a housing market model with down-payment constraints. In this model, a homeowner is endowed with some mortgage debt secured against the house. Stein shows that there are three groups of homeowners based on the mortgage debt: unconstrained movers, constrained movers, and non-movers. Stein argues that the opportunity cost of fishing for an above-market price is zero for non-movers since they cannot lose the utility gains associated with moving to a new home. Instead, the opportunity cost is positive for a homeowner in the mover group. As a result, Stein hypothesizes that "there should be more fishing … in the non-mover range" (Stein, 1995, p. 400). This argument is discussed in detail in the following paragraphs.

Stein (1995) uses a three-period model. In period one, homeowner i has one unit of housing stock and mortgage debt denominated in units of food F_i. Mortgage debt K_i is distributed from low to high debt according to the cumulative distribution function $G(K)$.[8]

In period two, homeowners trade with each other. A homeowner can buy a house of size H_i for which he pays PH_i. Hence, the rental market is not part of Stein's basic model. The homeowner repays the mortgage debt and, consequently, has net assets $P-K_i$. The down payment is paid with the net assets. In particular, homeowners are required to pay a minimum down payment equal to a fraction $\gamma \in (0,1)$ of the value of the new home. Due to the down-payment constraint, the housing investment is limited to $PH_i \leq (P-K_i)/\gamma$. The homeowner can borrow the housing investment net of the down payment at the riskless rate of interest, which is assumed to be zero.

In period three, the homeowner earns labor income $L_i = 1 + K_i$ and repays the mortgage.[9] Hence, total lifetime wealth (including the initial endowment) is equal to one unit of food and one unit of housing, $1+P$.[10] The homeowner also gets utility from consuming both food and housing. The homeowner's utility is $U_i = \alpha \ln(H_i) + (1-\alpha)\ln(F_i) + \theta M_i$, where

[8] Based on *G(K)*, Stein (1995) calculates the aggregate net excess demand schedule for the three groups of homeowners. In this chapter, we do not focus on Stein's results with respect to net excess housing demand.

[9] Hence, Stein assumes that income and the mortgage are positively related. In particular, this positive association implies that homeowners have to work harder if the mortgage is higher or homeowners who work harder can afford a higher mortgage.

[10] Stein assumes that labor income is equal to one unit of food and the mortgage debt such that homeowners do not differ in their total lifetime wealth, but only in the amount of debt relative to income. A benefit of this approach is that housing demand and, consequently, net excess housing demand is simply defined in terms of total lifetime wealth (which does not differ across homeowners). As mentioned, we do not focus on the results of Stein regarding net excess housing demand.

H_i is the housing good, F_i is food, α is the share of the budget spend on housing, and θ are exogenous trade gains if a homeowner moves ($M_i = 1$). Since the utility function is a Cobb-Douglas function, the homeowner's unconstrained housing demand is $H_i = \alpha(1+P)/P$. Since a homeowner buys a house of size H_i, he can spend $F_i = 1 + P - PH_i$ on food.

Constrained movers have a level of debt between K^* and K^{**}. The debt level K^* is determined by equating the demand based on the down-payment constraint, $H_i^c = (P - K_i)/\gamma P$, with the unconstrained demand function. As mentioned, we are not interested in unconstrained movers versus constrained movers, but we focus on homeowners who move versus those who do not move. Stein argues that homeowners are indifferent between moving and not moving if the utility of a homeowner who moves is equal to zero. In particular, if a homeowner does not move, he consumes one unit of housing and one unit of food, which leads to a utility of zero in the Cobb-Douglas utility function, $U_i^n = 0$. The utility of the constrained mover, U_i^c, implicitly defines the level of debt K^{**} if $U_i^c = U_i^n$. The homeowner decides not to move if mortgage debt is larger than K^{**}.

In accordance with the Dutch institutional setting, this chapter adjusts the model of Stein by replacing the down-payment constraint with the following mortgage qualification constraint:

$$PH_i \leq \psi \frac{rK_i}{\lambda_i}, \qquad (2.1)$$

where ψ is the income-to-mortgage debt multiplier (imposed by the mortgage provider), r is the mortgage interest rate, which is no longer assumed to be zero, rK_i is the mortgage loan payment, and λ_i is the loan payment-to-income (LTI) ratio. The term $\frac{rK_i}{\lambda_i}$ implicitly defines income. Equation (2.1) implies that a homeowner cannot buy a house that is worth more than the maximum amount he can borrow from the mortgage provider.[11]

The main parameter of interest, λ_i, is defined as

[11] In accordance with the Dutch institutional setting, equation (2.1) does not restrict the level of debt to be smaller than the value of the house. In an institutional setting with down-payment constraints, negative net housing equity may lead to corner solutions (lock-in effects) (see Chan, 2001).

$$\lambda_i = \frac{rK_i}{L_i}, \tag{2.2}$$

where we assume that $\lambda_i > 0$.[12] The LTI ratio is based on the income unadjusted for (future) loan payments. Instead, adjusted income equals $L_i - rK_i$. As a result, adjusted lifetime wealth is $1 + P - rK_i$.

To incorporate the fishing behavior of homeowners in the model, we first define the probability to move. As mentioned, homeowners are indifferent between moving and not moving if the utility associated with moving equals zero:

$$U_i^c = \alpha \ln(H_i^c) + (1-\alpha)\ln(1 + P - rK_i - PH_i^c) + \theta + \mu_i = 0, \tag{2.3}$$

where $1 + P - rK_i - PH_i$ of lifetime wealth is spend on food and housing demand is constrained by the mortgage qualification constraint, $H_i^c = \psi \frac{rK_i}{\lambda_i P}$. Although equation (2.3) again implicitly defines K^{**}, we are mainly interested in the effect of a change in the LTI ratio λ_i on residential mobility and, consequently, fishing behavior.

In comparison to the model of Stein, equation (2.3) contains the additional term μ_i. This term captures in a simple fashion that trade gains may differ between homeowners.[13] The μ_i's are distributed according to the cumulative distribution function $F(\mu)$. The remaining terms in equation (2.3) are deterministic and in total equal to C_i. As mentioned, a homeowner moves, $M_i = 1$, if utility is larger than zero, $U_i^c > 0$. Instead, a homeowner does not move if $U_i^c \leq 0$. Consequently, the chance of moving is equal to $F(\mu = C_i)$, which is a standard result in the latent variable representation of a binary choice model.[14]

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[12] In the following discussion, we will substitute equation (2.1) in the utility function. A negative LTI ratio may, given some positive level of debt, lead to negative housing consumption. In this case, the logarithmic utility function is not defined. In this chapter, we do not discuss the implications of a negative LTI ratio on housing consumption and, consequently, the decision to move (fishing behavior) in further detail.

[13] Alternatively, it is possible to assume that the theta parameter itself is stochastic. In this case, however, the chance that a homeowner does not move cannot be defined since utility is deterministic if a homeowner does not move (i.e. the indicator function *Mi* is zero, total utility equals zero). Instead, it is assumed that the stochastic term in equation (2.3) is not multiplied with the indicator function *Mi*.

[14] In principle, the chance to move is based on *F(-μ)*. This chance can be defined in terms of *F(μ)* if the *–μi*'s are symmetrically distributed, which is a common assumption in these type of binary choice models.

The chance that a homeowner moves depends on the LTI ratio. In particular, the partial derivative of $F(C_i)$ with respect to λ_i is

$$\frac{\partial F(C_i)}{\partial \lambda_i} = F^{'}(C_i)[-\frac{\alpha}{\lambda_i} + (1-\alpha)\frac{1}{(1+P-rK_i-PH_i)}\psi\frac{rK_i}{\lambda_i^2}]. \quad (2.4)$$

The sign of the partial derivative is indeterminate without further assumptions on the marginal utility of housing versus the marginal utility of food. In particular, $F^{'}(C_i)$ is positive, but the term within brackets can be positive or negative. Specifically, the marginal effect of a change in λ_i on utility due to a decrease in housing, $-\frac{\alpha}{\lambda_i}$, is negative, while the marginal effect on utility with respect to food (the remaining term within brackets) is positive if debt and expenditure on food are positive. The partial derivative defined in equation (2.4) is negative if we assume that an increase in the LTI ratio mainly affects housing utility.[15] Based on this assumption, we expect that a higher LTI ratio has a negative impact on the probability to move.

Next, we incorporate the fishing behavior as it is discussed by Stein (1995).[16] Stein argues that a homeowner can either sell his house for the market price with certainty or fish for a relatively high selling price. If the homeowner fishes for a better price, there is a chance that he may not (immediately) sell his house. Stein suggests that fishing is a no-lose proposition for non-movers. If they do not sell their house for a relatively high price, they stay in their current house. Nevertheless, this type of homeowner may get lucky and enjoy the gains of trade. Instead, the opportunity cost of fishing is positive for homeowners who move since they may lose the gains from trade if they do not sell their homes. Hence, especially non-movers have an incentive to fish for a relatively high selling price.

We argue that a homeowner moves if the expected selling price is higher than the reservation price $p_{r,mover}$.[17] A homeowner who moves can get the market price, p_m, with

[15] That is, an increase in the LTI ratio decreases housing consumption and total utility even though a homeowner may substitute away some of the housing consumption towards the consumption of food (which in itself increases utility).

[16] For a matching model that includes search effort, residential mobility, and expected prices, see Wheaton (1990).

[17] The reservation price captures the house price for which the homeowner is indifferent between moving or not moving. As mentioned, the increase in the LTI ratio decreases housing demand and the probability to move. As a consequence, the reservation price is increasing in the LTI ratio (i.e. it is endogenously determined in the model), which is in accordance with the argument of Genesove and Mayer (1997) with regard to the loan-to-value ratio.

certainty, where $p_m > p_{r,mover}$. In this case, the homeowner gets the trade gain, θ, with certainty (i.e. the stochastic term is ignored since it has an expected value of zero).

In contrast, this homeowner may fish for an above-market price, $p_s > p_m$. In particular, he might realize a mark-up with chance q. In this case, the homeowner still gets the trade gain θ. Since there are no additional benefits from fishing, this setup may be interpreted as a worse case scenario. If this homeowner cannot sell the house for a relatively high price, he sells the house for the market price $p_s = p_m$. Unfortunately, the homeowner looses part of the trade gains such that $\rho\theta$ remains, where $0 < \rho < 1$. The parameter ρ captures in a simple fashion the cost of fishing, such as spent time on the market.

This type of homeowner (mover) will fish for a high selling price if the expected benefits from fishing are larger than the trade gains:

$$\theta < q\theta + (1-q)\rho\theta. \quad (2.5)$$

It is evident that this inequality does not hold.[18] In essence, this type of homeowner will never fish for a high selling price since he is not certain whether he will sell the house for an above-market price. Moreover, in this simple setup there are no additional benefits, but only opportunity costs, of fishing. Since the homeowner does not fish, the expected sale price for this homeowner is equal to the market price p_m.

A homeowner who does not move, from an ex ante perspective, can also sell the house for the market price p_m with certainty. Nevertheless, this homeowner does not sell his house (i.e. he does not move) since the market price is below his reservation price, $p_m < p_{r,nonmover}$. Consequently, the reservation price of the non-mover is higher than that of the mover. Since the homeowner does not move, he does not benefit from trade and has utility equal to zero, $U_i^n = 0$.

Instead, this type of homeowner (non-mover) may fish for a sale price higher than the market price, which is again successful with chance q. With chance $1-q$ the homeowner is unsuccessful and remains in the current home (i.e he receives $U_i^n = 0$). Conditional on successful fishing, the homeowner has a chance $z = p(p_s > p_{r,nonmover} \mid p_s > p_m)$ to get a sale price above his reservation price. In this case, the homeowner moves and receives the trade

[18] See Appendix 2A.

gain θ. Instead, the sale price may turn out to be below the reservation price with chance $1-z$. In this case, the homeowner again stays in his current home (the status quo) and does not benefit from trade (i.e. he gets $U_i^n = 0$).

The homeowner who does not move from an ex ante perspective will fish for a high selling price if the aforementioned expected benefits from fishing are larger than the utility associated with the status quo (i.e. $U_i^n = 0$):

$$U_i^n < q[z\theta + (1-z)U_i^n] + (1-q)U_i^n. \tag{2.6}$$

If there is a chance that the homeowner is successful and sells the house for a price above the reservation price (i.e. such that $qz\theta > 0$), the inequality in equation (2.6) holds and the homeowner who does not move from an ex ante perspective will fish for a mark-up. Since this type of homeowner always decides to fish, the expected sale price for this homeowner is equal to $qp_s + (1-q)p_m$. This expected sale price is higher than the expected sale price of the homeowner who already decided to move from an ex ante perspective.

In accordance with Stein (1995), our results suggest that those homeowners who, from an ex ante perspective, have decided not to move are more likely to fish for a higher sale price and have a higher expected sale price. We combine these findings with the results on residential mobility in the following hypothesis:

Hypothesis 2.1 (Fishing Hypothesis): *A homeowner with a higher LTI ratio is less likely to move and, consequently, has more incentive to fish for a relatively high selling price of the house, a mark-up, than a homeowner with a lower LTI ratio.*

2.4 Empirical Model

We assume that the expected sale price consists of two additively separable components:

$$v_i = p_f(x_i) + p_p(x_i, h_i), \tag{2.7}$$

where v_i is the sale price expectation for homeowner *i*, p_f is the fundamental price of the home, and p_p is the part of the sale price expectation related to price setting behavior. The fundamental price p_f is the constant part of the value of the house that is dependent on house characteristics x_i and independent of the individual (household) characteristics h_i. If there is no price setting behavior in the housing market (i.e. a competitive market), the fundamental price equals the aggregate market price (the standard hedonic model). As a result, we start our empirical analysis with estimating a standard hedonic model:

$$\log(v_i) = x_i^{'}\beta_1 + \varepsilon_i, \tag{2.8}$$

where ε_i is the error term and β_1 is a vector of marginal attribute prices.

Unfortunately, the hedonic model in equation (2.8) ignores the effect of individual characteristics (i.e. the LTI ratio) in p_p. In the classical hedonic approach, individual characteristics of buyers and sellers play a role only in the determination of the marginal attribute prices (Rosen, 1974). However, as mentioned earlier, bargaining and market power may play an important role in the hedonic model (i.e. see Harding et al., 2003). As a result, we augment the hedonic model in equation (2.8) by including individual characteristics: [19]

$$\log(v_i) = x_i^{'}\beta_2 + h_i^{'}\gamma_2 + \eta_i, \tag{2.9}$$

where η_i is the error term. We ignore interaction terms.

Since individual and house characteristics are likely correlated (for instance due to sorting in the housing market), the attribute prices in equation (2.8) will be biased. Alternatively, there may be unobserved effects, such as neighborhood quality, which biases the coefficient estimates. Individual characteristics may proxy for such unobserved effects. A comparison between β_1 and β_2 will give an indication of the size of the bias.

To investigate the systematic deviation from market prices in further detail, sale price expectations are evaluated as a mark-up over the officially assessed value of the house:[20]

$$p_p(x_i, h_i) = markup_i = \log(v_i) - \log(a_i) = x_i^{'}\beta_3 + h_i^{'}\gamma_3 + u_i, \tag{2.10}$$

[19] The individual characteristics (i.e. the LTI ratio) are interpreted as seller characteristics (see Harding et al., 2003, for a discussion with regard to seller and buyer characteristics in the hedonic model).
[20] The assessed value is commonly used as a benchmark in the price index literature (see Clapp and Giacotto, 1998, in relation to the hedonic method; Bourassa et al., 2006, and De Vries et al., 2009, for the SPAR index).

where a_i is the officially assessed value and u_i is the error term. In particular, we argue that the assessed value is known ex ante to the homeowner and is used as a reference value such that the mark-up can be interpreted as an intentional deviation from the market price.

This chapter compares the sale price expectations of homeowners in 2006 with the officially assessed value of residential property at the 1st of January 2003. This assessed value was the reference value for taxation in the years 2005 and 2006. By law, the municipalities were required to send a notice with the assessed value of 2003 to the homeowner before the 28th of February 2005.

There are several caveats regarding the use of the officially assessed value as benchmark. First, the assessed values are from the year 2003, while the sale price expectations are from 2006. As a result, we also estimate equation (2.10) with housing capital gains between 2003 and 2006, $capgains_i$, as additional control variable to investigate whether the coefficient on the LTI ratio changes:

$$markup_i = x_i^{'}\beta_4 + h_i^{'}\gamma_4 + \pi capgains_i + \xi_i, \qquad (2.11)$$

where ξ_i is the error term. The capital gains were constructed based on regional quarterly price data from the Dutch Association of Realtors (NVM). The Dutch Association of Realtors publishes the median house price per type of house weighted by the number of sales for 76 NVM regions in the Netherlands. We use the self-reported buy price of the house to scale the regional capital gains.[21]

Second, the assessed value may not be equal to the market price. In particular, the municipality may underestimate the value of the home to avoid appeals. However, in the Netherlands the assessed value *does not* seem to differ substantially from the market price (for a discussion, see De Vries et al., 2009). This result is not entirely surprising. As mentioned, the assessed value is based on the recent sale price of comparable houses. In addition, the time to lodge an appeal was limited. In particular, homeowners had to lodge the appeal within six weeks of the 28th of February 2005. Moreover, the municipality would only consider lowering the assessed value if the decrease in value surpassed a threshold based on the assessed value of the house. For instance, the decrease in assessed value had to be at least 5 percent if the

[21] We include zip code fixed effects in the regressions models. If the assessed value is adjusted by capital gains per NVM region, only the zip code fixed effects would change. Hence, the individual-specific measure of percentage capital gains captures the additional variation in the mark-up related to the buy price of the current home.

assessed value was between 0 and 200,000 euros, and at least 4 percent (with a minimum of 10,000 euros) if the assessed value was between 200,000 and 500,000 euros.[22]

Third, homeowners may not use the assessed value of 2003 as a reference value. Note that the assessed value from 2005 was not yet available to homeowners in 2006 (and these assessed values were also not available in our dataset). In addition, we will provide evidence that homeowners do seem to use the assessed value as a lower bound on expectations by examining the distribution of the mark-up.

Fourth, the (officially) assessed value may not be (accurately) known to the homeowner. As mentioned, the assessed value was revealed to the homeowner the 28th of February 2005, which ensures that this value was available to the respondents in the 2006 survey. In addition, this chapter will provide indicative evidence that this benchmark was known to the homeowner by the comparison of the merged officially assessed values to the survey assessed values. In contrast, the (hedonic) predicted price (Ihlanfeldt and Martinez-Vazquez, 1986) or subsequent sale price (Goodman and Ittner, 1992) are commonly not a priori known to the homeowner.[23]

We end the empirical analysis by discussing the effect of the LTI ratio on the decision to move. As mentioned, the effect of the LTI ratio on the mark-up depends on the decision to move. Consequently, as a robustness check, we will estimate equation (10) for movers and non-movers. More importantly, we investigate whether the probability of moving depends on the LTI ratio:

$$w_i = x_i^{'}\beta_5 + h_i^{'}\gamma_5 + \omega_i, \qquad (2.12)$$

where w_i is an indicator of residential mobility and ω_i is the error term.

2.5 Data

In this chapter, we use the Dutch Housing Demand Survey of 2006 (WoON 2006), provided by the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM). The resulting dataset contains 64,005 respondents. These respondents were questioned somewhere within an eight month period (from August 2005-March 2006). We pool these cross-section data. We focus on the 30,294 respondents who indicated that they are a homeowner. The remaining respondents were predominately renters. The data were merged with the officially

[22] As of the 1th of Januari 2005, these ranges were stipulated in the law ("Wet WOZ", Article 26a).
[23] The previous sale price of the house used by Kiel and Zabel (1999) is more likely to satisfy this assumption.

assessed values of 2003. In addition, the taxing authorities provided the taxable income of the respondents to the Netherlands Ministry of Housing, Spatial Planning and the Environment.[24]

We deleted some outliers from the data. In particular, houses with a year of build before 1850 and a size larger than $450m^2$ are not used in the empirical analysis. Moreover, houses attached to a farm or with a shop as part of the house are kept out of the analysis (i.e. the largest selection) to ensure that the residential value of the home is not mixed with business value. The mark-up is constrained between -1 and 1 and a LTI ratio larger than 1 is not allowed. Furthermore, we exclude households with zero or negative income. In particular, we do not focus on households in financial distress. In addition, a household size larger than 10, and those households with a mortgage which have a remaining duration of more than 40 years, will not be used in the analysis. After these selections, the sample size is 27,860 observations. Finally, we restrict the number of observations per (4-digit) zip code to a minimum of 2 to indentify the zip code fixed effects (598 observations are deleted). As a result, the estimates in this chapter are based on 27,262 observations. Based on this sample, Table 2.1 reports the descriptive statistics of the main dependent and independent variables. Table 2.2 presents the descriptive statistics of the control variables.

2.5.1 Dependent variables: House price, the mark-up, and the decision to move

Respondents were asked the expected sale price of the house. The main empirical benefit of the resulting owner-stated home values is that these expectations are available for the full sample of homeowners (i.e. movers and non-movers), which avoids sample selection bias (see Gatzlaff and Haurin, 1998; Goetzman and Peng, 2006). The average estimate of the homeowner (head of the household or his/her partner) is 283,245 euros. The officially assessed value is substantially lower, 236,707 euros. Hence, the absolute mark-up is 46,539 euros, which is about 17 percent of the housing investment (i.e. based on the log differences). Average housing capital gains between (the first quarter of) 2003 and (the quarter the respondent was surveyed) 2006 have been 25,382 euros, which suggests that about half of the mark-up (45.5 percent) may be interpreted as excess returns (i.e. cannot be attributed to capital gains).[25]

[24] This income is adjusted for the tax deductibility of the loan payments. This government subsidy lowers the LTI ratio.

[25] Based on sample weights provided by VROM (the average weight is 123.73 and it is based on an extensive list of population characteristics such as age, place in household, ethnicity, income, type of residence, and location), the total mark-up in the Netherlands was about 160 billion euros in 2006. In addition, the excess market return in the Dutch housing market was 72 billion euros. Nominal GDP in 2006 was 540 billion euros. As a result, we argue that the mark-up is economically sizeable.

Table 2.1: Descriptive statistics: House price, financial position, and mobility

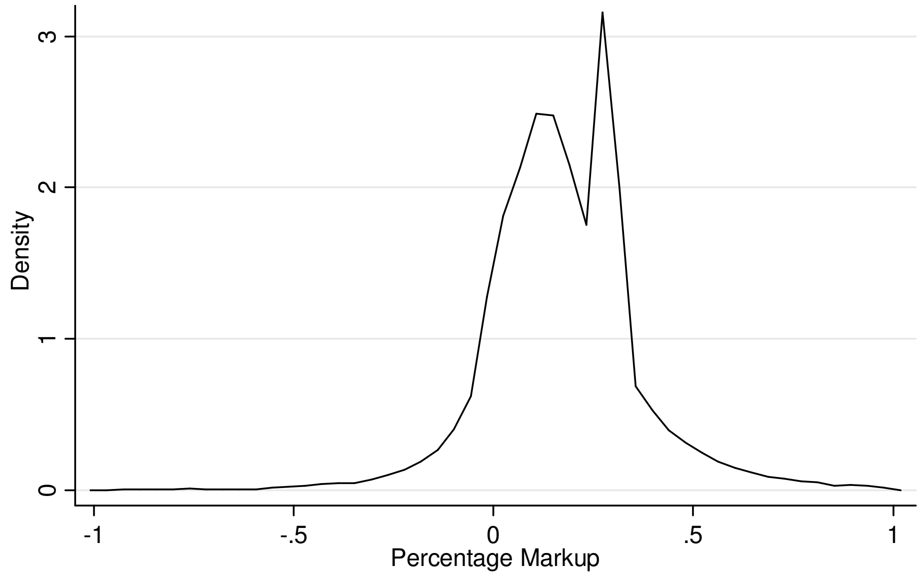
Variables	Mean	Std.dev.	p25	p50	p75
House prices					
Self-reported home value (Euros)	283,245	154,749	190,000	245,000	330,407
Officially assessed value (Euros)	236,707	125,370	161,000	207,000	275,000
Self-reported home value (Euros)/ Officially assessed value (Euros)	1.2111	0.2393	1.0677	1.1815	1.33
Log (Officially assessed value)	12.2724	0.4358	11.9892	12.2405	12.5245
Log (Self-reported home value)	12.4458	0.4478	12.1548	12.4090	12.7081
Mark-up percentage [log own valuation – log officially assessed value]	0.1734	0.1897	0.0655	0.1668	0.2852
Mark-up absolute [own valuation – officially assessed value]	46,539	69,617	13,300	35,000	67,000
Difference survey and officially assessed value a)	162	162,728	-55,000	0	6,000
Absolute difference survey and officially assessed value [|survey assessed- officially assessed|] a)	33,431	159,258	1,000	10,427	36,412
Absolute percentage difference survey and official assessed value [|log(survey assessed)- log(officially assessed)|] a)	0.1269	0.2097	0.0047	0.0520	0.1778
Original buy price (Euros)	130,513	103,590	63,529	107,546	174,705
Capital gains 2003-2006 (based on price index NVM, Euros)	25,382	11,521	19,400	25,500	31,800
Capital gains percentage [Capital gains 2003-2006/Original buy price]	0.4215	0.7368	0.1231	0.2231	0.4099
Financial Position					
Mortgage Payment To Taxable Household Income (fraction)	0.1554	0.1355	0.0614	0.1313	0.2174
Mortgage Payment (monthly, Euros)	539	453	232	490	750
Taxable Household Income (monthly, Euros)	3,963	2,886	2,391	3,510	4,891
Mortgage (Euros)	122,671	113,292	47,647	102,000	175,000
Mortgage_nr (1 if number of mortgages=2, 0 if nr.= 0 or 1)	0.1311	0.3376	0	0	0
Mortgagetype1 (1 if mortgage life insurance)	0.0686	0.2528	0	0	0
Mortgagetype2 (1 if escrow mortgage)	0.1525	0.3595	0	0	0
Mortgagetype3 (1 if investment mortgage)	0.0570	0.2317	0	0	0
Mortgagetype4 (1 if no-payoff mortgage)	0.2711	0.4445	0	0	1
Mortgagetype5 (1 if level payment (amortization) mortgage)	0.0478	0.2133	0	0	0
Mortgagetype6 (1 if linear mortgage)	0.0146	0.1200	0	0	0
Mortgagetype7 (1 if stocks mortgage)	0.0025	0.0495	0	0	0
Mortgagetype8 (1 if other type of mortgage)	0.0118	0.1082	0	0	0
Mortgagetype9 (1 if combination mortgage)	0.2420	0.4283	0	0	0
Mortgagetype10 (1 if no mortgage)	0.1322	0.3387	0	0	0
Remaining mortgage duration (years)	14.81	10.47	5	15	25
Decision to move					
Want to move (1 if prefer to move) b)	0.1756	0.3805	0	0	0
Length of residence (years)	14.52	12.43	5	11	21
Number of observations	27,262				

Notes: The results in this table are based on WoON 2006. Only the condition dummy=1 is specified (0 otherwise). All values are unweighted sample averages. a) the difference between survey and officially assessed value is based on 19,814 observations due to non-response. b) want to move=1 included respondents that, within two years: want to move; want to move, but cannot find a house; maybe want to move; already found a home; have to move.

The kernel density estimate of the mark-up is depicted in Figure 2.1. The distribution of the mark-up in Figure 2.1 suggests that the mark-up is predominantly positive and truncated at zero, which is in accordance with the argument of nominal loss aversion (see

Genesove and Mayer, 2001). In addition, these results suggest that the officially assessed value may indeed act as a lower bound on sale price expectations.[26]

Figure 2.1: The percentage mark-up



Notes: based on an Epanechnikov kernel. Optimal bandwidth (0.019) based on minimized mean integrated squared error. In this figure, the mark-up is constrained between -1 and 1.

The government revealed the assessed value in 2005. It is interesting to investigate whether homeowners have accurate knowledge about this value in 2006. The descriptive statistics in Table 2.1 indicate that the survey-assessed value is on average only 162 euros higher than the officially assessed value although there are substantial outliers. This result provides indicative evidence that on average most homeowners have accurate knowledge about the assessed value.[27]

Finally, we use an indicator whether homeowners *want to move* (i.e. potential movers versus potential non-movers) as dependent variable, not whether homeowners actually moved. In particular, actual mobility may depend on additional constraints, such as availability constraints (see de Palma and Rouwendal, 1996), which may be difficult to control for. Table 2.1 suggests that 17.6 percent of the homeowners want to move within two years. In addition, the average length of residence until the survey date is 14.5 years.[28]

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[26] There is an unexpected peak in the mark-up at 0.4. This peak does not affect the regression results.

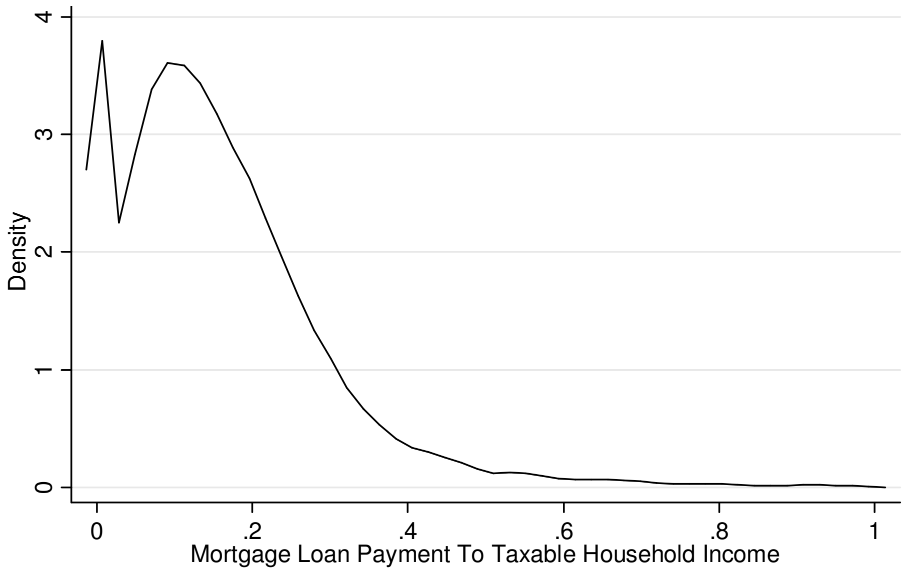
[27] Unfortunately, only 21,547 respondents reported the assessed value, which suggests that there may be a sample selection problem. This high non-response was one of the reasons to use the officially assessed values in the mark-up regressions.

[28] We do not include the length of residence as independent variable in our main regression models. In particular, the length of residence is a direct measure of the decision to move. However, we are interested in the effect of the LTI ratio unconditional on this decision. In addition, this decision is affected by sale price expectations (i.e. it is endogenous). Nevertheless, including the length of residence did not change the main conclusions.

2.5.2 Main independent variables: Financial position

The main independent variable of interest is the ratio of the monthly mortgage loan payment to monthly taxable household income. The average monthly mortgage payment (interest, premium, capital repayment) is 539 euros. The average monthly taxable household income is 3,963 euros. The mortgage payments constituted on average about 15.5 percent of taxable household income (i.e. a LTI ratio of 0.155). Homeowners with multiple mortgages (13.1 percent) reported the total mortgage amount and the total loan payment. The average mortgage loan is 122,671 euros.

Figure 2.2: The LTI ratio



Notes: based on an Epanechnikov kernel. Optimal bandwidth (0.0135) based on minimized mean integrated squared error. In this figure, the LTI ratio was not allowed to be larger than 1. Negative and zero income are also excluded.

Figure 2.2 displays the kernel density estimates of the LTI ratio. The distribution is skewed to the right. The peak around zero is due to households with no outstanding mortgage debt (13.2 percent of the sample). This distribution resembles the distribution of the mortgage loan-to-assessed value reported by Genesove and Mayer (1997).[29]

In extension to Genesove and Mayer (1997), ten mortgage types (the largest part of the sample, 27 percent, has a no-payoff mortgage) and the remaining mortgage duration (15 years on average) are used in the analysis.[30] Both measures may capture the unobserved

[29] An additional empirical benefit of the LTI ratio in comparison to the loan-to-value ratio is that the loan-to-value ratio, used by Genesove and Mayer (1997), has the same denominator as the mark-up. As a result, it is not surprising that they find a positive relationship between the mark-up and the loan-to-value ratio.

[30] If a homeowner has multiple mortgages, these control variables are based on the mortgage for which the homeowner has to pay the most.

heterogeneity in the LTI ratio due to differences in mortgage repayment schemes. In addition, the type of mortgage may be a proxy for differences in homeowners' risk attitudes.

2.5.3 Control variables

We include several additional control variables in the regressions (see Table 2.2). With regard to the individual characteristics, we include an indicator variable for households who have a child between the ages of 0-5 years, an indicator for households with no child, an indicator whether the respondent obtained a university/hbo degree, gender, household size, household type (eight types), age, and age squared.

The sample averages of these control variables are as follows. About 55 percent of the homeowners have no children, 35 percent completed higher education, 52 percent are females, the average household size is 2.7 persons, 41 percent of the respondents have a partner (and children), and the average age is 49 years.

With respect to the house characteristics, we include size in square meters (seven categories), dummies for different types of houses (six house types), a dummy whether a garden is present, a distance to center dummy (five categories, including rural area), and an indicator for home maintenance within the last half year.

The sample averages of the house characteristics are as follows. The average size of the house is about 144 m^2, 20 percent of the houses were built before 1945, 32 percent are row houses, 41 percent of the houses are located within 15 minutes from the center of the place of residence (5 percent are in rural areas), 85 percent of the houses have a garden, and home maintenance occurred for 23 percent of the houses.

Finally, we include zip code fixed effects (2,608 zip code dummies) and seven month of questioning dummies in the regressions. There are 3,495 unique 4-digit zip codes in the original dataset. There are 2,608 zip codes based on the sample of homeowners used in this chapter. The average number of observations is 10.46 observations per zip code. There are 2,608 zip codes based on the sample of homeowners used in this chapter. The average number of observations is 10.46 observations per zip code. There are about 4,000 (residential) 4-digit zip codes in the Netherlands (against 458 municipalities in 2006). Each neigborhood in the Netherlands has a 4-digit zip code. The average population per 4-digit zip code is about 4,000 (std.dev. 4,021, median 2,595) with a minimum of 0 and a maximum of 22,610.[31] The zip code fixed effects are included in x_i to keep neighborhood quality and local market

[31] Source: Statistics Netherlands.

Table 2.2: Descriptive statistics: Other individual and house characteristics

Variables	Mean	Std.dev.	p25	p50	p75
Other Individual characteristics					
Youngestchild0_5 (1 if child between 0 and 5)	0.1678	0.3737	0	0	0
Nochild (1 if no child)	0.5536	0.4971	0	1	1
Higheduc (1 if completed higher education)	0.3523	0.4777	0	0	1
Female (1 if female)	0.5174	0.4997	0	1	1
Household size (nr.)	2.661	1.228	2	2	4
Householdtype1 (1 if partners without children)	0.3681	0.4823	0	0	1
Householdtype2 (1 if partners with children)	0.4115	0.4921	0	0	1
Householdtype3 (1 if partners with children and others)	0.0042	0.0645	0	0	0
Householdtype4 (1 if partners with others)	0.0017	0.0410	0	0	0
Householdtype5 (1 if single parent with children)	0.0304	0.1716	0	0	0
Householdtype6 (1 if single parent with and with others)	0.0005	0.0227	0	0	0
Householdtype7 (1 if other composition)	0.0077	0.0872	0	0	0
Householdtype8 (1 if single)	0.1760	0.3808	0	0	0
Age (years)	49.20	14.86	37	48	59
House characteristics					
Size (m2) a)	144.24	67.61	100	130	175
Buildingyear1 (<1945)	0.2018	0.4014	0	0	0
Buildingyear2 (>=1945 and <=1959)	0.0806	0.2723	0	0	0
Buildingyear3 (>=1960 and <=1969)	0.1236	0.3291	0	0	0
Buildingyear4 (>=1970 and <=1979)	0.1853	0.3886	0	0	0
Buildingyear5 (>=1980 and <=1989)	0.1534	0.3603	0	0	0
Buildingyear6 (>=1990 and <=1999)	0.1722	0.3776	0	0	0
Buildingyear7 (>=2000)	0.0830	0.2760	0	0	0
Houseclass1 (1 if detached)	0.1946	0.3959	0	0	0
Houseclass2 (1 if semi-detached)	0.1890	0.3915	0	0	0
Houseclass3 (1 if corner)	0.1455	0.3526	0	0	0
Houseclass4 (1 if row)	0.3174	0.4655	0	0	1
Houseclass5 (1 if other)	0.0125	0.1113	0	0	0
Houseclass6 (1 if apartment)	0.1411	0.3480	0	0	0
Distancetocenter1 (1 if in center)	0.1342	0.3409	0	0	0
Distancetocenter2 (1 if 15 min from center)	0.4139	0.4925	0	0	1
Distancetocenter3 (1 if >15)	0.1747	0.3797	0	0	0
Distancetocenter4 (1 if suburb)	0.2279	0.4195	0	0	0
Distancetocenter5 (1 if rural)	0.0493	0.2164	0	0	0
Garden (1 if garden)	0.8547	0.3524	1	1	1
Techmaintenance (1 if technical maintenance conducted within the last half year)	0.2330	0.4226	0	0	0
Nr. of zip codes	2,606				
Nr. of months of questioning	8				
Number of observations	27,262				

Notes: The results in this table are based on WoON 2006. Only the dummy=1 condition is specified (0 otherwise). All values are unweighted sample averages. a) In the regressions, we use categorical size dummies.

conditions as constant as possible.[32] As a result, we are essentially comparing houses within neighborhoods.

2.6 Empirical Results

2.6.1 Regression results

The regression results of equations (2.8)-(2.12) are reported in Table 2.3. Column 1 shows a standard hedonic regression, equation (2.8), based on the self-reported home values. Since we estimate a log-level model with a substantial amount of dummy variables, it is important to note that the coefficients should be interpreted according to $\exp(\beta\Delta x)-1$. For instance, apartments are 50 percent cheaper (coefficient -0.699) relative to detached homes, ceteris paribus. Moreover, an increase in the size (m^2) of the home increases the perceived hedonic value of the home, but at a decreasing marginal rate. The largest homes (>300 m^2) are about 48 percent more expensive than the smallest category of houses (<50 m^2). The house characteristics are highly jointly significant (F-value of 546). In addition, the Hausman specification test suggests the zip code fixed effects are relevant as controls. The linear fit is large for a standard micro regression (R-squared of 0.48).

Column 2 adds the LTI ratio and other individual characteristics to the hedonic regression (i.e. equation (2.9)). The house characteristics are still jointly significant (F-value of 445). The individual characteristics are also jointly significant (F-value of 57). The regression results suggest that the augmented hedonic estimates differ substantially from the standard hedonic estimates. In accordance with our expectations, the standard hedonic estimates seem to be biased if individual characteristics are omitted. For instance, the largest category of homes seems to be only 42 percent higher in value relative to the smallest category of homes (in comparison to 48 percent in the standard hedonic regression).

With regard to the LTI ratio, the results in column 2 suggest that an increase in the LTI ratio increases sale price expectations. In particular, a standard deviation change in the LTI ratio increases sale price expectations by 2.3 percent, ceteris paribus.[33] This effect is statistically significant. These findings are in accordance with the fishing hypothesis.

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[32] Neighborhood quality may differ even within the neighborhood. The effect of this "within" variation on our results is out of the scope of this chapter. Black (1999) provides an interesting discussion on such within neighorhoods effects (i.e. border fixed effects model). Instead, we make the identifying assumption that the within neighborhood quality variation is not related to the individual characteristics (e.g. LTI ratio).

[33] A standard deviation change in the LTI ratio is a relatively large change in comparison to the mean of this ratio. Consequently, the results in this chapter are especially relevant when there are large changes in the LTI ratio.

Table 2.3: Hedonic, mark-up and the decision to move regressions, equations (2.8)-(2.12)

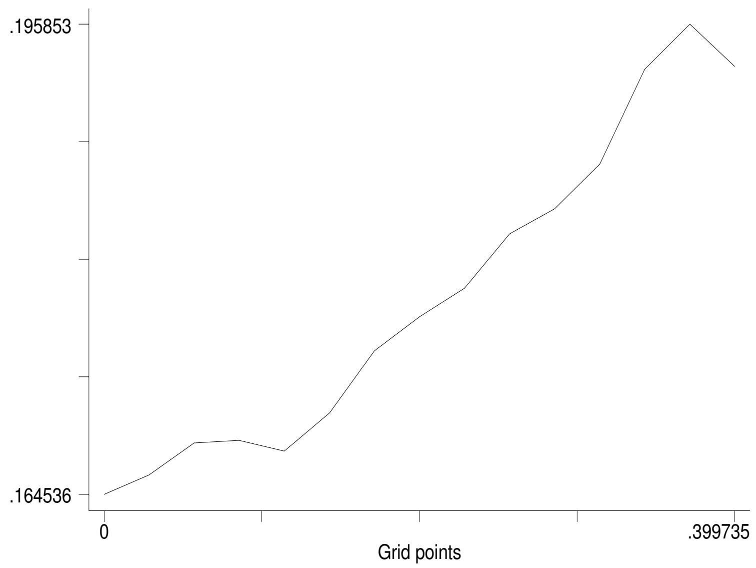
	Equation (2.8)	Equation (2.9)	Equation (2.10)	Equation (2.11)	Equation (2.12)
Model type	**Hedonic**	**Hedonic with individual characteristics**	**Percentage mark-up**	**Mark-up Conditional on capital gains**	**Decision to move**
Dependent variable	Log(own valuation)	Log(own valuation)	Log(own valuation) – Log(officially assessed value)	Log(own valuation) – Log(officially assessed value)	1 if Want to move within two years
Financial Position					
Mortgage payment to taxable household income	-	0.170***	0.070***	0.066***	-0.094***
		(0.017)	(0.012)	(0.012)	(0.022)
Capital gains percentage (from 2003-2006 across 76 NVM regions)	-	-	-	-0.014***	0.012***
				(0.002)	(0.004)
Mortgagetype1	-	-0.023**	0.002	-0.002	0.063***
(1 if mortgage life insurance)		(0.011)	(0.007)	(0.007)	(0.013)
Mortgagetype2	-	-0.049***	-0.003	-0.006	0.056***
(1 if escrow mortgage)		(0.010)	(0.006)	(0.006)	(0.012)
Mortgagetype3	-	-0.029**	0.001	-0.002	0.073***
(1 if investment mortgage)		(0.011)	(0.008)	(0.008)	(0.015)
Mortgagetype4	-	-0.008	0.002	-0.002	0.043***
(1 if no-payoff mortgage)		(0.009)	(0.006)	(0.006)	(0.009)
Mortgagetype5	-	-0.050***	-0.006	-0.009	0.063***
(1 if level payment (amortization) mortgage)		(0.011)	(0.008)	(0.008)	(0.014)
Mortgagetype6	-	-0.013	0.003	-0.000	0.025
(1 if linear mortgage)		(0.016)	(0.011)	(0.011)	(0.019)
Mortgagetype7	-	-0.083***	-0.010	-0.014	0.143**
(1 if stocks mortgage)		(0.027)	(0.020)	(0.020)	(0.057)
Mortgagetype8	-	-0.014	-0.013	-0.016	0.047**
(1 if other mortgage)		(0.021)	(0.015)	(0.014)	(0.022)
Mortgagetype 9	-	-0.032***	-0.002	-0.006	0.058***
(1 if combination mortgage)		(0.009)	(0.006)	(0.006)	(0.011)
Remaining mortgage duration (years)	-	-0.001***	0.00002	0.0001	-0.003***
		(0.0002)	(0.0001)	(0.0001)	(0.0003)
Other individual characteristics					
Youngestchild0_5	-	-0.001	-0.0004	-0.0001	0.031***
(1 if child between 0-5)		(0.005)	(0.004)	(0.004)	(0.009)
Nochild (1 if no child)	-	0.008	0.049	0.046	-0.251***
		(0.061)	(0.035)	(0.035)	(0.056)
Higheduc	-	0.064***	-0.002	-0.003	0.043***
(1 if completed higher education)		(0.004)	(0.003)	(0.003)	(0.006)
Female (1 if female,)	-	0.020***	0.008***	0.008***	-0.007
		(0.003)	(0.002)	(0.002)	(0.005)
Householdsize (nr.)	-	0.026***	0.005**	0.005**	-0.005
		(0.003)	(0.002)	(0.002)	(0.004)
Householdtype2	-	-0.006	0.042	0.039	-0.274***
(1 if partners with children)		(0.061)	(0.035)	(0.035)	(0.056)
Householdtype3	-	0.003	0.042	0.040	-0.197***
(1 if partners with children and others)		(0.067)	(0.038)	(0.038)	(0.070)
Householdtype4	-	-0.008	-0.007	-0.007	-0.051
(1 if partners with others)		(0.043)	(0.029)	(0.029)	(0.055)
Householdtype5	-	-0.077	0.008	0.005	-0.225***
(1 if parent with children)		(0.062)	(0.036)	(0.037)	(0.058)
Householdtype6	-	-0.117	0.037	0.033	-0.126
(1 if parent with children and others)		(0.077)	(0.052)	(0.052)	(0.135)
Householdtype7	-	0.015	-0.005	-0.004	0.118***
(1 if other composition)		(0.023)	(0.017)	(0.017)	(0.031)
Householdtype8	-	-0.080***	-0.021***	-0.020***	0.004
(1 if single)		(0.006)	(0.004)	(0.004)	(0.009)
Age (years) /1000	-	9.593***	-0.023	-0.126	-9.900***
		(0.867)	(0.601)	(0.597)	(1.137)
Age_sq /1000	-	-0.056***	-0.001	0.002	0.056***
		(0.008)	(0.006)	(0.006)	(0.010)
House characteristics					
Size2 (1 if >50 and <=100 m2)	0.071***	0.061***	0.010	0.008	0.009
	(0.012)	(0.011)	(0.008)	(0.008)	(0.016)
Size3 (1 if >100 and <=150 m2)	0.177***	0.151***	0.018**	0.016**	0.004
	(0.012)	(0.012)	(0.008)	(0.008)	(0.015)

Size4 (1 if >150 and <=200 m2)	0.273***	0.236***	0.030***	0.028***	0.001
	(0.013)	(0.013)	(0.008)	(0.008)	(0.016)
Size5 (1 if >200 and <=250 m2)	0.330***	0.290***	0.040***	0.038***	-0.003
	(0.015)	(0.014)	(0.009)	(0.009)	(0.017)
Size6 (1 if >250 and <=300 m2)	0.390***	0.348***	0.063***	0.059***	0.002
	(0.017)	(0.016)	(0.010)	(0.010)	(0.019)
Size7 (1 if >300 m2)	0.392***	0.354***	0.044***	0.041***	-0.009
	(0.019)	(0.018)	(0.012)	(0.012)	(0.019)
Buildingyear2 (1 if >=1945 and <=1959)	-0.036***	-0.040***	-0.017***	-0.018***	0.007
	(0.010)	(0.010)	(0.006)	(0.006)	(0.010)
Buildingyear3 (1 if >=1960 and <=1969)	-0.028***	-0.034***	-0.024***	-0.025***	0.021**
	(0.009)	(0.009)	(0.005)	(0.005)	(0.009)
Buildingyear4 (1 if >=1970 and <=1979)	0.040***	0.025***	-0.026***	-0.031***	0.020**
	(0.009)	(0.009)	(0.005)	(0.005)	(0.009)
Buildingyear5 (1 if >=1980 and <=1989)	0.050***	0.046***	-0.031***	-0.036***	0.012
	(0.009)	(0.009)	(0.005)	(0.005)	(0.010)
Buildingyear6 (1 if >=1990 and <=1999)	0.180***	0.174***	-0.038***	-0.044***	0.007
	(0.010)	(0.009)	(0.005)	(0.005)	(0.010)
Buildingyear7 (1 if >=2000)	0.270***	0.264***	-0.010	-0.016**	-0.040***
	(0.012)	(0.011)	(0.007)	(0.007)	(0.012)
Houseclass2 (1 if semi-detached)	-0.321***	-0.302***	-0.015***	-0.014***	0.018**
	(0.007)	(0.007)	(0.005)	(0.005)	(0.007)
Houseclass3 (1 if corner)	-0.483***	-0.450***	0.012**	0.014***	0.029***
	(0.008)	(0.008)	(0.005)	(0.005)	(0.009)
Houseclass4 (1 if row)	-0.582***	-0.539***	-0.002	0.000	0.041***
	(0.008)	(0.008)	(0.005)	(0.005)	(0.008)
Houseclass5 (1 if other)	-0.202***	-0.188***	0.005	0.004	0.009
	(0.022)	(0.021)	(0.011)	(0.011)	(0.020)
Houseclass6 (1 if apartment)	-0.699***	-0.638***	0.013	0.013	0.069***
	(0.016)	(0.015)	(0.008)	(0.008)	(0.015)
Distancetocenter2(1 if 15 min from center)	-0.032***	-0.027***	-0.023***	-0.023***	-0.001
	(0.007)	(0.006)	(0.004)	(0.004)	(0.008)
Distancetocenter3 (1 if >15)	-0.034***	-0.031***	-0.026***	-0.026***	-0.005
	(0.008)	(0.008)	(0.005)	(0.005)	(0.010)
Distancetocenter4 (1 if suburb)	-0.007	-0.009	-0.020***	-0.020***	-0.013
	(0.008)	(0.008)	(0.005)	(0.005)	(0.009)
Distancetocenter5 (1 if rural)	0.044***	0.036***	-0.009	-0.009	-0.017
	(0.014)	(0.014)	(0.009)	(0.008)	(0.012)
Garden (1 if garden)	0.062***	0.049***	-0.009	-0.008	-0.023*
	(0.011)	(0.010)	(0.006)	(0.006)	(0.013)
Techmaintenance	-0.008**	0.005	0.006**	0.006**	-0.028***
(1 if tech. maint. within the last half year)	(0.004)	(0.004)	(0.003)	(0.003)	(0.006)
Intercept	12.579***	12.183***	0.133***	0.147***	0.749***
	(0.019)	(0.069)	(0.040)	(0.041)	(0.073)
# explanatory variables	29	54	54	54	54
Adjusted R-squared	0.48	0.51	0.02	0.02	0.03
RMSE	0.26	0.25	0.17	0.17	0.35
Joint Significance Tests					
F-value individual characteristics	-	56.80***	6.49***	7.43***	25.18***
F-value house char. (without zip code fixed effect and month of questioning dummies)	545.93***	445.41***	10.15***	10.40***	6.52***
Other tests					
Hausman test (chi2) for zip code fixed effects (H0: no difference fe, re)	1235.07***	1021.18***	96.04***	108.76***	93.90***
F-value month of questioning dummies	0.90	1.48	2.76***	2.63**	1.95*

Notes: The regression results in this table are based on WoON 2006. Robust (clustered) standard errors are in parentheses. ***, **, *, 1%, 5%, 10% significance, respectively. Observations 27,262. In all specifications, the coefficients on the 7 month of questioning dummies and 2,608 zip code fixed effects are not reported and they are not included in the reported number of parameters. The reference category for mortgage type is no mortgage, for youngestchild0_5: children older than 5, for household type: partners without children, for size:<50, for buildingyear:<1945, for house class: detached, for distance to center: in center.

To examine the price-setting behavior of homeowners in further detail, we analyze the effect of the LTI ratio on the mark-up. Figure 2.3 estimates the relationship between the percentage mark-up and the LTI ratio non-parametrically (i.e. kernel regression). There seems to be a linear positive relationship between the two variables. The mark-up increases from 0.165 for a homeowner with a LTI ratio close to zero to 0.196 for a homeowner with a relatively high LTI ratio of 0.4. A simple bivariate regression shows a similar pattern. The coefficient on the LTI ratio in this regression is 0.063 (SE 0.009) and significant at the 5 percent significance level.

Figure 2.3: Kernel regression of the percentage mark-up on the LTI ratio



Notes: based on an Epanechnikov kernel. Bandwidth 0.05 with 15 equally spaced points. A LTI ratio below 0.4 captures most observations (i.e more than 95%). The kernel estimates after a LTI ratio of 0.4 are highly volatile due to the low number of respondents with a LTI ratio higher than 0.4.

Column 3 reports the estimates of equation (2.10), the mark-up regression with additional control variables. The regression results indicate that the self-reported home values differ systematically from the assessed values. In particular, the house characteristics and individual characteristics are jointly significant (F-value of 10 and 6, respectively), although the significance level drops in comparison to the previous regressions. These regression estimates are in line with the result that hedonic estimates based on self-reported home values are biased. In addition, the results suggest that the assessed value may filter out a substantial, albeit not all, part of the variation in sale price expectations with respect to house characteristics and individual characteristics.

As mentioned, this study focuses on the effect of mortgage commitment. With regard to the LTI ratio, we find that a standard deviation change in the LTI ratio statistically significantly increases the ratio of the expected sale price to the assessed value by 1 percent.[34] [35] Relative to the average ratio of 1.21, this effect equals a 1.2 percentage point increase in the mark-up. This effect is economically significant in comparison to an average percentage mark-up of 17 percent. This regression result supports our finding that homeowners with a higher LTI ratio fish for a relatively high selling price.

These results *do not* suggest that the LTI ratio is the only important determinant of the mark-up. For instance, singles seem to expect a lower ratio of the sale price to the assessed value of 2.1 percent. In addition, this ratio is 4.5 percent higher for the largest category of homes relative to the smallest category of homes, 1.5 percent lower for semi-detached houses versus detached houses, and it is 2.6 percent lower for house more than 15 minutes out of the center of the city (but not in a suburb) compared to the city center. Hence, these results suggest that market conditions may play an important role in the determination of the mark-up as well.[36]

Column 4 reports the regression estimates based on equation (2.11), the mark-up regression with percentage capital gains between 2003 and 2006 as control variable.[37] The estimates in column 4 suggest that our main conclusions remain unchanged although the effect of the LTI ratio is somewhat lower than in the previous estimate. As mentioned, if capital gains are interpreted as an adjustment of the mark-up only, we would expect a positive effect of a change in capital gains on the mark-up. Instead, the results seem to suggest that homeowners with higher capital gains may expect a lower mark-up. In particular, a standard deviation change in the percentage capital gains decreases the ratio of the self-reported home value to the assessed value by 1 percent, which is about 1.2 percentage points in terms of the mark-up. These results seem to be more in line with the fishing behavior of homeowners discussed by Stein (1995). Homeowners with more capital gains seem to be less inclined to fish for a relatively high selling price.

[34] The effect of the LTI ratio on the actual percentage mark-up is somewhat higher (coefficient of 0.0874, SE 0.0144).

[35] Genesove and Mayer (1997) find a higher effect of the loan-to-value ratio if this ratio is higher than 0.8. We did not find evidence that a homeowner with a relatively high LTI ratio (>0.4) has a relatively high marginal effect of the LTI ratio.

[36] The effects of these market conditions on the mark-up are out of the scope of this chapter.

[37] Alternatively, we also adjusted the mark-up by capital gains. This did not change the main results. In particular, the coefficient on the LTI ratio in this model is 0.0960 (SE 0.0142). In addition, the estimated model with capital gains as a control variable is more flexible since the coefficient on capital gains is not restricted to one.

Finally, column 5 shows the estimates of the Linear Probability Model in equation (2.12). We use the Linear Probability Model to keep the regression method/model comparable to the previous regressions.[38] The house characteristics and individual characteristics are again jointly significant (F-value of 7 and 25, respectively). This result suggests that the LTI ratio may not be the only important determinant of the propensity to move. Nevertheless, we focus our discussion on the LTI ratio. In accordance with the fishing hypothesis, a standard deviation increase in the LTI ratio decreases the preference to move within two years by 1.3 percentage points, ceteris paribus.[39] This effect is substantial in comparison to an average propensity to move of 17.6 percent.

2.6.2 Robustness checks

This sub-section reports several robustness checks with regard to the main regression in this chapter, the mark-up regression (Table 2.3, column 3).

We estimated the mark-up regression based on a subsample of homeowners who want to move (4,787 observations). In this model, the LTI ratio coefficient is 0.0312 (SE 0.027) and statistically insignificant. Instead, the LTI ratio based on the sample of homeowners who did not want to move is 0.0689 (SE 0.013) and statistically significant. These findings are in accordance with the fishing hypothesis.

The mark-up is based on the officially assessed value. The LTI ratio coefficient in the regression with the survey-based mark-up as dependent variable (19,813 observations) is 0.040 (SE 0.020), which is somewhat lower than the previous estimates.

We used three different measures of income. In addition, we also utilized an alternative measure of the loan payment. The monthly mortgage payment is based on interest, premium and capital repayment. The mark-up regression with the LTI ratio based on interest payments only results in a LTI coefficient of 0.068 (SE 0.013). The LTI ratio effect based on gross household income is 0.098 (SE 0.016). The income definition used by the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM) resulted in a LTI coefficient of 0.076 (SE 0.012). Based on the definition used by Statistics Netherlands (CBS),

[38] The predicted values range between -0.076 and 0.560 with an average predicted mobility of 0.176 and a standard error of the predicted value of 0.076. This results suggests that the predicted values stay predominately in the [0,1] range and the LPM method may be a valid method in comparison to the probit model.

[39] Without capital gains as control variable the coefficient on the LTI ratio is similar (-0.0967, SE 0.0216).

the LTI coefficient is 0.107 (SE 0.012).[40] These regression estimates suggest that alternative definitions of the LTI ratio do not affect our main results.

The mark-up may depend on local market conditions. As a result, we also estimated the mark-up regression based on the largest (in terms of observations) municipality in our dataset ('s-Gravenhage, 820 observations). We find a LTI ratio effect of 0.112 (SE 0.055). This estimate again strongly supports our main finding with regard to the fishing hypothesis.

Some homeowners may not be constrained by the LTI ratio since they own the house outright (i.e. the LTI ratio peaks at zero, see Figure 1). The coefficient on the LTI ratio is 0.0746 (SE 0.012) if homeowners without a mortgage are deleted from the dataset (i.e. the regression is based on 23,658 observations).

Finally, the house characteristics do not seem to have a large influence on the coefficient estimate of the LTI ratio. In particular, the LTI coefficient is 0.068 (SE 0.011) if we omit house characteristics and zip code fixed effects from the mark-up regression.

2.6.3 A policy perspective: Removing the net subsidy on housing

Homeowners in the Netherlands receive a net subsidy on housing from the government. This subsidy reduces the LTI ratios of homeowners. This subsection analyzes the change in the mark-up and residential mobility if this subsidy would be removed.

In the sample used in this chapter, the average net subsidy on housing is 177 euros per month. This subsidy is on average about 4.8% of the monthly taxable household income and it is positive for 76% of the sample. The net subsidy on housing consists of three main components. First, mortgage loan payments can be deducted from taxable income. Households on average deduct 507 euros from their monthly taxable income. Second, the house is assumed to generate fictitious income. This fictitious income is calculated based on the officially assessed value of the house. Homeowners pay on average 101 euros additional income tax per month due to this fictitious income. Finally, some homeowners have to pay rents to the owner of the land (usually the municipality) the house is standing on. The average land rent is 62 euros per month.[41]

If the net subsidy on housing is removed, the average LTI ratio increases from 15.5 to 17.4 percent. The estimates in this chapter can be used to evaluate the effect of this change in the LTI ratios on the mark-up (i.e. equation (11)) and residential mobility (i.e. equation (12))

[40] Both income definitions of VROM and CBS are measures of disposable household income. Housing subsidies/taxes are treated differently in these measures. For instance, the VROM-definition excludes government subsidies to homeowners.

[41] Only 621 of the 27,262 respondents had to pay land rents.

if these estimates are assumed to be policy invariant. The change in the LTI ratio of 1.9 percentage points increases the mark-up on average by 0.125 percent. Relative to the average ratio of 1.21, this effect equals a 0.15 percentage point increase in the mark-up. In addition, the chance to move within two years decreases by 0.01 percentage points. These results imply that the economic impact with respect to the mark-up and residential mobility of removing the net subsidy on housing may be minor.

2.7 Conclusion

This chapter has investigated self-reported home values in the Netherlands. In contrast, most previous studies on owner-reported values have focused on the US (e.g. Kish and Lansing, 1954; Kain and Quigley, 1972; Robins and West, 1977; Follain and Malpezzi, 1981; Ihlanfeldt and Martinez-Vazquez, 1986; Goodman and Ittner, 1992; Kiel and Zabel, 1999).

One of the key contributions of this chapter is related to the unique institutional setting in the Netherlands. In particular, homeowners in the Netherlands mainly face an income constraint in loan qualification instead of a down-payment constraint. As a result, we reformulated the housing market model of Stein (1995) to include mortgage commitment based on the loan payment-to-income (LTI) ratio and we tested Stein's fishing hypothesis with respect to this ratio.

In accordance with the fishing hypothesis, the estimation results in this chapter indicate that a standard deviation increase in the LTI ratio decreases the chance that a homeowner wants to move within two years by 1.3 percentage points, while it increases owner-reported home values by 2.3 percent and the mark-up of the self-reported value over the officially assessed value of the house by 1.2 percentage points. Moreover, we have found that the average mark-up is about 17 percent in the Netherlands in 2006 and that about half of this mark-up can be interpreted as excess market return. In comparison, the error in owners' estimates reported by Kiel and Zabel (1999), which is one of the most recent studies with regard to self-reported home values in the US, is smaller (i.e. an average error of 5.1 percent). In sum, the findings in this chapter suggest that homeowners seem to act as price setters in the Dutch housing market in 2006, not as price takers.

Further research should focus on how sale price expectations eventually lead to transaction prices or, more in general, how expectations lead to real outcomes. In particular, buyers (bargaining between buyers and sellers) also play an important role, which has been explicitly ignored in this chapter (for a discussion, see Harding et al., 2003).

From a policy perspective, we used the estimates in this chapter to investigate the impact of the change in LTI ratios if the net subsidy on housing would be removed. Even though the LTI ratios on average would increase by 1.9 percentage points, our findings suggest that the direct effect of this change on the mark-up and residential mobility may be minor. There have been some concerns in the Netherlands that removing the (net) subsidy on house (i.e. the mortgage tax deductibility) may especially reduce mobility in a housing market that is already "locked" (REA, 2006). The results in this chapter do not seem to provide evidence that would validate this concern. Nevertheless, it is important to note that the estimated effects in this chapter are partial effects since the mark-up model and the mobility model are reduced form models. A structural approach would for instance also incorporate the effects of the change in the LTI ratio on the general price level and the impact of the change in house price (housing capital gains) on turnover. In addition, such an approach should also take into account the welfare gains of a reduction in the distortion of the housing consumption allocation due to removing the net subsidy on housing.

A further result of this chapter is that hedonic regressions based on self-reported home values are biased if individual characteristics are omitted. In particular, sale price expectations of Dutch homeowners (the mark-up) seem to be systematically related to individual and house characteristics. These results are in accordance with Ihlanfeldt and Martinez-Vazquez (1986). For instance, standard hedonic results indicated that the largest category of homes in our sample is 42 percent higher in value relative to the smallest category of homes. Instead, this effect is 6 percentage points higher in the hedonic model with individual characteristics as controls.

Goodman and Ittner (1992) and Kiel and Zabel (1999) do not find much evidence of a systematic deviation of the owners' valuations from market prices in the US (except with regard to the length of residence). A possible explanation for this apparent discrepancy with our findings may be that, in some time periods, there is no systematic deviation in the US. As a result, further research on this topic based on data from other countries and time periods would be extremely interesting. Such research could improve our understanding about how price expectations in different institutional settings and under different market conditions are formed.

Appendix 2A: Proof that a mover does not fish

A homeowner who already decided to move from an ex ante perspective will fish if the inequality in equation (2.5) holds. If both sides of equation (2.5) are divided by θ, equation (2.5) suggests that $q+\rho-\rho q>1$ must hold. We know that $q+1-q=1$. We can compare this equation with $q+\rho-\rho q$. We know that $\rho<1$ and, consequently, $-\rho q>-q$. If the latter inequality dominates the former inequality, $q+\rho-\rho q$ is larger than one. However, we know that $(\rho-1)1+(1-\rho)q<0$ since $q<1$. As a result, the term $q+\rho-\rho q$ is smaller than one, which is in contradiction with equation (2.5) and concludes the proof.

Chapter 3

The Housing Capital Gains Effect in the Demand for Future Owner-Occupied Housing without Down-Payment Constraints

3.1 Introduction

A standard result in the housing literature is that housing capital gains have a positive effect on housing demand and residential mobility, especially in the presence of minimum down-payment requirements. In particular, a homeowner may use an increase in the price of the home to pay for the down payment on a new home (e.g. Stein, 1995; Chan, 2001; Lee and Ong, 2005; Ortalo-Magné and Rady, 2006). This microeconomic relationship is commonly used to explain why prices and turnover in the housing market may be positively related (see Hort, 2000, for an overview).

The aim of Chapter 3 is to investigate the effect of (expected) housing capital gains on housing demand in the absence of minimum down-payment requirements. We argue that without those requirements capital gains do not necessarily have a positive effect on housing demand. To explain this result, we focus on two standard restrictions in the effect of total housing capital gains on housing demand. First, an analysis that only uses the homeowner's total housing capital gains is based on the assumption that buying a home for a relatively low price has the same effect on housing demand as selling that home for a relatively high price. In both cases housing capital gains are relatively high, since housing capital gains equals the difference between the selling price of the home and the original buy price of that home, but both cases cannot be distinguished based on information on total capital gains alone. Second, the housing capital gains effect is usually assumed to be independent of the homeowner's decision to trade up or down the property ladder.

The novelty of this chapter is that we show in a "bare bones" microeconomic housing consumption model, without uncertainty in housing consumption or down-payment constraints, that these two basic assumptions do not hold. That is, we find that buying your house for a relatively low price may have a positive effect on housing demand if the income effect of a price decrease dominates the substitution effect of such a decrease. This buy price effect differs from the housing demand effect of an increase in the selling price of the home.

Specifically, we find that an increase in the selling price of the house may well increase housing demand, especially for those homeowners who want to trade down. Hence, there may be an upward sloping housing demand curve, which is in contrast to the classical effect of prices on demand. Instead, housing demand is more likely to be downward sloping for those homeowners who decide to trade up. The intuition behind this result is straightforward. The cost effect of a price increase may outweigh the capital gains effect of such an increase, especially for those homeowners who trade up. Instead, the capital gains effect of a price increase may play a relatively important role in housing demand for those homeowners who want to trade down. These findings imply that those studies that only focus on the effect of total housing capital gains on housing demand (or residential mobility for that matter) may ignore the full nature of the housing capital gains effect.

In a related model, Dusansky and Koç (2007) provide an alternative explanation for the existence of an upward sloping housing demand curve. They show that an increase in house price may increase housing demand if expectations about the future house price are based on the current house price. In particular, a price increase may increase expectations about future house prices, which has a positive effect on housing demand. This expectations effect may well outweigh the standard negative income and substitution effects. In line with their theory, Dusansky and Koç (2007) find empirical evidence of an upward sloping demand curve with respect to the homeowner's sale price expectations in the United States.

One of the key contributions of this chapter is that our model provides a simple alternative explanation for the existence of an upward sloping housing demand curve. The main difference between the housing consumption model used in this chapter and the model of Dusansky and Koç (2007) is that the housing market consumption model of Dusansky and Koç (2007) is based on the idea that homeowners choose to become renters in the future. Instead, the model in this chapter explicitly takes into account that most homeowners tend to buy a new home when they move house. This model characteristic leads to interesting comparative static results with regard to future owner-occupied housing demand that are in line with the concept of investment versus consumption demand for housing (see Ioannides and Rosenthal, 1994). In particular, it results in a cost and a capital gains effect of a price increase. As mentioned, if the capital gains effect dominates, this model explains why housing demand may be upward sloping.[1]

[1] The model in this chapter also incorporates transaction costs proportional to the total housing investment since transaction costs provide an alternative explanation for the positive effect of price increases on housing demand.

In contrast to the Dusansky and Koç model, the model in this chapter does not fully incorporate the uncertainty in house price. That is, although the future house price will be interpreted as a single-valued expectation, housing consumption is not uncertain in the model. Of course the uncertainty in house price, house price risk, may in itself play an important role in housing demand. Han (2008, 2010) for instance shows that an increase in house price risk may pose a financial risk to homeowners, but current housing demand may increase if the homeowner's hedging demand is high (i.e. the homeowner trades up). The results in this chapter are in line with Han (2008, 2010) to the extent that a homeowner who trades up may be insufficiently hedged against the price increases in the future home, which in our model reduces future owner-occupied housing demand.

From an empirical perspective, the implications of this simple housing market model may be difficult to investigate since in many countries, such as the US and the UK, homeowners have to make a down payment on a new home. As a result, the empirical analysis in this paper is based on a sample of about 30,000 homeowners from the Dutch Housing Demand Survey (WoON) of 2006. The average loan-to-value ratio, which implicitly captures the down-payment constraint, is 90 percent in the Netherlands, but it can as high as 115 percent (see Green and Wachter, 2005). As mentioned in the previous chapter, this result implies that down-payment constraints may not be binding in the Netherlands, although other liquidity constraints, as always, may play an important role in housing demand.

We will use the homeowner's expected sale price and the variation in whether homeowners want to move within two years to examine the effect of housing capital gains on housing demand. Although house price expectations may play an important role in the household decision-making process (e.g. see Shiller, 1990) and the decision to move is one of the key housing decisions, there is virtually no literature on the impact of price expectations on residential mobility/housing demand (e.g. Dusanski and Koç, 2007; Enghelhardt, 2003). This chapter contributes to our knowledge about how such price expectations influence the homeowner's decision to move.

Finally, Stein (1995) argues that there may be a self-reinforcing effect of house price changes on housing demand in the presence of down-payment constraints. In particular, an increase in house price may increase the homeowner's housing demand, which, in the aggregate, may increase housing prices. This self-reinforcing effect of house price changes, fueled by down-payment constraints, may create excess volatility in the housing market. As a result, it is also interesting to investigate whether there is a positive aggregate price-turnover relationship in the Netherlands where there are no down-payment requirements. That is, the results in this chapter provide interesting counterfactual evidence in comparison to those studies that focus on homeowners in countries with minimum down-payment requirements.

The remainder of this chapter is organized as follows. Section 3.2 presents the model. Section 3.3 discusses the data and empirical methodology. Section 3.4 shows the regression results. Section 3.5 concludes.

3.2 The model

This chapter uses a two-period housing consumption model to investigate the effect of housing capital gains on housing demand. First, the wealth constraint is discussed. Subsequently, the utility maximization problem is formulated. Finally, we use the model to calculate comparative static results with regard to future owner-occupied housing demand.

Assume that in period one the homeowner buys a house. This house provides the homeowner with units of owner-occupied housing services x_1. Alternatively, x_1 may be interpreted as housing stock, where housing services are proportional to the housing stock. The marginal price of a unit of owner-occupied housing is p_1. Hence, $p_1 x_1$ is the total price of the house. In this chapter, renting a house (the opportunity costs of owner-occupied housing) is ignored. Since the homeowner may not have enough assets to own the house outright, he may borrow an amount m_1 from a mortgage provider at the fixed mortgage interest rate r_m. The net housing equity in period one, H_1, consists of the previously accumulated net housing assets, H_0, which may include previous housing capital gains, and the net housing equity in period one, $p_1 x_1 - m_1$. The increase in net housing equity (i.e. $p_1 x_1 - m_1$) is paid with the previously accumulated non-housing assets in period zero, A_0, or the homeowner's savings in period one, s_1. The previously accumulated non-housing assets and savings determine the non-housing assets in period one, A_1. The savings in period one consist of labor income in period one, y_1, and capital income in period one, $r_a A_0$, where r_a is the market interest rate. Homeowners pay transaction costs $t-1$ proportional to the value of the house, with $t>1$. Hence, a homeowner owns a house with value $p_1 x_1$, while he effectively paid $t p_1 x_1$. As a result, savings decrease with the net housing equity adjusted for transaction costs, $t p_1 x_1 - m_1$. Summarizing, period one can be formalized by the following equations:

$$\left.\begin{aligned} &A_1 = A_0 + s_1 \\ &s_1 = y_1 + r_a A_0 - (tp_1 x_1 - m_1) \\ &H_1 = H_0 + (p_1 x_1 - m_1) \\ &T_1 = A_1 + H_1 = H_0 + (1 + r_a) A_0 + y_1 + (1-t) p_1 x_1 \end{aligned}\right\}, \tag{3.1}$$

where A_1 is non-housing assets in period one, s_1 is savings in period one, H_1 is net housing assets in period one, and T_1 is total assets in period one.

In period two, the homeowner sells his home and repays the mortgage. In particular, the homeowner's previous housing assets, H_1, decrease with $p_1 x_1 - m_1$. Moreover, the homeowner receives $p_2 x_1 - m_1$ in his savings account, s_2, due to the sale of his house, where p_2 is the second period marginal transaction price per unit of housing. In this model, the sale of a home is not associated with any transaction costs. However, the homeowner does have to pay interest on the mortgage $r_m m_1$, where r_m is the mortgage interest rate. In period two, the homeowner also buys a new home, which is associated with housing services x_2. As a result, his net housing assets increases by $p_2 x_2 - m_2$.[2] The net housing equity is paid by the non-housing assets in period one, A_1, second period income, y_2, and the proceeds out of the sale of the house, $p_2 x_1 - m_1$. Again, the homeowner pays transaction costs $t-1$ proportional to the value of the house. Hence, savings in period two decrease by more (i.e. $tp_2 x_2 - m_2$) than the additional housing assets accumulated in period two, $p_2 x_2 - m_2$. Summarizing, the asset accumulation in the second period is characterized by the following equations:

$$\left.\begin{aligned} &A_2 = A_1 + s_2 \\ &s_2 = y_2 + r_a A_1 - r_m m_1 + (p_2 x_1 - m_1) - (tp_2 x_2 - m_2) \\ &H_2 = H_1 - (p_1 x_1 - m_1) + (p_2 x_2 - m_2) \\ &T_2 = A_2 + H_2 = H_0 + (1 + r_a) A_1 + y_2 - (1 + r_m) m_1 + p_2 x_1 + (1-t) p_2 x_2 \end{aligned}\right\}, \tag{3.2}$$

where A_2 is non-housing assets in period two, s_2 is savings in period two, H_2 is net housing assets in period two, and T_2 is total assets in period two.

[2] Since there is no third period in the model, the capital gains on the second period house and the costs of the second period mortgage are not included in the model. In addition, the model does not incorporate that the homeowner sells his second period house and repays the principal balance of the second period mortgage.

Based on the capital accumulation rules in (3.1) and (3.2) the total wealth constraint of the homeowner is

$$(tp_1 - p_1^*)x_1 + (t-1)p_2^*x_2 = (1+r_a)A_0 + H_0^* + y_1 + y_2^* + (r_a - r_m)m_1^*, \qquad (3.3)$$

where we assume that total assets in period two, T_2, are zero (i.e. no bequest). The asterisk indicates that the parameter is divided by $(1+r_a)$. The right hand side of equation (3.3) equals lifetime wealth W_T. The budget constraint has two important features. First, without transaction costs ($t=1$) a house in period two would have a net price of zero. Second, the first period house is not only a consumption good (i.e. tp_1x_1), but it is also an investment (i.e. $p_2^*x_1$). In this chapter, it is assumed that $(tp_1 - p_2^*) > 0$ such that the house is a net consumption good. The main difference between the budget constraint in equation (3.3) and the budget constraint reported by Dusansky and Koç (2007) is that the wealth constraint in this chapter includes future owner-occupied housing demand. This chapter does not focus on corner solutions as a result of the wealth constraint in equation (3.3) or other liquidity constraints.[3]

The homeowner is assumed to maximize the following two-period utility function subject to the wealth constraint in equation (3.3):

$$V(W_T, p_1, p_2^*) = \max_{x1,x2} \; U_1(x_1) + U_2(x_2) \quad \text{s.t. equation (3.3)}, \qquad (3.4)$$

where V is the value function. Utility is assumed to be intertemporally additively separable. For notational convenience, we will omit the utility subscript 1 and 2 in the following discussion. For simplicity, we assume that the discount factor is one. In addition, expenditures on other consumption goods are not incorporated in the model. The solution of this maximization problem is based on the first order conditions (see appendix 3A.1) characterized by the Euler equation:

[3] The mortgage is assumed to be exogenous. However, the mortgage may be chosen by the homeowner. For instance, the homeowner might decide not to borrow if the mortgage interest rate is higher than the asset interest rate. In addition, mortgage lenders could constrain this choice by a mortgage qualification constraint. As a result, this chapter will control for mortgage qualification based on income, which is captured by the loan-to-income ratio, in the regression analysis.

$$\frac{U_{x1}}{U_{x2}} = \frac{(tp_1 - p_2^*)}{(t-1)p_2^*}, \tag{3.5}$$

where U_{x1} and U_{x2} are the marginal derivatives of utility with regard to x_1 and x_2, respectively.[4]

The comparative static results are based on Chiang (1984). First, the effect of a first period price change on second period housing demand is analyzed. This discussion will highlight the "standard" effect of a price change. Subsequently, the effect of a second period price change is discussed. Since first period consumption and second period prices are directly related in the wealth constraint, a second period price change will lead to interesting comparative static results in comparison to a standard consumption model.

The effect of a change in the first period marginal price p_1 on the optimal choices can be investigated by totally differentiating the first order conditions evaluated at the optimum (see appendix 3A.2). Subsequently, Cramer's rule is used to solve for the partial derivatives. The solution of the partial derivative with regard to second period housing consumption x_2 is (see appendix 3A.3)

$$\partial\overline{x}_2 / \partial p_1 = \underbrace{\frac{t\overline{x}_1}{|J|}(t-1)p_2^* U_{x1x1}}_{\substack{\text{Income effect} \\ -}} - \underbrace{\frac{\overline{\lambda} t}{|J|}(t-1)p_2^*(p_2^* - tp_1)}_{\substack{\text{Cross-price substitution effect} \\ \text{of a first period price increase} \\ +}}, \tag{3.6}$$

where J is the Jacobian with regard to the first order conditions and the optimal housing demand solutions are $\overline{x}_1$ and $\overline{x}_2$. The determinant of the Jacobian is positive, since this determinant equals the determinant of the bordered Hessian (i.e. second order condition).

Equations (3.6) is a Slutsky equation. The first term in the partial derivative $\partial\overline{x}_2 / \partial p_1$ is the income effect ($\frac{-1}{|J|}(t-1)p_2^* U_{x1x1}$, see appendix 3A.4). The income effect is equal to the effect of an exogenous increase in wealth on second period housing consumption. In equation (3.6), this effect is weighted by $-t\overline{x}_1$. The income effect is negative since $t > 1$, $\overline{x}_1 > 0$, $p_2^* > 0$ $|J| > 0$, and $U_{x1x1} < 0$. In a standard consumption model, the sign of the income effect is indeterminate and a negative income effect is the result of the normal goods

[4] The Euler equation remains unchanged if other consumption goods are excluded if the utility of consumption is assumed to be additively separable from the utility of housing consumption.

assumption. In this chapter, the sign of the income effect is determined due to 1) the additively intertemporal separability of the utility function assumption, and 2) diminishing marginal utility of housing consumption (i.e. $U_{x1x1} < 0$). Based on these assumptions current (future) housing is a normal good in the model. The second part of $\partial \overline{x}_2 / \partial p_1$ is the substitution effect (see appendix 3A.5). The substitution effect in $\partial \overline{x}_2 / \partial p_1$ is positive since $\overline{\lambda} > 0$, $t > 1$, $|J| > 0$, $p_2^* > 0$, $p_1 > 0$, and $tp_1 > p_2^*$. In accordance with standard results, the partial derivative $\partial \overline{x}_2 / \partial p_1$ is indeterminate since the income effect is negative and the substitution effect is positive. Hence, this result implies that a *decrease* in the first period price of housing consumption (i.e. a capital gains increase) has a positive effect on housing demand if the income effect dominates the substitution effect, but it is negative if the substitution effect is larger than the income effect (Capital Gains Hypothesis 1). Hence, the housing capital gains effect of buying your house for a relatively low price is mainly an empirical question.

We are also interested in the effect of a change in the second period house price on future housing demand and how this effect differs from the effect of a first period house price change. In our model, an increase in the second period house price p_2 leads to the following change in second period housing consumption (see appendix 3A.6):

$$\partial \overline{x}_2 / \partial p_2^* = \underbrace{\frac{(t-1)\overline{x}_2 - \overline{x}_1}{|J|}(t-1)p_2^* U_{x1x1}}_{\substack{\text{Income effect} \\ +/(-)}} + \underbrace{\frac{\overline{\lambda}}{|J|}(t-1)p_2^*(p_2^* - tp_2)}_{\substack{\text{Cross-price substitution effect} \\ \text{of a first period price decrease} \\ -}} \\ \underbrace{-\frac{(t-1)\overline{\lambda}}{|J|}(p_2^* - tp_1)^2}_{\substack{\text{Subsitution effect of a second} \\ \text{period price increase} \\ -}}. \tag{3.7}$$

The first term in equation (3.7) is again related to the income effect (see equation (3.6) or appendix 3A.4). The last two terms capture the substitution effect (see appendix 3A.7).

The two substitution effects in equation (3.7) always have a negative impact on second period housing demand. As mentioned, an increase in the second period price increases the price of second period housing consumption, but it simultaneously decreases the total price of first period housing consumption. The later effect is captured by the second term in equation (3.7). In particular, this effect is called a cross-price substitution effect since it resembles the substitution effect in $\partial \overline{x}_2 / \partial p_1$, equation (3.6), albeit the weights are different. The former effect is captured by the third term in $\partial \bar{x}_2 / \partial p_2^*$, which is a standard negative substitution effect (since $\bar{\lambda} > 0$, $t > 1$, $|J| > 0$) of a second period price increase on second period housing consumption.

The most interesting part of the partial derivative in equation (3.7) is the income effect. In particular, equation (3.7) implies that the income effect depends on the importance of current versus future housing consumption in the budget. In a standard budget constraint situation the income effect would be negative (i.e. see equation (3.6)). However, the income effect in $\partial \bar{x}_2 / \partial p_2^*$ is positive if $\bar{x}_1 > (t-1)\bar{x}_2$. Although it is possible that this inequality does not hold (i.e. negative income effect), it is likely that this inequality holds if transaction cost are relatively low (*t* is close to 1). Since the income effect is likely to be positive, the total partial derivative $\partial \bar{x}_2 / \partial p_2^*$ may also be positive. That is, the standard non-inferiority assumption is no longer sufficient to obtain a downward sloping housing demand curve.[5] In addition, the partial derivative $\partial \bar{x}_2 / \partial p_2^*$ is more likely to be positive (or less negative) for those homeowners who trade down than for those homeowners who trade up since the (positive) income effect is weighted by the extent to which a homeowner wants to trade down (Capital Gains Hypothesis 2).

The intuition behind this effect is straightforward. An increase in the second period house price increases effective income since the price of first period housing consumption decreases. However, the homeowner also buys a new home. The price of this home increases. As a result, effective income decreases. If the investment in first period housing consumption is relatively high in comparison to second period housing consumption, the former (positive) income effect plays a relatively important role in second period housing demand. By contrast, the cost effect of a price increase may become increasingly more important if the homeowner moves from a relatively small house to a large house in terms of housing consumption (i.e. he trades up).

A final result in this chapter is that the outcomes based on equations (3.6) and (3.7) imply that a first period price decrease does not have the same effect on future housing demand as a second period increase. In particular, equations (3.6) and (3.7) show some similarities, but they are not equal. Although this result is evident based on the theory provided in this chapter, it is the first standard assumption that we will formally test empirically (Equivalence Hypothesis).

[5] Even though the housing demand curve may be upward sloping, housing is not a Giffen good since housing is still an inferior good (i.e. see Dusansky and Koç (2007).

The following three hypotheses summarize the three key theoretical results discussed above:

Hypothesis 3.1 (Equivalence Hypothesis): *Buying a house for a relatively low price does not have the same effect on future owner-occupied housing demand as selling your house for a relatively high price.*

Hypothesis 3.2 (Capital Gains Hypothesis 1): *Buying a house for a relatively low price has a positive effect on future owner-occupied if the income effect of such a price decrease outweighs the substitution effect of this decrease.*

Hypothesis 3.3 (Capital Gains Hypothesis 2): *A higher sale price of the home has a less negative or even a more positive effect on future owner-occupied housing demand for a homeowner who wants to trade down in comparison to a homeowner who wants to trade up.*

We will investigate these hypotheses in further detail in the empirical results section.

3.3 Data and methodology

3.3.1 Data

The estimates in this chapter are based on the Dutch Housing Demand Survey of 2006 (WoON 2006), provided by the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM). As mentioned in the previous chapter, this dataset contains 64,005 respondents. These respondents were questioned between August 2005 and March 2006. In our analysis, we use the 30,294 respondents (head of the household or his/her partner) who indicated that they were a homeowner.

To avoid outliers, especially with regard to the continuous variables in our analysis, we exclude several observations. These outliers are mainly the result of the fact that we use survey (self-reported) data. Most of these selections exclude observations that are outside the 1st - 99th percentile interval of the distribution of the variables in the original dataset and these selections are largely in line with the previous chapter. In particular, if the original buy price of the home, the currently expected sale price of this home, or the preferred buy price of the next home, is smaller than 10,000 or higher than 1 million euro, the observation is excluded from the dataset. In addition, we did not include homeowners with capital gains lower than -50,000 euro and higher than 1 million euro in the analysis. Moreover, those homeowners who prefer a house that differs more than 500,000 euros in comparison to the expected sale price of the current home are not incorporated in the dataset. In addition, homeowners with a loan-to-income (LTI) ratio larger than 1 are not used in the empirical analysis. Moreover, households with zero or negative taxable household income are not analyzed in this paper to avoid negative or infinite LTI ratios. As a consequence, we do not focus on households that may be in financial distress. Furthermore, a household that consists of more than 10 persons is not included in the dataset (i.e. some of the household sizes were highly implausible, which is an indication of coding error). In addition, if the size of the current house is larger than 450 m^2 the observation is deleted. That is, we do not focus on relatively large houses, which is line with the selection that we do not investigate houses with a relatively high transaction price. After these selections, the cleaned-up dataset consists of 27,430 observations.

We also exclude some additional observations since those observations do not belong to the population of interest in this chapter. Specifically, we excluded those houses that are attached to a farm or with a shop as part of the house from the dataset. As such, we do not focus on the business value of a house. Moreover, in a few cases the type of house was unknown. Since we will use an instrumental variable that is house type specific, those cases were kept out of the analysis. In addition, some homeowners did not know whether they wanted to move within two years. Those homeowners are not analyzed in this paper. Moreover, a few homeowners (119 respondents in the original dataset) who did not want to move or did not know whether they want to move reported that they had to move. To our opinion, these homeowners are not described by the simple utility model in this chapter.[6] In addition, we focus on those homeowners who want to buy a new home after a move. About 82 percent of the homeowners in the original dataset indicated that they prefer to buy a new home instead of renting a home. Hence, we ignore the minority of homeowners who prefer to move to a rental house or were indifferent between moving to a rental house versus buying a new home after a move. In contrast to Dusansky and Koç (2007), we do not estimate a tenure choice selection model, since we are only interested in the house price parameter estimates for the sample of homeowner who want to buy a new home.[7] After these selections, the dataset contains 25,745 observations. All regression estimates of the basic models are based on this sample. Table 3.1 shows the descriptive statistics of the dependent and independent variables based on this dataset.

[6] That is, these homeowners are likely to move due to financial/social distress, not because of their preference to move.

[7] For a comparison of the housing demand functions of renters versus owners, see for instance Henderson and Ioannides (1989).

Table 3.1: Descriptive statistics

Variable	Mean	Std.dev.	p25	p50	p75
Main dependent variable					
Want to move within two years (1 if prefer to move)	0.151	0.358	0.000	0.000	0.000
Maybe want to move	0.084	0.277	0.000	0.000	0.000
Want to move, but cannot find a home	0.007	0.081	0.000	0.000	0.000
Definitely want to move	0.040	0.197	0.000	0.000	0.000
Just found a new home	0.020	0.140	0.000	0.000	0.000
Definitely do not want to move	0.849	0.358	1.000	1.000	1.000
Length of residence	13.76	11.57	5.00	10.00	20.00
Conditional on whether households want to move [a)]					
Trade up? (1 if yes, preferred price – expected sale price>0)	0.748	0.434	0.000	1.000	1.000
Preferred buy price – Expected sale price (Euros)	53,103	107,494	0	50,000	100,000
Preferred buy price of the future home (Euros)	304,274	133,220	211,000	279,000	350,000
Expected sale price of the current home (Euros)	251,171	120609	175,000	222,500	295,000
Main independent variables					
Expected capital gains (log sale price expectation – log buy price)	0.917	0.727	0.293	0.810	1.319
log(Homeowner's sale price expectation)	12.45	0.44	12.18	12.43	12.74
log(Buy price current home)	11.54	0.75	11.09	11.61	12.07
Expected capital gains, (Euros)	151,749	128,753	57,228	129,706	205,580
Homeowner's expected sale price of the current home (Euros)	283,399	141,247	195,000	250,000	340,000
Buy price current home (Euros)	131,650	94,767	65,798	110,000	175,000
Controls					
Mortgage Loan payment To Taxable Household Income (fraction)	0.158	0.135	0.065	0.134	0.219
Mortgage Loan Payment (monthly, Euros)	551	446	250	500	750
Mortgage (Euros)	125,317	111,270	50,823	106,638	178,000
Taxable Household Income (monthly, Euros)	4,000	2,731	2,472	3,571	4,937
Child (1 if child living at home)	0.462	0.499	0.000	0.000	1.000
Higheduc (1 if completed higher education)	0.360	0.480	0.000	0.000	1.000
Female (1 if female)	0.515	0.500	0.000	1.000	1.000
Household size (nr.)	2.70	1.30	2.00	2.00	4.00
Age (years)	48.5	14.4	37.0	47.0	58.0
Householdtype1 (1 if partners)	0.796	0.403	1.000	1.000	1.000
Householdtype2 (1 if single parent)	0.030	0.172	0.000	0.000	0.000
Householdtype3 (1 if single)	0.167	0.373	0.000	0.000	0.000
Householdtype4 (1 if other composition/unknown)	0.007	0.081	0.000	0.000	0.000
Current house size (m2)	145.5	67.9	100.0	132.0	176.0
Houseclass1 (1 if detached)	0.204	0.403	0.000	0.000	0.000
Houseclass2 (1 if semi-detached)	0.193	0.394	0.000	0.000	0.000
Houseclass3 (1 if corner)	0.146	0.353	0.000	0.000	0.000
Houseclass4 (1 if row)	0.316	0.465	0.000	0.000	1.000
Houseclass5 (1 if apartment)	0.141	0.348	0.000	0.000	0.000
Garden (1 if the house had a garden)	0.855	0.352	1.000	1.000	1.000
Techmaint (1 if tech. maint. conducted within the last half year)	0.238	0.426	0.000	0.000	0.000
Nr. of observations	25,745				

Notes: The results in this table are based on WoON 2006. Only the dummy=1 condition is specified (0 otherwise). The variables that are left aligned are directly used in the regression analysis. However, we will use taxable household income in thousands of euros and the current house size per 10 m2. a) Sample size of 3,879 observations.

The dependent variable: Mobility

In this chapter, we will not directly measure future (second period) housing demand. Instead, we will use an indicator w_i that captures whether homeowner i wants to move within two years. We argue that this indicator will mainly pick up the variation in future housing demand. In particular, although the decision to move is based on the utility of current versus future housing consumption, the question whether homeowners want to move within two years is obviously conditional on the respondent owning a home (i.e. first period housing demand). In addition, we will condition mobility on some of the characteristics of the current home to filter out the effect of the demand for the current home. As mentioned in the previous chapter, a further benefit of this indicator is that actual residential mobility may be influenced by availability constraints, which may be hard to empirically control for (see De Palma and Rouwendal, 1996).

Table 3.1 indicates that about 15.1 percent of the homeowners want to move within two years. By contrast, Table 3.1 suggests that the majority of households, 84.9 percent, do not want to move within two years. The want to move category consists of those homeowners who reported that they maybe want to move; want to move, but can not find a home; definitely want to move; just found a new home.[8] The largest subcategory, about 8.4 percent of the homeowners, is the maybe want to move category. We do not investigate the variation in the strength of the homeowner's preference to move in further detail.

Trade up or trade down?

As mentioned in the theory section, we are mainly interested to identify those homeowners who consider trading up versus those who want to trade down. Those homeowners who reported that they want to move and buy a new home were also asked about the preferred buy price of the future house. In addition, all homeowners reported their expectation about the sale price of the current home. A homeowner is assumed to trade up if the preferred buy price of the future house is larger than the expected sale price of the current home. Although the impact of moving up or down the property ladder is obviously a continuous effect that depends on the extent to which homeowners trade up or down, we will only focus on the difference in the capital gains effect between these two groups.

Based on the sample of homeowners who want to move within two years, the average expected sale price of the current home is 251,171 euros. By contrast, these homeowners have

[8] Those homeowners who just found a new home reported an average length of residence 11.7 years. Hence, we argue that these homeowners belong to the mover group.

an average preferred buy price of the future home of 304,274 euros. In particular, these homeowners on average want an increase in the value of the house of 53,103 euros. Based on this price difference, about 74.8 percent of the homeowners who want to move within two years also want to trade up in terms the value of the house.[9] [10]

The main independent variable: Housing capital gains

Homeowners reported the original buy price of the home and the currently expected sale price of their home. We use these two sources of price information to create a measure of expected housing capital gains. Although these expected capital gains may well differ from the actual realized capital gains, we argue that the decisions of homeowners are based on their expectations. In addition, housing capital gains are sometimes constructed by means of price indices (i.e. see Chan, 2001; Lee and Ong, 2005), which may lead to measurement error (attenuation bias), while we will use an individual-specific measure of housing capital gains.[11]

Unfortunately, the buy or sale price of the house may also capture variation in current housing consumption (x_1) since the total price of a house equals housing services times the marginal price of those services. As a result, we will use percentage (log-differenced) housing capital gains in the analysis to filter out the effect of housing consumption. In particular, this measure captures the total variation in the marginal prices ($p_2 - p_1$) if housing consumption remains constant between the time the house is bought and the expected time the house is sold. To the extent that current housing consumption is not constant, the change in housing consumption will be captured in the regression analysis by the intercept and a variable which represents whether housing services might have changed (i.e. technical maintenance dummy). In addition, if the buy price and sale price of the house have a different impact on housing demand, the log-difference does no longer filter out current housing consumption. As a result, we will also condition on a set of current house characteristics to control for the effect of current housing consumption. Finally, since we use the logarithm, the proportional transaction costs are also captured by the intercept.

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[9] About 5.1 percent of the homeowners were indifferent between moving up or down. We included those homeowners in the trade down group.

[10] In comparison, about 75 percent of the total transactions in the US (based on the PSID, 1980-1997) are associated with moving up the property ladder (Han, 2010).

[11] Housing capital gains may also be related to the length of residence. As mentioned in Chapter 2, the length of residence is a direct measure of the decision to move (i.e. the dependent variable in Chapter 3) and, consequently, it is not included as control variable. Moreover, the length of residence is not part of the theoretical model in this chapter. However, including the length or residence in the basic regression models did not change the main conclusions in this chapter.

With regard to the descriptive statistics of housing capital gains, Table 3.1 suggests that the average reported buy price of the home is about 131,650 euros. The self-reported expected sale price of the house at the time the respondents were surveyed is 283,399 euros. The average expected housing capital gains based on the difference between the buy and expected sale price of the house are 151,749 euros. The approximate (log-difference) percentage capital gains are about 91.7 percent, which is sizeable. The average length of residence of 13.8 years implies that the yearly expected capital gains have been 10,996 euros, which is about 4.8 percent (annualized compound return) per year.

Control variables

We use several control variables in the regression analysis. An important control variable is the loan-to-income ratio, which is utilized as proxy for mortgage commitment (mortgage qualification constraint). Households seem to pay about 15.8 percent of their taxable household income to repay the mortgage loan. The monthly taxable household income is about 4,000 euros. We also include income in the regression as a proxy for permanent income.[12]

We incorporate a set of additional control variables. First, we include some individual/household characteristics that determine the preference to move (i.e. determine the shape of the first and second period utility function). In particular, we will use an indicator variable whether the respondent had at least one child living at home, an indicator variable whether the respondent obtained higher education (university/hbo degree), a gender dummy, household size, age of the respondent, and dummies for the type of household (4 categories: partners, single parents, single, other composition). The descriptive statistics in Table 3.1 suggest that about 46.2 percent of the homeowners have at least 1 child living at home, 36.0 percent completed higher education, 51.5 percent are female, the average household size is 2.7 persons, the average age is 48.5 years, and most respondents, about 79.6 percent, have a partner/are married.

Second, we control for some of the basis characteristics of the home. We include the size of the current home, which is on average about 145.5 m^2. In addition, we incorporate dummies for the type of house. It seems that most homeowners in our sample, about 31.6 percent, own a row house. Moreover, we use an indicator variable whether the there is a garden attached to the house. The descriptive statistics suggest that about 85.5 percent of the

[12] Alternatively, Dusansky and Koç (2007) measure permanent income by the predicted income based on a hedonic (homeowner's characteristics) regression model.

houses have a garden. Furthermore, we incorporate an indicator whether the homeowner performed technical maintenance on the home within the last half year. About 23.8 percent of the homeowners in our sample performed such maintenance activities.

Finally, we include month of questioning dummies and 40 regional (COROP) dummies. The month of questioning dummies are used to filter out the effect of changing housing market conditions over the survey period. We incorporate the region dummies to take into account regional differences in the propensity to move. The acronym COROP is named after the commission that defined these regions in 1971. The regions are in accordance with the NUTS-3 classification used by the European Commission and these regions were defined to capture regional labor markets. In particular, most households both work and live in these regions.

3.3.2 Methodology

We will start the empirical analysis with a discussion of the parameter estimates of a relatively restricted model and, subsequently, we will present models that loosen these restrictions (in line with hypotheses 3.1-3.3). As mentioned, this chapter focuses on whether homeowners want to move within two years. In particular, we will investigate the chance that this event occurs. We estimate 3 basic limited dependent variable models, which we will estimate by maximum likelihood.

In the first model, we focus on the total effect of capital gains β_1 on the decision to move:

$$\left.\begin{aligned} w_i^* &= \beta_{0,1} + \beta_1[\log(p_{2,i}) - \log(p_{1,i})] + controls_i'\gamma_1 + \varepsilon_{i,1}\ ,\ \varepsilon_{i,1} \sim LID(0, \pi^2/3) \\ w_i &= 1 \text{ if } w_i^* > 0 \\ w_i &= 0 \text{ if } w_i^* \leq 0 \end{aligned}\right\}, \quad (3.8)$$

where a homeowner moves ($w_i = 1$) if the utility based on the future home is larger than the utility of the current home ($w_i^* = U_2(x_2) - U_1(x_1) > 0$).[13] In addition, $\varepsilon_{i,1}$ is assumed to be standard logistically distributed, such that the model in equation (3.8) fully describes a logit model of the decision to move. As is standard in these type of models, the variance of $\varepsilon_{i,1}$ is restricted, in our case to $\pi^2/3$, such that we can indentify unique parameter estimates. As

[13] For simplicity, the threshold utility difference is equal to zero.

mentioned, we capture $\log(p_{2,i})$ by the logarithm of the buy price of the home and $\log(p_{1,i})$ by the logarithm of the expected sale price of the home. We can use this model to estimate the chance to move, $P(w_i = 1 | p_{2,i}, p_{1,i}, controls_i) = G(\beta_{0,1} + \beta_1[\log(p_{2,i}) - \log(p_{1,i})] + controls_i'\gamma_1)$, where *G* is the standard logistic cdf. Based on the model in equation (3.8), we investigate the gross effect of capital gains on future housing demand. As mentioned in the introduction to this chapter, this model is based on two unrealistic restrictions (i.e. the buy price and the sale price have the same coefficient; the coefficients are independent of the decision to trade up or down). We remove those restrictions in the following two models.

The second model that is estimated is

$$\left.\begin{aligned} w_i^* &= \beta_{0,2} + \theta_1 \log(p_{2,i}) + \theta_2 \log(p_{1,i}) + controls_i'\gamma_2 + \varepsilon_{i,2} \ , \ \varepsilon_{i,2} \sim LID(0, \pi^2/3) \\ w_i &= 1 \text{ if } w_i^* > 0 \\ w_i &= 0 \text{ if } w_i^* \leq 0 \end{aligned}\right\}. \quad (3.9)$$

The model in equation (3.9) strongly resembles the model in equation (3.8) except for the fact that we do not impose the restriction $\theta_1 = -\theta_2$. That is, a decrease in the buy price of the home does not necessarily have the same impact on the decision to move as an increase in the sale price of this home. We can use a simple Wald test to test this restriction. Of course, we will also compare the average marginal effects (AME). As such, we will use the estimates of the model in (3.9) to test hypothesis 3.1. We will also investigate hypothesis 3.2.

The final basic model is a multinomial logit model based on three alternatives: the homeowner does not want to move; the homeowner wants to move and wants to trade up; the homeowner wants to move and wants to trade down. Assume that each alternative *j* gives homeowner *i* the following total utility:

$$U_{tot,i,j} = \lambda_{1,j} \log(p_{2,i}) + \lambda_{2,j} \log(p_{1,i}) + controls_i'\gamma_{2,j} + \varepsilon_{i,j,3} \quad \text{j=1,2,3} \ , \quad (3.10)$$

where $\varepsilon_{i,j,3}$ is the stochastic part of utility and the rest, $V_{i,j}$, is the deterministic part. Note that we only use case/individual-specific regressors (no alternative-specific regressors). In this additive random utility model, the chance that homeowner *i* chooses alternative *n* is

$$P_{i,n} = \frac{\exp(V_{i,n})}{\sum_{j=1}^{3} \exp(V_{i,j})}. \quad (3.11)$$

Again, the parameters are only identified up to some scale. As such, the model is underidentified. Therefore, we assume that the coefficients for the alternative "do not want to move" are equal to zero. This assumption implies that this category will be the reference category. As a result, we will investigate the chance to move and trade up or the chance to move and trade down relative to not moving at all. Consequently, the two sets of parameter estimates that are shown in the results section are in essence not much more than the parameter estimates on two separate logit models. Since these models are estimated jointly in the multinomial setup, there are of course some efficiency gains of the joint estimation procedure. In the multinomial logit model described by equations (3.10) and (3.11), we are mainly interested in the coefficient on the expected sale price, $\lambda_{1,j}$, and whether this coefficient differs for those homeowners who want to trade up versus those who want to trade down. These multinomial logit estimates will mainly be used to investigate hypothesis 3.3. We will also investigate the effect of the buy price (hypothesis 3.2) and whether the buy price and sale price of the house have a similar effect (hypothesis 3.1) for both the trade-up and trade-down group.

Finally, we will show two extensions to the multinomial logit model. In the first extension, we will estimate a nested logit model to deal with the independence of irrelevant alternatives assumption in the multinomial logit model. That is, we will take into account the clear nesting structure of the homeowner's decisions (i.e. moving versus not moving; conditional on moving: trade up or trade down). In the second extension, we will use an instrumental variable approach to correct for the possible endogeneity of the homeowner's expected sale price of the home ($p_{2,i}$). Both of these extensions are discussed in further detail in the results section.

3.4 Results

3.4.1 Regression results of the basic models

Table 3.2 shows the parameter estimates based on the models in equations (3.8) to (3.10). Column 1 reports the logit regression based on equation (3.8). As mentioned, this model captures the total effect of capital gains on the probability that a homeowner wants to move within two years. As is evident from column 1, an increase in capital gains increases the probability that a homeowner want to move within two years, ceteris paribus. This effect is statistically significant at the one percent significance level. We also calculated the average marginal effect (AME) of a change in capital gains. We use the average marginal effect instead of the marginal effect evaluated at the mean since the regressions include relatively a lot of indicator variables. The average marginal effect suggests that a standard deviation increase in the approximate percentage expected capital gains (i.e. an increase in the marginal price of housing) increases the probability that a homeowner wants to move within two years by 1.2 percentage points.[14] [15] This effect is economically sizeable against the average propensity to move of 15.1 percent.[16]

With regard to the other statistically significant coefficients in column 1, we find that a higher loan-to-income ratio decreases the probability to move; more income increases the chance to move; those respondents that completed higher education have a higher propensity to move; females are less willing to move; older respondents are also less mobile; especially homeowners living in apartments easily move house relatively to those respondents owning a detached house; and interestingly those homeowners who did technical maintenance on their homes are less likely to move. Finally, we find that the month of questioning dummies and the regional specific effects are statistically significant (Chi-square of 33 and $6.4*10^5$, respectively). In general, it seems that the aforementioned results are not unreasonable. They are more or less in line with what one would expect to find.

Summarizing, the results in column 1 suggest that, grosso modo, capital gains are positively associated with the probability to move house. However, these results may be incorrect since this total capital gains effect is based on two unrealistic assumptions. In particular, an increase in the sale price of the house is assumed to have the same effect as buying a home for a relatively cheap price. Secondly, the capital gains effect is independent of the homeowner's decision to trade up or down. We discuss the regression models that do not impose these restrictions in columns 2 and 3, respectively.

[14] The actual increase in probability (based on the difference in probabilities) is relatively similar, 1.3 percentage points. Nevertheless, we will use the AMEs to calculate the change in probabilities throughout this chapter.

[15] In comparison, the AME of the loan-to-income variable is -0.07, which is somewhat lower than the LPM estimates in the previous chapter. It seems that a standard deviation increase in the loan-to-income ratio decreases the probability that a homeowner wants to move by about 1 percentage point, which is pretty similar to the result found in the previous chapter.

[16] This effect may be interpreted as a long term effect since a standard deviation change in the marginal price of housing usually does not occur overnight (unless there are sudden price increases or price declines).

Table 3.2: Regression results of the basic models, equations 3.8-3.10

Model type	Equation (3.8)	Equation (3.9)	Equation (3.10)	
	Capital gains	Buy/sale price	Trade up	Trade down
Dependent variable	Want to move	Want to move	Want to move	Want to move
Main independent variables				
Expected capital gains (log sale price expectation – log buy price) P2-P1	0.142*** (0.032)	-	-	-
log(Homeowner's sale price expectation) P2	-	-0.347*** (0.061)	-0.878*** (0.079)	0.802*** (0.084)
log(Buy price current home) P1	-	-0.181*** (0.033)	-0.221*** (0.034)	-0.059 (0.059)
Average marginal effects (AME)				
Expected capital gains (log sale price expectation – log buy price) P2-P1	0.0168***(0.004)	-	-	-
log(Homeowner's sale price expectation) P2	-	-0.041*** (0.007)	-0.081*** (0.007)	0.032*** (0.003)
log(Buy price current home) P1	-	-0.021*** (0.004)	-0.019*** (0.003)	-0.001 (0.002)
Controls				
Mortgage Loan payment To Taxable Household Income (fraction)	-0.618*** (0.138)	-0.328** (0.156)	-1.231*** (0.259)	1.089*** (0.261)
Taxable Household Income (monthly, Euros, in thousands)	0.042*** (0.010)	0.060*** (0.012)	0.092*** (0.018)	-0.012 (0.025)
Child (1 if child living at home)	0.023 (0.088)	0.011 (0.087)	0.072 (0.084)	-0.032 (0.181)
Higheduc (1 if completed higher education)	0.389*** (0.050)	0.432*** (0.052)	0.584*** (0.060)	0.047 (0.080)
Female (1 if female)	-0.126*** (0.046)	-0.119*** (0.046)	-0.211*** (0.056)	0.067 (0.075)
Household size (nr.)	-0.022 (0.036)	-0.011 (0.036)	0.043 (0.035)	-0.123 (0.081)
Age (years)	-0.049*** (0.002)	-0.047*** (0.002)	-0.062*** (0.003)	-0.017*** (0.003)
Householdtype2 (1 if single parent)	0.183 (0.134)	0.149 (0.136)	0.094 (0.157)	0.343 (0.184)
Householdtype3 (1 if single)	0.075 (0.069)	0.036 (0.066)	0.073 (0.078)	-0.001 (0.135)
Householdtype4 (1 if other composition/unknown)	0.136 (0.219)	0.149 (0.216)	-0.378 (0.306)	0.846*** (0.300)
Current house size (m2, per 10 m2)	-0.005 (0.003)	0.003 (0.003)	0.003 (0.004)	0.0004 (0.005)
Houseclass2 (1 if semi-detached)	0.317*** (0.069)	0.187*** (0.072)	0.533*** (0.088)	-0.030 (0.113)
Houseclass3 (1 if corner)	0.470*** (0.080)	0.259*** (0.083)	0.651*** (0.106)	-0.073 (0.120)
Houseclass4 (1 if row)	0.553*** (0.071)	0.306*** (0.070)	0.677*** (0.113)	-0.006 (0.111)
Houseclass5 (1 if apartment)	0.924*** (0.136)	0.624*** (0.134)	1.083*** (0.180)	-0.163 (0.175)
Garden (1 if the house had a garden)	-0.129 (0.088)	-0.116 (0.089)	-0.080 (0.104)	-0.168 (0.137)
Techmaint (1 if tech. maint. within the last half year)	-0.200*** (0.051)	-0.215*** (0.050)	-0.220*** (0.055)	-0.240*** (0.075)
Intercept	-0.266 (0.199)	6.188*** (0.782)	12.942*** (1.044)	-11.329***(1.081)
Nr. of observations	25,745	25,745	25,745	
# explanatory variables	64	65	65 (in each equation)	
Pseudo R-squared	0.080	0.083	0.109	
Log likelihood	-10,035	-10,002	-11,674	
Tests				
Joint sig. month of questioning dummies (Chi2)	33	30	16	16
Joint sig. region (COROP) dummies (Chi2)	6.4e+05	4.1e+05	2.7e+08	3.1e+09
Equality -buy price coef. vs sale price coef. (Chi2)	-	69	168	79
Equality -buy price AME vs sale price AME (Chi2)	-	72	192	110
Equality coef. Trade up vs trade down equation (Chi2)	-	-	2.3e+06	
Equality sale price coef. trade up vs trade down (Chi2)	-	-	220	
Equality sale price AME trade up vs trade down (Chi2)	-	-	214	

Notes: The regression results in this table are based on WoON 2006. Standard errors are in parentheses. We use clustered (per region) standard errors. ***, **, *, 1%, 5%, 10% significance, respectively. The reference group for the type of household is householdtype1 (1 if partners). The reference category for the type of house is detached houses. All specifications include month of questioning and region (COROP) dummies.

Column 2 estimates a similar model as in column 1, but the main two main elements of the housing capital gains – the buy price of the house and the expected sale price of this house – are incorporated separately (equation (3.9)). The regression results of this model suggests that a homeowner who bought his house relatively cheap, and as a result has relatively high capital gains, is still more likely to move, which is in accordance with hypothesis 3.1. That is, the (positive) income effect of a price decrease seems to outweigh the substitution effect of such an increase.

The average effect across all homeowners of an increase in the expected sale price of the house (i.e. an increase in the marginal price of second period housing) seems to be negative. Although this result is interesting, it is not unexpected given the theory discussed in this chapter. In particular, most homeowners in our sample want to trade up and an increase in the price of housing for those homeowners may be mainly a net cost.

With regard to hypothesis 3.1, the equality of the sale price coefficient and the negative of the buy price coefficient is soundly rejected (H0: $\theta_1 = -\theta_2$, Chi-square of 69). In addition, the log likelihood of this model is somewhat higher than the log likelihood in the previous model, which suggests that the model in column 2 is indeed preferred to the previous model. Of course, the AMEs also differ statistically significantly from each other (Chi-square of 72). We find that a standard deviation percentage point increase (i.e. std.dev. of the log of sale price expectations) in the homeowner's sale price expectations decreases the probability that a homeowner wants to move by 1.8 percentage points. Instead, a homeowner with a standard deviation lower buy price is 1.6 percentage points more likely to prefer to move.[17]

Of course, the effect of an increase in the sale price of the house in the previous regression model is still assumed to be independent of the homeowner's decision to trade up or down. As a result, columns 3 and 4 show the estimates of the multinomial logit model as described by equations (3.10) and (3.11). In particular, in this model we allow the coefficients to differ between the homeowners who want to trade up (column 3) versus those who want to trade down (column 4). As is evident from columns 3 and 4, all coefficients of the trade up equation seem to jointly differ from the trade down equation (Chi-square of $2.3*10^6$). As mentioned, we are especially interested whether the coefficient on the sale price expectations variable differs between both groups.

[17] The effect of a standard deviation change in the buy price or sale price on mobility does not differ substantially. However, the standard deviation change in the buy price is different from that of the sale price. Therefore, we tested the AMEs.

The most important result based on columns 3 and 4 is that an increase in the sale price of the house decreases the likelihood that a homeowner wants to move given that he wants to trade up (versus not moving at all), while a price increase has a positive effect on the probability to move for the homeowners who want to trade down.[18] That is, for the former homeowner the cost effect of a marginal price increase dominates the capital gains effect of such an increase in the demand for future owner-occupied housing, while the reverse situation holds for the latter homeowner. The difference in these two coefficients is also statistically significantly different (Chi-square of 220). Of course, this result also holds with regard to the AMEs (Chi-square of 214). The AMEs imply that a standard deviation increase in the expected sale price of the house seems to decrease the chance that a homeowner wants to move within two years by 3.6 percentage points for those homeowners who want to trade up, which is a relatively large effect. Instead, the same increase in sale price expectations increases the probability to move by 1.4 percentage points for those homeowners who want to trade down. These results are in line with hypothesis 3.3.

With regard to the buy price of the home, we find that a decrease in the buy price of the current home is still associated with an increase in the propensity to move, in accordance with hypothesis 3.2, although this effect is no longer statistically significant for those homeowners who want to trade down. In particular, the AMEs suggest that a standard deviation (in terms of percentage) decrease in the buy price of the house increases the chance that a homeowner wants to move by 1.5 percentage points for those homeowners who want to trade up and only by 0.1 percentage points for those homeowners who want to trade down. In accordance with the previous results (hypothesis 3.1), the coefficient on the buy price also differs statistically significantly from the coefficient on the sale price for both the homeowners in the trade up and trade down group (Chi-square of 168 and 79, respectively). This result also holds with regard to the AMEs (Chi-square of 192 and 110, respectively).

3.4.2 The independence of irrelevant alternatives

The previous models are based on two important assumptions. First, the odds ratio between two alternatives is independent of the availability of other alternatives. Second, the homeowner's sale price expectations are assumed to be exogenous. Both of these assumptions

[18] Interestingly, a similar result holds with regard to the loan-to-income ratio. In particular, there is positive coefficient on the LTI ratio in the trade down equation. It seems that a high LTI ratio constrains the homeowner's possibility to move house if the homeowner wants to trade up, while instead a higher LTI ratio seems to give an incentive to move for those homeowners who want to trade down.

may be violated. In this case, the previous models lead to incorrect or inconsistent estimates. This subsection focuses on the first assumption.

The previous logit-based models are based on the independence of irrelevant alternatives (IIA) assumption. The IIA assumption is most clearly understood in terms of the additive random utility model, which we discussed with regard to the multinomial logit model in the data and methodology section of this chapter. As mentioned in the methodology section, each of the three alternatives in the additive random utility model has utility equal to a deterministic part plus an error term. One of the manifestations of the IIA assumption is that the error terms across alternatives are not correlated. However, this assumption may be unrealistic. That is, the IIA assumption implies that the chance to trade up versus the chance to not moving at all is independent of whether the homeowner has the possibility to trade down. In particular, the (relative) increase in the respective probabilities, referred to as the pattern of substitution, is assumed to be fixed. To relax this assumption, we estimate a nested logit model.

In the nested logit model, we take into account the obvious nesting structure in the data. In particular, we cluster the decisions into groups. In the upper nest, the homeowner decides whether he wants to move or not. In the lower nest, a homeowner decides to trade up or down if he decided to move. The key feature of the nested logit model is that the error term in the random utility of the homeowners who trade up is allowed to be correlated with the error term for those homeowners who want to trade down. That is, the errors are allowed to be correlated within nests, but not between nests. In particular, the random utility that homeowner *i* receives when choosing alternative *j* is $U_{tot,i,j} = V_{i,j} + \varepsilon_{i,j,4}$. These alternatives are grouped in different nests N_k (i.e. want to move, do not want to move). In contrast to the univariate extreme value distribution that was used in the multinomial logit model, the errors in the random utility model are assumed to be distributed in accordance with the generalized extreme value (GEV) distribution. The multinomial logit model is based on a particular form of this distribution (i.e. a particular form of the pattern of substitution) and, consequently, is also a GEV model. In the nested logit model, the error terms have the following (GEV-type) joint cumulative distribution function, $\exp\left(-\sum_{k=1}^{K}\left(\sum_{j\in N_k} e^{-(\varepsilon_{i,j,4})/\rho_k}\right)^{\rho_k}\right)$. The interesting feature of this distribution is that ρ_k, called the dissimilarity parameter, measures the degree of independence between the error terms within the nest *k*. If $\rho_k = 1$ the nested logit model collapses to the multinomial logit model. We will explicitly test this hypothesis. Since one of the branches (i.e. the not moving nest) is degenerate, we will constrain the dissimilarity parameter in this case to 1. The chance, $P_{i,n}$, that homeowner *i* chooses alternative *n* (in a particular nest *k*) can be calculated based on the nested logit GEV distribution and the parameters of the model can be estimated using full information maximum likelihood.

Table 3.3, columns 1 and 2, show the nested logit estimates. We will focus on the effect of the individual-specific variables (e.g. the expected sale price) in the lower nest. The conclusion based on these two columns is that the main results discussed in section 3.4.1 remain unaffected. Specifically, a decrease in the buy price of the house has a positive effect on the decision to move in both the trade up and trade down equation (in line with hypothesis 3.1). In addition, a decrease in the original buy price of the house does not have the same effect as an increase in the sale price of that house (in accordance with hypothesis 3.2). Again, an increase in the expected sale price has a negative effect on the probability to move for those homeowners who want to trade up, while this change in house price has a positive effect on this probability for those homeowners who want to trade down (in line with hypothesis 3.3).

Remarkably, the nested logit estimates (AMEs, tests) are very similar to the multinomial logit estimates reported in Table 3.2, columns 3 and 4. The estimated dissimilarity parameter with regard to the move nest is 0.787, which is lower than 1 and, consequently, in accordance with the additive random utility setup. Based on this estimate, we cannot reject the null hypothesis that the dissimilarity parameter differs from 1 (p-value 0.103). That is, the similarity of the multinomial logit and nested logit estimates is reflected in the fact that we do not find statistical evidence that the independence of irrelevant alternatives is violated. Hence, we continue using the multinomial logit model.

3.4.3 The endogeneity of sale price expectations

Besides the independence of irrelevant alternatives assumption, one of the main independent variables, the sale price expectations of homeowners, may be endogenous. There are two interrelated reasons why sale price expectations may be endogenous. First, sale price expectations are measured by self-reported home values. Enghelhardt (2003) argues that the results on mobility may be biased (attenuation bias) if there is an error in homeowner's estimates which is systematically related to the independent variables (i.e. see Chapter 2). In addition, it may be that sale price expectations itself are fundamentally determined by the

Table 3.3: Nested logit and instrumental variable approach

Model type	Nested logit		IV approach	
	Trade up	**Trade down**	**Trade up**	**Trade down**
Dependent variable	**Want to move**	**Want to move**	**Want to move**	**Want to move**
Main independent variables				
log(Homeowner's sale price expectation) P2	-0.812*** (0.124)	0.659*** (0.179)	-20.614*** (0.670)	10.986*** (0.569)
log(Buy price current home) P1	-0.209*** (0.036)	-0.089* (0.052)	3.209*** (0.114)	-1.831*** (0.112)
Average marginal effects (AME)				
log(Homeowner's sale price expectation) P2	-0.077 (-)	0.028 (-)	-1.561*** (0.037)	0.414*** (0.028)
log(Buy price current home) P1	-0.020 (-)	-0.0037 (-)	0.243*** (0.007)	-0.069*** (0.005)
Controls				
Mortgage Loan payment To Taxable Household Income (fraction)	-1.057*** (0.280)	0.808* (0.449)	0.476 (0.302)	0.252 (0.265)
Taxable Household Income (monthly, Euros, in thousands)	0.087*** (0.018)	-0.005 (0.021)	0.493*** (0.025)	-0.234*** (0.029)
Child (1 if child living at home)	0.057 (0.077)	-0.009 (0.162)	-0.278*** (0.086)	0.218 (0.161)
Higheduc (1 if completed higher education)	0.558*** (0.063)	0.114 (0.094)	1.419*** (0.059)	-0.485*** (0.084)
Female (1 if female)	-0.198*** (0.051)	0.042 (0.078)	0.178** (0.048)	-0.187** (0.072)
Household size (nr.)	0.034 (0.039)	-0.104 (0.071)	0.609*** (0.041)	-0.409*** (0.075)
Age (years)	-0.059*** (0.004)	-0.023*** (0.007)	0.105*** (0.006)	-0.103*** (0.006)
Householdtype2 (1 if single parent)	0.105 (0.147)	0.298* (0.190)	-0.747*** (0.148)	0.812*** (0.207)
Householdtype3 (1 if single)	0.067 (0.075)	-0.004 (0.118)	-0.672*** (0.088)	0.406*** (0.133)
Householdtype4 (1 if other composition/unknown)	-0.286 (0.304)	0.714** (0.308)	0.446 (0.288)	0.026 (0.283)
Current house size (m2, per 10 m2)	0.004 (0.004)	-0.0004 (0.005)	0.234*** (0.009)	-0.122*** (0.009)
Houseclass2 (1 if semi-detached)	0.464*** (0.102)	0.020 (0.120)	-4.013*** (0.199)	2.488*** (0.177)
Houseclass3 (1 if corner)	0.566*** (0.122)	0.014 (0.151)	-6.249*** (0.255)	4.177*** (0.279)
Houseclass4 (1 if row)	0.592*** (0.118)	0.090 (0.146)	-7.386*** (0.287)	4.938*** (0.313)
Houseclass5 (1 if apartment)	0.971*** (0.167)	0.049 (0.285)	-9.504*** (0.381)	5.784*** (0.386)
Garden (1 if the house had a garden)	-0.084 (0.098)	-0.160 (0.123)	0.442*** (0.098)	-0.403** (0.168)
Techmaint (1 if tech. maint. within the last half year)	-0.220*** (0.054)	-0.233*** (0.065)	-0.621*** (0.054)	-0.072 (0.089)
Residual first-stage regression	-	-	20.741*** (0.679)	-10.889*** (0.579)
Intercept	12.029***(1.670)	-8.798*** (2.794)	213.361***(6.932)	-115.753***(5.886)
Nr. of observations	77,235 (25,745 cases)		25,452	
# explanatory variables	65 (in each equation)		65 (in each equation)	
Pseudo R-squared	-		0.229	
Log likelihood	-11,672		-9,997	
Tests				
Joint sig. month of questioning dummies (Chi2)	17	15	16	23
Joint sig. region (COROP) dummies (Chi2)	8.7e+07	3.9e+08	1.0e+03	311
Equality -buy price coef. vs sale price coef. (Chi2)	54	9	948	372
Equality -buy price AME vs sale price AME (Chi2)	-	-	1.8e+03	226
Equality coef. trade up vs trade down equation (Chi2)	7.0e+06		1.9e+03	
Equality sale price coef. trade up vs trade down (Chi2)	28		1.2e+03	
Equality sale price AME trade up vs trade down (Chi2)	-		1.7e+03	
Coef. log regional house price, first-stage IV regression	-	-	0.462*** (0.030)	0.440*** (0.086)
Dissimilarity parameter move nest (not move ρ = 1)	0.787 (0.201)		-	-
LR test for IIA, ρ = 1 move nest (Chi2)	2.67 (p-value 0.103)		-	-

Panel B Descriptive statistics IV		Av.	Std.	Av. log	Std.	Nr. Mun.
Med. House price per mun. (euros), apartments	-	149,352	24,997	11.9	0.166	277
Med. House price per mun. (euros), row houses	-	201,986	44,769	12.2	0.226	402
Med. House price per mun. (euros), corner houses	-	211,272	53,998	12.2	0.247	388
Med. House price per mun.(euros),semi-det. houses	-	250,525	100,215	12.4	0.317	422
Med. House price per mun. (euros), detached houses	-	336,218	127,631	12.7	0.327	424

Notes: The regression results in this table are based on WoON 2006. Standard errors are in parentheses. In the second stage IV approach, we use bootstrapped standard errors (5000 replications). In the nested logit model, the IIA test could not be computed based on the clustered standard errors. Hence, this test is based on the nested logit estimates without clustered standard errors. ***, **, *, 1%, 5%, 10% significance, respectively. The reference group for the type of household is householdtype1 (1 if partners). The reference category for the type of house is detached house. All specifications include month of questioning and region (COROP) dummies.

homeowner's decision to move house (reverse causality). In particular, Stein (1995) argues that homeowners, especially those who do not move, may have an incentive to "fish" for a relatively high selling price. In particular, the opportunity cost of fishing for these homeowners may be relatively low since the alternative of this strategy may be not moving at all. Chapter 2 formalized this relationship in the Dutch institutional setting with regard to the loan-to-income ratio.

To deal with the endogeneity of sale price expectations, we use an instrumental variable approach. In accordance with Enghelhardt (2003), we utilize regional house price data to construct an instrument for the self-reported home values.[19] In particular, we calculated the median price per municipality and type of house in 2005 and merged those data to the homeowner-specific data.[20] Since we condition on the region (a COROP consists of multiple municipalities) and the type of house in our regressions, it is especially the within-regional variation in house price levels that is used to capture the exogenous variation in sale price expectations. In particular, we argue that sale price expectations are correlated with the market price, but the market price is in itself not affected by the individual homeowner's decision to move. For instance, each homeowner may well be a price setter in the housing market, but the behavior of such a homeowner cannot in itself affect the market price since there are many other homeowners in the housing market (i.e. monopolistic competition).

The descriptive statistics of the merged instrumental variable are reported in Table 3.3, panel B. It seems that the average house price across homeowners is highest, about 336,218 euros, for detached houses and lowest for apartments, about 149,352 euros. In addition, the number of municipalities in which apartments are sold seems to be relatively low (i.e. 277 municipalities). Moreover, due to missing observations in the instrumental variable, the number of observations that is used in the regression analysis decreases by a small amount to 25,452 observations.

We use this instrument to re-estimate the multinomial logit model reported in Table 3.2, columns 3 and 4. In particular, we apply the control function approach. That is, we estimate a first-stage regression of the expected sale price on the log of the instrument and the control variables for the trade up group, trade down group, and those that do not want to move at all, and use the residuals from these regressions as a control variable in our main

[19] Enghelhardt (2003) uses house price returns based on the Freddie/Fannie indices at the MSA level in the US.
[20] By law, a separate organization in the Netherlands (the Kadaster), collects the transaction prices of all existing homes that are sold. We used this data ("Bestaande Koopwoningen 200812V1") to create the median price per municipality and type of house. Since the median price data in all years is based on the 441 municipalities in 2009, we recoded the municipal-specific codes to be in accordance with the 2009 classification.

specification. An additional benefit of the control function approach is that we can test whether the expected sale price is endogenous. As always, (uncorrected) standard errors in this regression should be interpreted with caution. Consequently, we calculated the standard errors in the second stage by a nonparametric bootstrap procedure (5000 replications).

Table 3.3, columns 3 and 4, shows the instrumental variable regression estimates. With regard to the instrumental variable, the first-stage regression results indicate that the median house price positively and statistically significantly affects the sale price expectations of homeowners. In particular, a one percentage point increase in the median house price increases the self-reported home value by 0.46 percent in the trade up equation and 0.44 percent in the trade down equation.[21] This effect is highly statistically significant (t-value of 15.32 and 5.11, respectively). Hence, the instrument in each of the equations is a relevant instrument. With regard to the endogeneity of the sale price expectations, the Hausman-Wu endogeneity test implies that the null hypothesis of no endogeneity is rejected for both the trade-down group and trade-up group. That is, the first-stage residuals are statistically significant in both the trade-up and trade-down equation (t-values of 31 and -19, respectively).

In comparison to the previous multinomial logit estimates, the coefficient estimates reported in Table 3.3, columns 3 and 4 are substantially larger. Nevertheless, our main conclusions again remain unchanged. In particular, the homeowner's sale price expectation negatively affects the probability whether homeowners want to move within two year for the trade-up group and it positively influences this probability for the trade-down group, which is in line with hypothesis 3.3. In addition, the (negative of the) buy price coefficient differs from the sale price coefficient in both equations (in accordance with hypothesis 3.1) although, interestingly, the buy price coefficient is no longer negative in the trade-up regression (rejection of hypothesis 3.2). The AMEs suggest that a one percent increase in the self-reported house value decreases the probability to move versus the probability of not moving at all by 1.56 percentage points for those homeowners who want to trade up, while it increase the probability to move by 0.4 percent for those homeowners who want to trade down. Hence, in comparison to the previous estimates the economic significance of our results seems to have increased. These outcomes are in line with the attenuation bias argument.

[21] The effect for those homeowners who do not want to move is very similar, about 0.42 percent (s.e. 0.023).

3.4.4 A positive price-turnover relationship?

As mentioned in the introduction to this chapter, down-payment constraints can explain why there may be an aggregate relationship between houses price and turnover (residential mobility of homeowners). Since there are no direct minimum down-payment requirements in the Netherlands, it is interesting to investigate whether such a relationship also exists.

Figure 3.2: A positive price-turnover relationship in the Netherlands

Source: The average house price changes are based on the publically available Dutch Association of Realtors data. The number of transactions are based on the Kadasterdata ("Bestaande Koopwoningen 200812V1").

Figure 3.2 shows the relationship between the aggregate percentage yearly house price change reported by the Dutch association of realtors and the yearly total number of transactions in the housing market over the period 1995-2008.[22] Figure 3.2 implies that there also seems to be a positive price-turnover relationship in the Netherlands (except between 1996-1998; 2000-2002). Although the effect of down-payment constraints on residential mobility may arguably be relatively low in the Netherlands, there are three other reasons why price changes may still be positively related to turnover in the housing market. First, the existence of substantial transaction costs when a homeowner moves can result in a threshold effect of capital gains on residential mobility, which amplifies the positive price-turnover relationship (i.e. see Goodman, 2003; Enghelhardt, 2003). A second reason is that nominal loss aversion with regard to the selling price of the house may create a positive link between

[22] To obtain the number of transaction, we used the same dataset ("Bestaande Koopwoningen 200812V1") that was utilized to create the instrumental variable.

house prices and turnover (see Genesove and Mayer, 2001; Enghelhardt, 2003). Finally, it may be that aggregate housing demand shocks mainly determines house prices (i.e. see Stein, 1995), not vice versa.

How is the previously reported microeconomic evidence related to this macroeconomic phenomenon? As mentioned, the microeconomic evidence in this paper suggests that a house price increase may have a negative effect on whether a homeowner wants to move if this homeowner decides to trade up. If these preferences, at least in part, are also reflected in actual mobility patterns, we would expect a negative relationship between house prices and turnover since most homeowners, at least in the sample used in this chapter, have a tendency to trade up when they move house.[23] Although we do not formally test the aforementioned four explanations for a positive price-turnover relationship, the results in this chapter suggest that the microeconomic evidence is not fully in line with the three micro-economic explanations (i.e. down-payment constraints, transaction costs, nominal loss aversion) for a positive price-turnover relationship. Hence, it seems that the aggregate demand explanation may provide a more plausible reason for the existence of a positive price-turnover relationship in the Netherlands. That is, in a country without down-payment constraints there may still be a positive association between house prices and residential mobility of homeowners although it may not be of the self-reinforcing nature as described by Stein (1995).

3.5 Conclusion

Many studies have found that an increase in housing capital gains has a positive effect on housing demand and residential mobility, especially in the presence of minimum down-payment requirements. In this chapter, it has been argued that this result does not necessarily hold in an institutional setting without direct down-payments constraints.

We focused our discussion on two standard, albeit unrealistic, restrictions on the total capital gains effect. In particular, a common assumption is that the buy price of the house has the same effect on housing demand as an increase in the sale price of this house. Moreover, the effect of a price increase is usually assumed to be independent of the homeowner's decision to trade up or down.

[23] The decision to trade up or down may depend on housing market conditions. However, we argue that most homeowners may have decided to trade up if they moved house between 1995 and 2008, since average house price changes were large and mainly positive during the sample period.

We have found that these two restrictions do not hold in practice. We argued that the housing market in the Netherlands may provide an ideal case study to investigate the effect of housing capital gains in the absence of minimum down-payment requirements. Based on the variation in whether homeowners want to move within two years, which we have used to capture the variation in future owner-occupied housing demand, our results have indicated that buying a house for a relatively low price has a positive impact on the probability that a homeowner wants to move within two years. This effect was statistically significantly different from the effect of an increase in the sale price of the house on housing demand. Specifically, we have found that a house price increase has a negative impact on whether homeowners want to move within two years for those homeowners who trade up, while it increases housing demand for those homeowners who trade down.

These results are fully rationalized by the “bare bones” microeconomic housing consumption model presented in this chapter. In this model, a house price increase implies that a homeowner can sell his house for a higher price, but it also suggests that a new house may be more expensive to buy. Empirically, the former effect seems to dominate for those homeowners who trade down, which results in an upward sloping demand curve for these type of homeowners. Instead, the latter effect dominates for those homeowners who trade up. In addition, these results imply that, in contrast to previous studies, an increase in housing capital gains due to an increase in the selling price of the house does not necessarily have a positive effect on housing demand.

Finally, we investigated whether there is a positive aggregate price-turnover relationship in the Netherlands. In contrast to the microeconomic evidence – a price increase is negatively associated to residential mobility for those homeowners who trade up and most homeowners trade up –, we have found a positive price-turnover relationship. A possible explanation is that it is especially the aggregate housing demand of homeowners that affects house prices and not vice versa. These results imply that a country with down-payment requirements that would remove those requirements would still have a positive price-turnover relationship in the housing market although this relationship would not be necessarily self-reinforcing. As mentioned, this self-reinforcing effect is one of the main explanations for the excess volatility in, for instance, the US housing market (e.g. see Stein, 1995).

Further research should focus on whether the strength of the capital gains effect depends on the extent to which homeowners trade up or down. In addition, a housing market model that would incorporate all of the explanations for the positive price-turnover relationship could help to formally test these explanations. In particular, this chapter did not investigate the impact of transaction costs, nominal loss aversion, or corner solutions as a result of down-payment constraints in further detail. Nevertheless, the results in this chapter have further increased our understanding about the main allocation mechanism in the housing market, residential mobility, and its connection to the price expectations of homeowners.

Appendix 3A: First order conditions and proofs

3A.1: First order conditions

The Lagrangian associated with the utility maximization problem is

$$L = U_1(x_2) + U_2(x_2) + \lambda[W_T - (tp_1 - p_2^*)x_1 - (t-1)p_2^* x_2]. \qquad (3A.1.1)$$

Hence, the first order conditions are

$$\left.\begin{aligned} \frac{\partial L}{\partial \lambda} &= W_T - (tp_1 - p_2^*)x_1 - (t-1)p_2^* x_2 = 0 \\ \frac{\partial L}{\partial x_1} &= U_{x1} - \lambda(tp_1 - p_2^*) = 0 \\ \frac{\partial L}{\partial x_2} &= U_{x2} - \lambda(t-1)p_2^* = 0 \end{aligned}\right\}. \qquad (3A.1.2)$$

The utility subscript 1 and 2 are omitted too avoid cluttering. Based on the equations in (3A.2) the derivation of the Euler equation is straightforward.

3A.2: Total derivative of the first order conditions

The first order conditions hold identically at the optimum. The total derivative of the first order conditions (evaluated at the optimum) are

$$\left.\begin{aligned} (p_2^* - tp_1)d\overline{x}_1 - (t-1)p_2^* d\overline{x}_2 &= t\overline{x}_2 dp_1 + [(t-1)\overline{x}_2 - \overline{x}_1]dp_2^* + (p_1\overline{x}_1 + p_2^*\overline{x}_2)dt - dW_T \\ (p_2^* - tp_1)d\overline{\lambda} + U_{x1x1}d\overline{x}_1 &= \overline{\lambda}t dp_1 - \overline{\lambda}dp_2^* + \overline{\lambda}p_1 dt \\ -(t-1)p_2^* d\overline{\lambda} + U_{x2x2}d\overline{x}_2 &= \overline{\lambda}(t-1)dp_2^* + \overline{\lambda}p_2^* dt \end{aligned}\right\}, \qquad (3A.2.1)$$

where the change in the exogenous parameters are stated on the right hand side of the equations and the change in the endogenous variables are reported on the left hand side of the equations. The bar on the endogenous variables indicates that the variable is evaluated at the optimum. The cross-derivatives U_{x1x2} and U_{x2x1} are zero due to the intertemporal separability of the utility function.

3A.3: The effect of a change in the current house price, equation (3.6)

Only p_1 changes on the right hand side of the equations in (3A.2.1). Divide by dp_1 and interpret the ratios of differentials as partial derivates:

$$\begin{bmatrix} 0 & (p_2^* - tp_1) & -(t-1)p_2^* \\ (p_2^* - tp_1) & U_{x1x1} & 0 \\ -(t-1)p_2^* & 0 & U_{x2x2} \end{bmatrix} \begin{bmatrix} \partial\bar{\lambda}/\partial p_1 \\ \partial\bar{x}_1/\partial p_1 \\ \partial\bar{x}_2/\partial p_1 \end{bmatrix} = \begin{bmatrix} t\bar{x}_1 \\ \bar{\lambda}t \\ 0 \end{bmatrix}, \qquad (3A.3.1)$$

where the first matrix is the (symmetric) Jacobian matrix (J) of the first order conditions (with respect to x_1, x_2 and λ, evaluated at the optimum). The partial derivatives can be solved by Cramer's rule (and cofactor expansion). With respect to x_2 this leads to

$$\partial\bar{x}_2/\partial p_1 = \frac{1}{|J|}\begin{vmatrix} 0 & (p_2^* - tp_1) & t\bar{x}_1 \\ (p_2^* - tp_1) & U_{x1x1} & \bar{\lambda}t \\ -(t-1)p_2^* & 0 & 0 \end{vmatrix} =$$

$$\frac{t\bar{x}_1}{|J|}\begin{vmatrix} (p_2^* - tp_1) & U_{x1x1} \\ -(t-1)p_2^* & 0 \end{vmatrix} - \frac{\bar{\lambda}t}{|J|}\begin{vmatrix} 0 & (p_2^* - tp_1) \\ -(t-1)p_2^* & 0 \end{vmatrix}. \qquad (3A.3.2)$$

Based on the cross-multiplication of the diagonals in the final matrices (to calculate the determinants of the matrices), the results in equation (3.6) are straightforward.

3A.4: The income effect of an exogenous increase in wealth, equation (3.6)

Assume that only W_T changes on the right hand side of the equations in (3A.2.1) and divide by dW_T. In matrix notation this leads to

$$\begin{bmatrix} 0 & (p_2^* - tp_1) & -(t-1)p_2^* \\ (p_2^* - tp_1) & U_{x1x1} & 0 \\ -(t-1)p_2^* & 0 & U_{x2x2} \end{bmatrix} \begin{bmatrix} \partial\bar{\lambda}/\partial W_T \\ \partial\bar{x}_1/\partial W_T \\ \partial\bar{x}_2/\partial W_T \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \\ 0 \end{bmatrix}. \qquad (3A.4.1)$$

where the first matrix is still the Jacobian matrix. Based on Cramer's rule we get

$$\partial \overline{x}_2 / \partial W_T = \frac{1}{|J|} \begin{vmatrix} 0 & (p_2^* - tp_1) & -1 \\ (p_2^* - tp_1) & U_{x1x1} & 0 \\ -(t-1)\,p_2^* & 0 & 0 \end{vmatrix} = \frac{-1}{|J|} \begin{vmatrix} (p_2^* - tp_1) & U_{x1x1} \\ -(t-1)\,p_2^* & 0 \end{vmatrix}. \qquad \text{(3A.4.2)}$$

Based on the cross-multiplication of the diagonals in the final matrix (to calculate the determinant of the matrix), the income effect is

$$\partial \overline{x}_2 / \partial W_T = \frac{-1}{|J|}(t-1)\,p_2^* U_{x1x1}. \qquad \text{(3A.4.3)}$$

3A.5: The substitution effect, equation (3.6)

The substitution effect can be obtained by using the envelope theorem and constant utility:

$$dV / dp_1 = \partial L / \partial p_1 \big|_{optimum} = -\overline{\lambda} t \overline{x}_1 = 0. \qquad \text{(3A.5.1)}$$

This suggests that $\overline{x}_1 = 0$ (since $\overline{\lambda} > 0$ and $t > 0$). After substitution of $\overline{x}_1 = 0$ in the solution for the partial derivative in appendix 3A.3 (i.e. equation (3.6)), the substitution effect in equation (3.6) is straightforward.

Appendix 3A.6: The effect of a change in the future house price, equation (3.7)

Only p_2 changes on the right hand side of the equations in (3A.2.1). Divide by dp_2 to obtain

$$\begin{bmatrix} 0 & (p_2^* - tp_1) & -(t-1)\,p_2^* \\ (p_2^* - tp_1) & U_{x1x1} & 0 \\ -(t-1)\,p_2^* & 0 & U_{x2x2} \end{bmatrix} \begin{bmatrix} \partial \overline{\lambda} / \partial p_2^* \\ \partial \overline{x}_1 / \partial p_2^* \\ \partial \overline{x}_2 / \partial p_2^* \end{bmatrix} = \begin{bmatrix} (t-1)\overline{x}_2 - \overline{x}_1 \\ -\overline{\lambda} \\ (t-1)\overline{\lambda} \end{bmatrix}. \qquad \text{(3A.6.1)}$$

Based on Cramer's rule we get

$$\partial \overline{x}_2 / \partial p_2^* = \frac{1}{|J|} \begin{vmatrix} 0 & (p_2^* - tp_1) & (t-1)\overline{x}_2 - \overline{x}_1 \\ (p_2^* - tp_1) & U_{x1x1} & -\overline{\lambda} \\ -(t-1)p_2^* & 0 & (t-1)\overline{\lambda} \end{vmatrix} =$$

$$\frac{(t-1)\overline{x}_2 - \overline{x}_1}{|J|} \begin{vmatrix} (p_2^* - tp_1) & U_{x1x1} \\ -(t-1)p_2^* & 0 \end{vmatrix} + \frac{\overline{\lambda}}{|J|} \begin{vmatrix} 0 & (p_2^* - tp_1) \\ -(t-1)p_2^* & 0 \end{vmatrix} \tag{3A.6.2}$$

$$+ \frac{(t-1)\overline{\lambda}}{|J|} \begin{vmatrix} 0 & (p_2^* - tp_1) \\ (p_2^* - tp_1) & U_{x1x1} \end{vmatrix}.$$

Based on the cross-multiplication of the diagonals in the final matrices (to calculate the determinants of the matrices), the results in equation (3.7) are straightforward.

3A.7: The substitution effect, equation (3.7)

The substitution effect can be obtained by using the envelope theorem and constant utility:

$$dV / dp_2 = \partial L / \partial p_2 \big|_{optimum} = -\overline{\lambda}[\overline{x}_1 - (t-1)\overline{x}_2] = 0. \tag{3A.7.1}$$

This suggests that $\overline{x}_1 - (t-1)\overline{x}_2 = 0$ (since $\overline{\lambda} > 0$ and $t > 0$). After substitution of $\overline{x}_1 - (t-1)\overline{x}_2 = 0$ in the solution for the partial derivative in appendix 3A.6 (i.e. equation (3.7)), the substitution effect in equation (3.7) is straightforward.

PART II
HOUSE PRICE VOLATILITY

Chapter 4

House Price Risk and the Hedging Benefits of Homeownership

4.1 Introduction

Owning a house can be profitable, but it may also be risky. If the subprime crisis has taught us anything, it is that homeowners may not be fully aware of the risk of owning a home. While the classical institutional investor might have the expertise and knowledge to incorporate risk in his investment strategy, homeowners typically have not. This problem is partly due to the lack of publically available information on the risk of owning a home (e.g. it is costly for a homeowner to acquire information on risk). In addition, it is well known that even with some information on risk, individuals have problems with choice under uncertainty and they find it difficult to assess the magnitude of risk (Kahneman and Tversky, 1979).

The uncertainty with regard to the sale price of a home may be one of the most risky aspects of owning a home. In particular, a homeowner does not know with absolute certainty for how much he could sell his house in the future. The fact that house prices may be quite volatile reflects this uncertainty.[1] However, in an important study, Sinai and Souleles (2009) show that homeowners may use the current house as a hedge against future housing costs. In particular, a 10,000 dollar increase in the value of the future home may be hedged if a homeowner also receives 10,000 dollar more on his current home when he moves house (i.e. ignoring transaction costs).

The aim of Chapter 4 is to investigate the size and development of house price risk and the hedging benefits of homeownership in the Netherlands. The results in this chapter are based on a unique dataset consisting of all administrative transaction prices of existing homes that are sold in the Netherlands over the period 1995-2008. This dataset also contains information on both the type of house that is sold and its location.

This chapter provides novel evidence with regard to three important dimensions of house price risk: market segment, time, and location. In particular, house price risk may be different for an owner of a villa than for an owner of an apartment. Moreover, we show empirical evidence whether house price volatility is highest during an economic boom or

[1] For instance, real house prices in the US decreased by about 31 percent between 2005 and 2008, while they increased by about 73 percent in the years before 2005 (see Sinai and Souleles, 2009). Moreover, the variation of house price changes across locations and market segments may be additional sources of house price risk.

economic bust. Furthermore, risk may be spatially related. We investigate whether there is a core-periphery pattern in risk and returns.

The hedging benefits of homeownership are also based on the aforementioned three dimensions. We argue that the hedging benefits depend on whether a homeowner plans to move to a rental unit or decides to buy a new home in the future. The former homeowner may only be intertemporally hedged against house price risk. Instead, the latter homeowner may also have a cross-location hedge and, if he buys another type of house, a cross-market segment hedge against house price risk.

The findings reported in this chapter are important because they provide evidence whether, where, and when homeowners should be especially on guard against house price risk. In particular, if homeowners are not fully aware of house price risk due to a lack of knowledge or financial illiteracy (i.e. see Van Rooij et al., 2011; Lusardi and Mitchell, 2007), information on the nature of this risk will be extremely valuable, also for policy makers and mortgage lenders. In addition, if this risk does not turn out in the homeowner's favor, it may well limit the amount of housing they can buy in the future and could ultimately affect their pension wealth. These effects may be sizeable since a substantial amount of the wealth of households is invested in housing. For instance, households in the US hold about 34 percent of their total net wealth in net home equity, but this amount can be as high as 62 percent in the UK (Banks et al. 2002). In comparison, households in the Netherlands hold about 56 percent of their total net worth in net housing equity (Jäntti and Sierminska, 2007).

The results in this chapter are also central to the debate on the risk-reducing benefits of a derivatives market. Although there is an increasing amount of literature on this topic, the main advocates of the establishment of such markets have been Case et al. (1991) and Shiller (2008). In particular, cash-settled futures based on house price indices could be used to hedge against house price risk, which would allow homeowners and other investors in housing to manage this risk. The results on the hedging benefits of homeownership reported in this chapter are important since these benefits could explain why a derivatives market based on house prices may have failed to take off (e.g. also see Sinai and Souleles, 2009).

Finally, the findings in this chapter are interesting since, in contrast to previous studies, the analysis in this chapter is comparable to a highly disaggregated within-MSA investigation. For instance, Sinai and Souleles (2009) investigate the hedge quality of home owning across Metropolitan Statistical Areas (MSAs) in the US. Instead, the Netherlands is comparable in terms of population (about 16.5 million in 2009) to large MSAs such as the New York MSA (about 19 million in 2009), but it is about two times as large in terms of land size (13,000 square miles). In addition, the Netherlands has about 441 municipalities, while the New York MSA consists of 23 counties. In accordance with a MSA, the Netherlands has an urban core and a periphery. An investigation of house price risk based on returns per MSA could aggregate out most of the variability in house prices that are relevant to homeowners, since most homeowners may decide to move within their current place of residence. In particular, Sinai and Souleles (2009) report that about four-fifth of households who move within a five-year period will stay within the MSA they currently live in.

The remainder of this chapter is organized as follows. Section 4.2 discusses the previous literature. Section 4.3 considers the underlying theory. Section 4.4 outlines the empirical strategy. Section 4.5 discusses the data. Section 4.6 reports some stylized facts on house price levels and house price changes in the Netherlands. Section 4.7 shows some descriptive statistics on house price risk and the hedge against this risk. Section 4.8 discusses house price risk and the hedging benefits of homeownership based on regression analysis. Section 4.9 concludes.

4.2 Previous literature

Although house price risk is an important phenomenon, the literature on house price risk is scarce. In a seminal paper, Sinai and Souleles (2005) argue that owner-occupied housing may act as a hedge against rent risk. Sinai and Souleles (2005) conclude that homeownership is only risky if 1) the expected length of stay is short and 2) housing markets have a low spatial correlation. Sinai and Souleles (2005) show empirical evidence that an increase in the net (of sale price risk) rent risk increases homeownership and house prices in the US.[2] However, they do not investigate house price risk in further detail.

In an important follow-up study, Sinai and Souleles (2009) argue that house price risk may be lower than conventionally assumed since homeowners are hedged against house price risk if they move house and buy a new home. They argue that the hedge quality, which is measured by the correlation between house price growth series per MSA, may be higher than previously considered since households tend to move to correlated housing markets. That is, the correlations weighted by migration between MSAs is higher than the unweighted average correlation. Moreover, Sinai and Souleles (2009) find that homeownership is positively affected by the moving-hedge quality, but that this effect is lower if the chance to move decreases.

[2] Hilber (2004) finds similar evidence. He shows that higher housing investment risk due to changes in neighborhood amenities has a negative impact on the probability of homeownership in the US.

The results of Sinai and Souleles (2005; 2009) are closely related to the concept of hedging demand for housing. In particular, Han (2008; 2010) argues that housing demand may decrease if house price uncertainty increases. Instead, housing demand may increase if the hedging demand for housing is high. In particular, she argues that the hedging benefits of homeownership may be high if a household moves to a larger home in a correlated housing market. In an important paper, Han (2010) finds evidence of this financial risk effect versus hedging effect in the US. In addition, Banks et al. (2010) argue that house price risk may create a hedging demand against this risk early in life. They find that homeowners in the UK and the US own their first home at a younger age at places where house price risk is relatively high.

Since house price risk may be substantial, some researchers have suggested the use of housing price derivatives, such as futures and options, or the short selling of real-estate stocks to hedge house price risk (i.e. see Case et al., 1991; Englund et al., 2002; Iacoviello and Ortalo-Magné, 2003; Shiller (2008). However, as mentioned by Sinai and Souleles (2009), the homeowner could be easily "unhedged" by the use of a simple derivative since the homeowner is already naturally hedged against house price risk. A more complex investment strategy may be necessary, depending on the housing equity position and future housing plans of the homeowner, to adequately hedge against house price risk.

Finally, there is also some literature that suggests that house price risk may be related to other types of risk. For instance, Chan (2001) discusses the risk of lock-in of credit-constrained households due to the price drops after the US recession in the 1990s. In particular, Chan shows that these negative price changes reduced residential mobility in the 1990s. In addition, such decreases in house price also increases the risk of default.[3] Both the risk of default and lock-in are more likely to occur during a recession since income shocks and house price shocks are usually positively correlated. The above discussion suggests that price changes may be associated with different types of risk and that these risks may be interrelated. In this chapter, we only investigate the volatility in house prices, house price risk, which is just part of the risk of owning a home.

4.3 Theory

This section examines house price risk and the hedging benefits of homeownership from a

[3] Especially negative net housing equity may deter residential mobility (see Henley, 1997). However, negative equity is a necessary, but not a sufficient condition for default (Foote et al., 2008). In particular, the risk of default (i.e. foreclosure) may be relatively high if homeowners are locked-in and, for instance, lose their job.

theoretical perspective.

Assume that the homeowner paid $-p_t^{A,r}$ when he bought the home at time *t*. The house is located at location *A* and it is of house type *r*. The homeowner receives $\tilde{p}_{t+s}^{A,r}$ at time $t+s$ when he sells the house. Hence, s is the expected length of stay at time t, where $s>t$. The selling price of the current home $\tilde{p}_{t+s}^{A,r}$ is uncertain at time t, which is indicated by the tilde sign. Since the sale price is uncertain, the homeowner faces a sale price risk. This risk is only important to a homeowner if he considers at time t to move at time $t+s$.[4]

Homeownership is typically a persistent state. If a homeowner moves, he tends to stay a homeowner.[5] In particular, about 82 percent of those Dutch homeowners who want to move within two years prefer to buy a house instead of renting a house.[6] The homeowner pays $\tilde{p}_{t+s}^{B,c}$ for his new house at time $t+s$. This house is located at location *B* and is of type *c* (which may be of the same type as the current home). Since both the selling price and buy price are future pay-offs, they are discounted by δ^{t+s}, with $\delta \leq 1$. Summarizing, the homeowner's total value position in housing is

$$Total_{A,B,r,c,t,s} = -p_t^{A,r} + \delta^{t+s}(\tilde{p}_{t+s}^{A,r} - \tilde{p}_{t+s}^{B,c}). \tag{4.1}$$

Equation (4.1) resembles, in simplified form, the cost of owning as stated in Sinai and Souleles (2005).[7]

Several aspects of owning a home are ignored in equation (4.1). In particular, previous residence spells are not incorporated in equation (4.1) since the resulting pay-offs are already realized and, consequently, do not attribute to house price risk. In addition, it ignores the pay-offs of future residence spells after $t+s$. Moreover, transaction costs are not incorporated in equation (4.1). A further issue is that only a few homeowners may have purchased the house outright. Nevertheless, equation (4.1) does not take into account the effect of the mortgage on

[4] The homeowner does not sign a binding contract with regard to his future plans. The homeowner may postpone the sale of the current home or he may move to another type of house (location) than he originally planned. If a homeowner considers at time *t* to move at time *t+s*, but at time *t+s* he does not move, due to for instance a change in preferences or hyperbolic preferences (i.e. see Laibson, 1997), the homeowner still incurred house price risk from an ex ante point of view (i.e. at time *t*).

[5] Two reasons for the persistence in homeownership are a tax benefit as a result of owning a home or more utility from owner-occupied housing consumption than rental housing consumption.

[6] Source (dataset): WoON 2006.

[7] The cost of owning as stated in Sinai and Souleles (2005) is equation (4.2) times minus 1. However, Sinai and Souleles also incorporate the subsequent sale price of the future home at location *B*, but not the buy price at location *C* (or further residence spells). As a consequence, an additional risk is introduced in their equation that is not hedged. We ignore this additional risk. Moreover, we incorporate the type of house in our analysis.

house price risk (i.e. leverage). In addition, we do not focus on homeowners who possess multiple houses at a particular point in time. Equation (4.1) also does not incorporate other assets, such as stocks and bonds.[8] Moreover, the focus in equation (4.1) is on housing as an investment, even though housing is also a consumption good.[9]

House price risk is measured by the variance of the total housing assets reported in equation (4.1):

$$VAR(Total_{A,B,r,c,t,s}) = \delta^{2(t+s)}[\sigma^2_{A,t+s,r} + \sigma^2_{B,t+s,c} - 2COV(\tilde{p}^{A,r}_{t+s}, \tilde{p}^{B,c}_{t+s})], \tag{4.2}$$

where $-p^{A,r}_t$ is assumed to be known at time t, and $VAR(\tilde{p}^{A,r}_{t+s}) = \sigma^2_{A,t+s,r}$, $VAR(\tilde{p}^{B,r}_{t+s}) = \sigma^2_{B,t+s,r}$.

Equation (4.2) consists of several terms. Each of those terms is a determinant of house price risk. The first important factor in house price risk is the discount factor. The discount factor reflects the opportunity cost of the housing investment, such as renting. A homeowner with a lower discount factor may have a lower house price risk.[10]

The second main determinant of house price risk is the volatility in the house price of the current and future home (i.e. $\sigma^2_{A,t+s,r}$ and $\sigma^2_{B,t+s,c}$). In particular, equation (4.2) implies that this volatility depends on the current and future type of house, the current and future place of residence, the time t the homeowner bought the home, and the time s the homeowner planned to sell the old home and buy a new home.

The third key aspect of house price risk is the expected length of residence. In particular, house price risk is discounted more if the expected length of residence is higher. However, an increase in the length of residence may also increase $\sigma^2_{A,t+s,r}$ and $\sigma^2_{B,t+s,c}$ since there may be more house price shocks that contribute to house price risk. If the former effect outweighs the latter effect, house price risk converges to zero for a homeowner who never plans to move (i.e. length of residence towards infinity), which is in accordance with Sinai and Souleles (2005).

The final important term in equation (4.2) is the covariance term. The covariance term suggests that the homeowner may be hedged against house price risk if he moves house and buys a new home. As is evident from equation (4.2), the hedge against house price risk depends on where the homeowner currently lives and where this homeowner wants to move

[8] See, for instance, Englund et al. (2002) for the portfolio choice of homeowners.
[9] For a discussion on consumption demand versus investment demand, see Ioannides and Rosenthal (1994).
[10] The discount factor itself may be uncertain, which is ignored in equation (4.2).

to in the future. In particular, the current house acts as a cross-location hedge against the uncertainty in the price of the future house. In contrast to standard investors, repeated homeowners benefit from a positive covariance between house price series across locations. In addition, a homeowner who buys another type of house may have a cross-market segment hedge against house price risk. That is, the hedging benefits for this homeowner are higher if house price changes between market segments are similar. Finally, the homeowner may have a delta hedge related to the time on the market. However, for simplicity, equations (4.1) and (4.2) ignore the delta hedge (i.e. the homeowner sells the current home and buys the new home simultaneously at time $t+s$).

There are several further aspects of house price risk that are not directly evident from equation (4.2). First, house price risk may depend on the tenure choice. A homeowner who sells his home and becomes a renter may only face the term $\sigma^2_{A,t+s,r}$. A household that currently rents a home and buys a new home may face a similar type of risk with regard to the buy price of the house, $\sigma^2_{B,t+s,r}$. Both types of homeowners may also have to deal with rent risk. Specifically, owner-occupied housing may provide a hedge against rent risk, which is not directly incorporated in equation (4.2).[11]

A second aspect is that equation (4.2) seems to suggest that a homeowner who sells his home and becomes a renter may not be hedged against house price risk. Instead, we argue that this homeowner may be intertemporally hedged against price changes. In particular, the price at period $t+s$ is based on the accumulated price changes between t and s. Hence, the variance term $\sigma^2_{A,t+s,r}$ consists of the (co)variance terms of the price changes between t and s. Consequently, price changes that cancel out over time (i.e. negative covariance terms) may result in a reduction of total house price risk. Alternatively, price changes may also be amplified by previous price changes, which would lead to more house price risk. A homeowner who plans to buy a new house may also be intertemporally hedged against house price risk at locations *A* and *B*. However, if price changes are the same at locations *A* and *B* (conditional on the type of house), this homeowner is perfectly hedged against these price changes. In this case, the intertemporal hedge is only relevant for the homeowner who moves to a rental unit in the future.

The third aspect of house price risk that is not directly apparent from equation (4.2) is that house price risk depends on the information set of the homeowner at time t. In particular,

[11] For a discussion, see Sinai and Souleles (2005).

the volatility of the total housing assets position is a conditional volatility. Hence, a homeowner who has intrinsic knowledge about house price change and uses this knowledge to accurately predict those changes may have a lower house price risk. In addition, if a homeowner has at least some understanding about the future volatility of price changes, he may use this knowledge to make an informed investment decision. Hence, financial literacy may play an important role in dealing with house price risk. As mentioned, this study may enhance the homeowner's information on house price risk.

Finally, equation (4.2) only captures house price risk. The welfare implications of house price risk depend on the homeowner's utility function. Sinai and Souleles (2005) use an expected utility framework based on the household's wealth and the cost of owning. If homeowners are risk averse, house price risk is detrimental for their welfare.

4.4 Empirical strategy and hypotheses

4.4.1 The aspects of house price risk that are investigated in this study

As mentioned in the theory part of this chapter, there are multiple aspects that influence house price risk. We will only investigate some of these aspects in this chapter. Although an approach that would encompass all elements of house price risk would be invaluable, there is no study to date that incorporates all determinants of house price risk.

This study focuses on the volatility of house price changes to investigate house price risk and the hedging benefits of homeownership. As such, we will analyze the patterns in some of the determinants of house price risk, not total house price risk for each individual homeowner. In particular, a homeowner who sells his house at location *A* and buys another home at location *B* should take into account *both* the volatility of house price at location *A* and location *B*. This study only investigates how large volatility is at location *A* and *B*, and the extent to which this volatility differs between these two locations. As mentioned, house price risk for this homeowner also depends on the time the current house is sold, the time the new home is bought, and the current versus future type of house. As a result, we will examine whether house price volatility changes over time and, more interestingly, whether it differs across types of houses.

A further issue for this type of homeowner is that he may be hedged against house price risk. As mentioned, Sinai and Souleles (2009) calculate correlations between MSA house price growth series. However, we argue that the hedging benefits of homeownership are not based on the equivalence of percentage returns across locations, but whether the change in the *total* value of the house is sufficient to hedge the risk of value changes in the new house. As a result, we will mainly use the differences in nominal house price changes, not percentage changes, to examine house price risk and the hedging benefits of homeownership. In addition, we do not focus on price levels. In particular, a different level of house prices at location *A* versus location *B* may already exist before the homeowner bought the house, for instance, due to differences in local market conditions. Specifically, especially the change in the difference in house price levels across locations contributes to house price risk. Finally, Han (2010), proxies the hedging incentive by the probability to trade up within the same market in a five year time span. Hence, in contrast to this chapter, both the study of Sinai and Souleles (2009) and Han (2010) do not quantify the hedge quality or how large the volatility in house price, for instance in comparison to the housing investment, may be.

As mentioned, the length of residence may also play an important role through its multiplier effect on the discount factor and its impact on the volatility of house prices and the hedge. As a result, Sinai and Souleles (2009) use migration patterns (the chance to move) to weight the correlations. However, the migration weights may be endogenously determined by the measure it is supposed to weight. Specifically, residential mobility itself may be determined by (relative) house price changes (see for instance Han, 2010). Instead, we will use distance between housing markets to capture that homeowners may not move randomly across locations.

Han (2010) uses a five year time horizon to estimate the future volatility using a GARCH setup. In this chapter, price changes at a yearly level are utilized to investigate the volatility of those changes. As is discussed by Bernartzi and Thaler (1995) in relation to the equity premium puzzle, it might be that an asset is kept for a prolonged period of time, but is evaluated over a shorter time horizon. For instance, a homeowner may move at the year $t+s$, but he may (re)evaluate his asset position each year. A yearly evaluation horizon would be in accordance with the tax system in the Netherlands (i.e. yearly tax payments). In addition, a benefit of this approach is that it allows us to analyze house price risk across time even if the time dimension in the dataset is limited. However, the length of residence also reduces house price risk through the discount factor. Both the study of Sinai and Souleles (2009) and Han (2010) do not investigate the effect of the discount factor on house price risk, although they do make some correction for the expected time horizon. The exact impact of the length of residence and the discount factor on house price risk are, although interesting, out of the scope of this text. Nevertheless, we will show some results that are related to a longer expected investment horizon than one year (i.e. chance of negative returns, value at risk, long term relative capital gains).

The theory section also suggested that the tenure choice determines house price risk and the hedging benefits of homeownership. In particular, a homeowner who rents his next home (or currently rents a home) may face rent risk. In contrast to Sinai and Souleles (2005), we do not investigate rent risk in further detail. Rent risk may be of less importance in the Netherlands, versus for instance the US, since the Dutch housing market is characterized by a large social rental sector. In this sector, rents are highly regulated. As a result, especially the volatility of house prices is of interest for this type of Dutch homeowner. Moreover, Sinai and Souleles (2005; 2009) argue that the tenure choice may itself be affected by house price risk and the hedge against this risk. In this chapter, we will not investigate the impact of house price risk on the tenure choice in further detail.

A further issue is the scale of aggregation used in this chapter. We will mainly examine house price changes across municipalities (types of houses and years). In particular, if the homeowner has some knowledge about the local housing market at his current place of residence, it may especially be the variation in price changes across housing markets that is of interest (risky) to the homeowner. This approach is a substantial improvement in comparison to Sinai and Souleles (2009) and Han (2010) (i.e. MSA level data). However, it may still be that we aggregate out some of the volatility in house prices that may be of interest to the homeowner. Therefore, as an extension, we will also investigate the volatility of price changes across zip codes and estimate regressions based on a sample of repeat sales.

A final issue is that house price risk depends on the information set of the homeowner. As mentioned, Han (2010) uses the GARCH regression setup. In this approach, it is assumed that the homeowner knows past volatility and uses this volatility to predict future volatility. Instead, the empirical analysis in this chapter consists of two parts. In the first part, we will focus on some simple descriptive statistics, such as the standard deviation of price changes and relative price changes, to quantify house price risk and the hedge quality. In this part, all changes in house price are assumed to be risky. These descriptive statistics are discussed in further detail in the empirical analysis. In the second part, we use regression analysis to formally test the patterns discussed in the first part. In addition, we will use the regressions to condition on the part of the house price changes that may not be risky. To some extent, this approach will provide insight in the reduction of house price risk if the homeowner's information on house price changes would increase. The regression methodology is discussed in further detail below.

4.4.2 The persistence in house prices

We start the regression analysis with an investigation of the persistence in house prices. Assume that house prices follow the AR(1) process

$$p_{i,t,r} = \mu_{i,t,r} + \varphi_{i,t,r} p_{i,t-1,r} + \varepsilon_{i,t,r} , \qquad (4.3)$$

where $p_{i,t,r}$ is the median transaction price (in euros) at municipality i ($i = 1,...,I$), house type r ($r = 1,...,R$), and year t ($t = 1,...,T$), $\mu_{i,t,r}$ is a municipal, time and house type specific intercept, $\varphi_{i,t,r}$ is the house price persistence parameter, and $\varepsilon_{i,t,r}$ is the error term. Although the error term is assumed to be i.i.d., we will also investigate whether there is for instance serial correlation in the error term.

The panel model in equation (4.3) is too general to identify all of the parameters. As a result, we will estimate the following restricted version of equation (4.3):

$$p_{i,t,r} = \alpha_i + \tau_t + \gamma_r + \varphi p_{i,t-1,r} + \varepsilon_{i,t,r} , \qquad (4.4)$$

where α_i is a municipal-specific intercept (municipality dummies), τ_t are common time shocks (time dummies) and γ_r is an intercept specific to the type of house (house type dummies). Hence, we assume that the intercept in equation (4.3) is additively separable in the aforementioned elements. For simplicity, we also restrict the persistence parameter $\varphi_{i,t,r}$, such that it is not specific to the type of house, time, or location. We estimate φ along the lines of Arellano-Bond (1991), since the standard strict exogeneity assumption in equation (4.4) is violated.[12] [13]

If house prices are persistent, the current price does not contain additional information for the homeowner to predict the changes in the future price. In this case, house price shocks have a persistent effect on house prices. Especially those shocks may contribute to house price risk. As a result, our first hypothesis is

[12] We also estimated equation (4.4) per type of house. However, the house price was highly persistent for each of the sub-equations. Consequently, we decided to estimate the relatively simple regression model in equation (4.4).
[13] We also investigated whether a second lag of house prices should be included in equation (4.4). However, this second lag was statistically insignificant.

Hypothesis 4.1: *House prices are persistent.*

If house prices are persistent (i.e. $\varphi = 1$), we can rewrite equation (4.4) to

$$\Delta p_{i,t,r} = \alpha_i + \tau_t + \gamma_r + \varepsilon_{i,t,r}. \tag{4.5}$$

We will use equation (4.5) to estimate the location-specific, time-specific, house type specific, and house price shock component in house price changes. This model will be mainly utilized to examine the hedge against house price risk. With regard to the error term, we assume that the standard strict exogeneity assumption holds $E(\varepsilon_{i,t,r} | \alpha_i, \boldsymbol{\tau}, \gamma_r) = 0$, where $\boldsymbol{\tau}$ captures all τ_t.

4.4.3 House price risk

This chapter investigates the volatility of house price returns, which is one of the main determinants of house price risk. From a regression perspective, we estimate the following model:

$$\varepsilon^2_{i,t,r} = \alpha_{i,2} + \tau_{t,2} + \gamma_{r,2} + \xi_{i,t,r} \ , \tag{4.6}$$

where $\xi_{i,t,r}$ is the error term, which is assumed to be i.i.d. and strictly exogenous, and $\varepsilon^2_{i,t,r}$ is the squared error term from equation (4.5). The subscript 2 indicates that the parameters from equation (4.6) may differ from those of equation (4.5).

Equation (4.6) implies that especially house price shocks may contribute to house price risk, while α_i, τ_t, and γ_r in equation (4.5) are not assumed to be risky. Since $E(\varepsilon^2_{i,t,r} | \alpha_i, \boldsymbol{\tau}, \gamma_r) = \text{var}(\varepsilon_{i,t,r} | \alpha_i, \boldsymbol{\tau}, \gamma_r) = \sigma^2_{i,t,r\varepsilon}$ due to the strict exogeneity assumption and $\text{var}(\varepsilon_{i,t,r} | \alpha_i, \boldsymbol{\tau}, \gamma_r) = \text{var}(\Delta p_{i,t,r} | \alpha_i, \boldsymbol{\tau}, \gamma_r)$, we can use the model in equation (4.6) to investigate all the aforementioned dimensions of the volatility of house price changes. Specifically, we will formally test whether house price risk differs across types of houses, years, and municipalities in the Netherlands:

Hypothesis 4.2 (market segment): *The volatility of house price changes is the same across types of houses.*

Hypothesis 4.3 (time): *The volatility of house price changes is constant across years.*

Hypothesis 4.4 (location): *The volatility of house price changes does not differ across municipalities.*

We examine these hypotheses using the standard Breusch-Pagan test. Specifically, we test the significance of $\alpha_{i,2}$, $\tau_{t,2}$, and $\gamma_{r,2}$ to test the null hypotheses $\sigma^2_{i,t,r}\varepsilon = \sigma^2_{i,t}\varepsilon$, $\forall r$; $\sigma^2_{i,t,r}\varepsilon = \sigma^2_{i,r}\varepsilon$, $\forall t$; and $\sigma^2_{i,t,r}\varepsilon = \sigma^2_{t,r}\varepsilon$, $\forall i$, where we replace $\varepsilon^2_{i,t,r}$ with its estimate, the squared residual from equation (4.5).

4.4.4 The hedge against house price risk

The hedge against house price risk will be investigated based on equation (4.5). In particular, equation (4.5) is used to estimate whether price changes are the same across types of houses, years, and municipalities in the Netherlands:

Hypothesis 4.5 (market segment): *The cross-market segment hedge is perfect.*

Hypothesis 4.6 (time): *The intertemporal hedge is perfect.*

Hypothesis 4.7 (location): *The cross-location hedge is perfect.*

If the hedge against house price risk is perfect, the ratio of house price changes between two types of houses, time periods, or locations will be equal to one. We will use two approaches to investigate these relative house price changes. In the first approach, we will test the significance and equality for each of the terms α_i, γ_r, τ_t using standard t-tests and F-tests. Specifically, the term γ_r captures differences in price changes across market segments. If there are no disparities in price changes across market segments, $\gamma_1 = \gamma_2 = ... = \gamma_R$, the cross-market segment hedge is perfect. The time-specific intercept τ_t captures the common part of house price changes across municipalities. As mentioned, a homeowner who buys a new home may be perfectly hedged against these common price changes. However, we will investigate whether price changes have a tendency to cancel out over time, $\sum_t^T \tau_t = 0$, which will provide us with some valuable insight about the quality of the intertemporal hedge against house price risk. Finally, the municipal-specific intercept α_i captures the heterogeneity in returns across municipalities. The cross-location hedge for a homeowner who buys a new home in the future is perfect if there are no differences in price changes across municipalities, $\alpha_1 = \alpha_2 = ... = \alpha_I$.

The first approach is more in line with the descriptive statistics part in which the total house price change is assumed to be risky. An alternative method is to examine the error structure in equation (4.5). That is, house price shocks may be an important determinant of house price risk. Equation (4.6) only investigates the structure in the diagonal of the error variance-covariance matrix. Instead, the off-diagonal part of this matrix, the covariances across market segments, time periods, and municipalities, are interesting from a hedging perspective. As a result, we will also estimate regressions of the following form:

$$\left.\begin{aligned} \varepsilon_{i,t,r} &= a_1 + \rho_1 \varepsilon_{i,t,r-1} + \chi_{1,i,t,r} \\ \varepsilon_{i,t,r} &= a_2 + \rho_2 \varepsilon_{i,t-1,r} + \chi_{2,i,t,r} \\ \varepsilon_{i,t,r} &= a_3 + \rho_3 \varepsilon_{Amsterdam,t,r} + \chi_{3,i,t,r} \end{aligned}\right\}, \qquad (4.7)$$

where $\chi_{1,i,t,r}$, $\chi_{2,i,t,r}$, and $\chi_{3,i,t,r}$ are the error terms, which are again assumed to be i.i.d. We are especially interested in the ρ_k terms. In particular, negative serial correlation in the error term $\varepsilon_{i,t,r}$, a negative ρ_2, quantifies the extent to which house price shocks cancel out over time (i.e. the intertemporal hedge). In addition, the hedge against house price shocks across types of house and municipalities is perfect if $\rho_1 = 1$ and $\rho_3 = 1$, respectively, for all pairs of house types or municipalities. Nevertheless, we will not investigate all ρ_k coefficients between types of houses, time periods, or municipalities. With regard to the type of house, we will only focus on the natural ordering indicated by the property ladder (i.e. Apartment–Row houses, Row houses–Corner houses, Corner houses–Semi-detached houses, Semi-detached houses–Detached houses).[14] In addition, we will only estimate the ρ_2 of a simple AR(1) model. Finally, since there is no natural ordering in the error term regarding the municipality dimension, we will report the average estimate of ρ_3 across municipalities with $\varepsilon_{Amsterdam,t,r}$ as independent variable.[15]

[14] Homeowners may be most likely to move in accordance with the property ladder. In addition, with respect to the other house type pairs, we find that the rho coefficients are statistically insignificant.
[15] A natural extension of the equations in (4.4)-(4.7) is to use spatial weights. Although a regression model that incorporates spatial weights would surely be interesting, such an extension is out of the scope of this text.

4.4.5 A repeat sales approach

Although the previous models are appealing for their simplicity, they ignore the variation in individual transaction prices. As a result, we also re-estimate equations (4.5) and (4.6) based on a sample of repeat sales:

$$\left.\begin{aligned}\Delta p_{h,t,m,i,t,r} &= \alpha_{i,3} + \tau_{t,3} + \gamma_{r,3} + m_t + \varepsilon_{h,t,m,i,t,r} \\ \varepsilon^2_{h,t,m,i,t,r} &= \alpha_{i,4} + \tau_{t,4} + \gamma_{r,4} + m_{t,2} + \xi_{h,t,m,i,t,r}\end{aligned}\right\}, \qquad (4.8)$$

where $\Delta p_{h,t,m,i,t,r}$ is the *yearly* house price change for house *h* if it is sold for a second (third, fourth, etc.) time at year *t* and month *m*. Again, the price change is allowed to be municipal specific, time specific and house type specific. Both $\varepsilon_{h,t,m,i,t,r}$ and $\xi_{h,t,m,i,t,r}$ are error terms, which are assumed to be i.i.d. Moreover, the volatility model uses the squared error term from the price changes model as dependent variable. Both equations include month of transaction dummies to estimate the calendar effects m_t and $m_{t,2}$. The subscript 3 and 4 indicates that the coefficients in equation (4.8) may differ from the coefficients of equations (4.5) and (4.6).

The main benefit of the repeat sales approach is that, from a hedonic perspective, unobserved, time invariant characteristics of the house that determine the price of the house are differenced out.[16] The main caveat of the this methodology is that there may be an endogenous sample selection problem since the individual's housing capital gains are only observed if a homeowner moves house, which itself may crucially depend on the housing capital gains (for a discussion, see Gatzlaff and Haurin, 1998). Although it is in principle possible to correct for the sample selection bias in the estimates by modeling the transaction process (i.e. the Heckman approach, Heckman, 1979), such a correction is out of the scope of this chapter.

4.5 Data

The empirical analysis in this chapter is based on all transaction prices of existing homes in the Netherlands between 1995 and 2008. We were provided access to this dataset by Statistics Netherlands/Kadaster.[17] By law (Kadaster Act), all transaction prices are recorded by a separate institute called the Kadaster. After a transaction, the notary provided the relevant

[16] However, the equations in (4.8) do not take into account the panel structure with regard to returns.

[17] In particular, the Kadaster provided the dataset to Statistics Netherlands. Statistics Netherlands granted us access to this dataset ("Bestaande Koopwoningen 200812V1").

information to the Kadaster (e.g. date, price, location).[18] The transaction prices of newly-built homes are not included in the dataset. There are 5 types of houses available in the dataset: apartments, row/terraced houses, corner houses, semi-detached houses, detached houses. In what follows, we use for these types of houses the abbreviations AP, RH, CH, SH, DH, respectively. In some cases the type of house is unknown.

The dataset contains 2,683,130 transaction prices. If the type of house is unknown, we excluded the transaction price of that house from the dataset. Mainly due to this selection, we only use 2,486,236 transaction prices in this chapter.[19] We constructed three datasets based on these transaction prices. The first two datasets contain data at the municipal level. The third dataset is based on repeat sales. The first and main dataset is used to capture the variation in house price changes across municipalities. Instead, the second dataset includes information on differences in house price changes within the municipality. Finally, the third dataset is used to emphasize the variation in price changes at the individual level.

The first dataset is based on the median transaction price at the municipal level for each type of house and each year. There are 441 municipalities in the Netherlands (classification of 2009). The spatial distribution of these municipalities in the Netherlands (within 40 COROP regions, NUTS-3 classification) is depicted in Figure 4.1. Without missing observations there would be about 30,870 observations in this dataset (441 municipalities * 14 years * 5 types of houses). Since in some municipalities (years and types of houses) there have been no transactions,[20] and we selected those median prices that are based on at least 10 transaction prices,[21] and the analysis in this chapter is based on price changes, the dataset contains 23,627 observations at the level of the municipality.[22] The regression estimates of equations (4.6) to (4.8) are based on this dataset. Most of the descriptive statistics are also based on this dataset, but we report these statistics per type of

[18] The buyer and seller usually agree on the transaction price a few months before the official transaction. As a result, the price data is lagged 1 quarter in comparison to actual market prices.

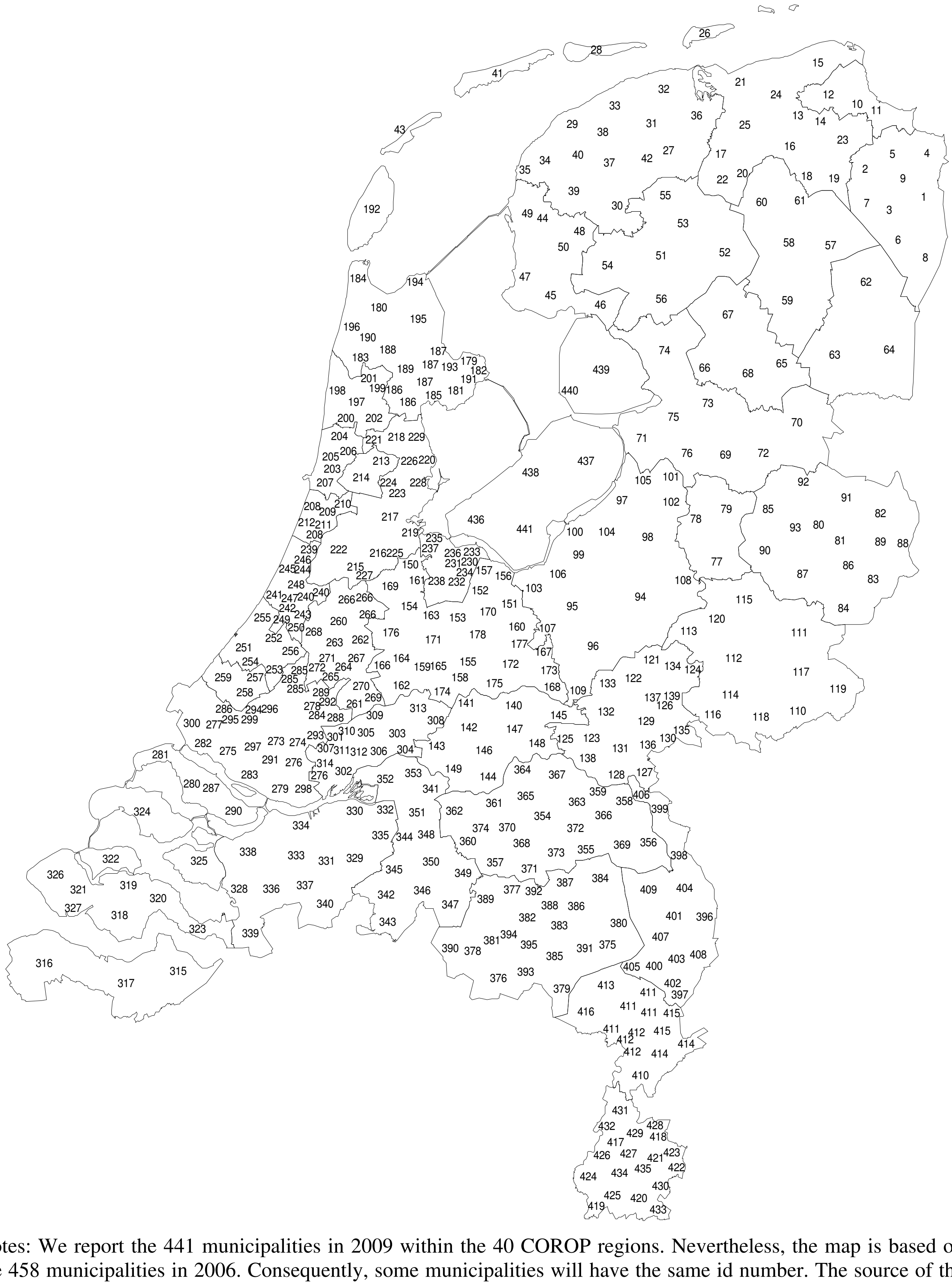
[19] In particular, the type of house was unknown in 172,432 cases (largest selection). The remaining loss of observations is due to some other minor selections. In decreasing order of importance: The transaction price of a house that was sold more than once in a particular month was deleted from the dataset. A transaction price that was smaller than 10,000 euro's or larger than 5 million euros was also excluded from the dataset. Finally, 174 of the 4-digit zip codes could not be uniquely linked to the municipal codes. The observations that had an incorrect code were deleted from the dataset.

[20] In particular, there are only 30,200 median price observations available.

[21] We imposed this restriction to avoid disclosure of individual transaction prices and to obtain reliable estimates of the median price at the municipal level. There were still 26,379 median transaction prices in this panel dataset.

[22] There are 3,048 price change observations for apartments (RH: 5,350 observations; CH: 4,880 observations; SH 5,141 observations; DH 5,208 observations).

Figure 4.1: Municipalities in the Netherlands by COROP region, 2009



Notes: We report the 441 municipalities in 2009 within the 40 COROP regions. Nevertheless, the map is based on the 458 municipalities in 2006. Consequently, some municipalities will have the same id number. The source of the municipality names is Statistics Netherlands. The 50 largest municipalities based on the population at the 1st of January 2009 have a * after the municipality name.

01 Oost-Groningen

Bellingwedde (1)
Menterwolde (2)
Pekela (3)
Reiderland (4)
Scheemda (5)
Stadskanaal (6)
Veendam (7)
Vlagtwedde (8)
Winschoten (9)

02 Delfzijl e.o.

Appingedam (10)
Delfzijl (11)
Loppersum (12)

03 Overig Groningen

Bedum (13)
Ten Boer (14)
Eemsmond (15)
Groningen * (16)
Grootegast (17)
Haren (18)
Hoogezand-Sappemeer (19)
Leek (20)
De Marne (21)
Marum (22)
Slochteren (23)
Winsum (24)
Zuidhorn (25)

04 Noord-Friesland

Achtkarspelen (26)
Ameland (27)
het Bildt (28)
Boarnsterhim (29)
Dantumadiel (30)
Dongeradeel (31)
Ferwerderadiel (32)
Franekeradeel (33)
Harlingen (34)
Kollumerland c.a. (35)
Leeuwarden * (36)
Leeuwarderadeel (37)
Littenseradiel (38)
Menaldumadeel (39)
Schiermonnikoog (40)
Terschelling (41)
Tytsjerksteradiel (42)
Vlieland (43)

05 Zuidwest-Friesland

Bolsward (44)
Gaasterlân-Sleat (45)
Lemsterland (46)
Nijefurd (47)
Sneek (48)
Wûnseradiel (49)
Wymbritseradiel (50)

06 Zuidoost-Friesland

Heerenveen (51)
Ooststellingwerf (52)
Opsterland (53)
Skarsterlân (54)
Smallingerland (55)
Weststellingwerf (56)

07 Noord-Drenthe

Aa en Hunze (57)
Assen (58)
Midden-Drenthe (59)
Noordenveld (60)
Tynaarlo (61)

08 Zuidoost-Drenthe

Borger-Odoorn (62)
Coevorden (63)
Emmen * (64)

09 Zuidwest-Drenthe

Hoogeveen (65)
Meppel (66)
Westerveld (67)
De Wolden (68)

10 Noord-Overijssel

Dalfsen (69)
Hardenberg (70)
Kampen (71)
Ommen (72)
Staphorst (73)
Steenwijkerland (74)
Zwartewaterland (75)
Zwolle * (76)

11 Zuidwest-Overijssel

Deventer * (77)
Olst-Wijhe (78)
Raalte (79)

12 Twente

Almelo * (80)
Borne (81)
Dinkelland (82)
Enschede * (83)
Haaksbergen (84)
Hellendoorn (85)
Hengelo * (86)
Hof van Twente (87)
Losser (88)
Oldenzaal (89)
Rijssen-Holten (90)
Tubbergen (91)
Twenterand (92)
Wierden (93)

13 Veluwe

Apeldoorn * (94)
Barneveld (95)
Ede * (96)
Elburg (97)
Epe (98)
Ermelo (99)
Harderwijk (100)
Hattem (101)
Heerde (102)
Nijkerk (103)
Nunspeet (104)
Oldebroek (105)
Putten (106)
Scherpenzeel (107)
Voorst (108)
Wageningen (109)

14 Achterhoek

Aalten (110)
Berkelland (111)
Bronckhorst (112)
Brummen (113)
Doetinchem (114)
Lochem (115)
Montferland (116)
Oost Gelre (117)
Oude IJsselstreek (118)
Winterswijk (119)
Zutphen (120)

15 Arnhem/Nijmegen

Arnhem * (121)
Beuningen (122)
Doesburg (123)
Druten (124)
Duiven (125)
Groesbeek (126)
Heumen (127)
Lingewaard (128)
Millingen aan de Rijn (129)
Nijmegen * (130)
Overbetuwe (131)
Renkum (132)
Rheden (133)
Rijnwaarden (134)
Rozendaal (135)
Ubbergen (136)
Westervoort (137)
Wijchen (138)
Zevenaar (139)

16 Zuidwest-Gelderland

Buren (140)
Culemborg (141)
Geldermalsen (142)
Lingewaal (143)
Maasdriel (144)
Neder-Betuwe (145)
Neerijnen (146)
Tiel (147)
West Maas en Waal (148)
Zaltbommel (149)

17 Utrecht

Abcoude (150)
Amersfoort * (151)
Baarn (152)
De Bilt (153)
Breukelen (154)
Bunnik (155)
Bunschoten (156)
Eemnes (157)
Houten (158)
IJsselstein (159)
Leusden (160)
Loenen (161)
Lopik (162)
Maarssen (163)
Montfoort (164)
Nieuwegein (165)
Oudewater (166)
Renswoude (167)
Rhenen (168)
De Ronde Venen (169)
Soest (170)
Utrecht * (171)
Utrechtse Heuvelrug (172)
Veenendaal (173)
Vianen (174)
Wijk bij Duurstede (175)
Woerden (176)
Woudenberg (177)
Zeist (178)

18 Kop van Noord-Holland

Andijk (179)
Anna Paulowna (180)
Drechterland (181)
Enkhuizen (182)
Harenkarspel (183)
Den Helder (184)
Hoorn * (185)
Koggenland (186)
Medemblik (187)
Niedorp (188)
Opmeer (189)
Schagen (190)
Stede Broec (191)
Texel (192)
Wervershoof (193)
Wieringen (194)
Wieringermeer (195)
Zijpe (196)

19 Alkmaar e.o.

Alkmaar * (197)
Bergen (198)
Heerhugowaard (199)
Heiloo (200)
Langedijk (201)
Schermer (202)

20 IJmond

Beverwijk (203)
Castricum (204)
Heemskerk (205)
Uitgeest (206)
Velsen * (207)

21 Agglomeratie Haarlem

Bloemendaal (208)
Haarlem * (209)
Haarlemmerliede c.a. (210)
Heemstede (211)
Zandvoort (212)

22 Zaanstreek

Wormerland (213)
Zaanstad * (214)

23 Groot-Amsterdam

Aalsmeer (215)
Amstelveen * (216)
Amsterdam * (217)
Beemster (218)
Diemen (219)
Edam-Volendam (220)
Graft-De Rijp (221)
Haarlemmermeer * (222)
Landsmeer (223)
Oostzaan (224)
Ouder-Amstel (225)
Purmerend * (226)
Uithoorn (227)
Waterland (228)
Zeevang (229)

24 Het Gooi en Vechtstreek

Blaricum (230)
Bussum (231)
Hilversum * (232)
Huizen (233)
Laren (234)
Muiden (235)
Naarden (236)
Weesp (237)
Wijdemeren (238)

25 Agglomeratie Leiden en Bollenstreek

Hillegom (239)
Kaag en Braassem (240)
Katwijk (241)
Leiden * (242)
Leiderdorp (243)
Lisse (244)
Noordwijk (245)
Noordwijkerhout (246)
Oegstgeest (247)
Teylingen (248)
Voorschoten (249)
Zoeterwoude (250)

26 Agglomeratie 's-Gravenhage

's-Gravenhage * (251)
Leidschendam-Voorburg * (252)
Pijnacker-Nootdorp (253)
Rijswijk (254)
Wassenaar (255)
Zoetermeer * (256)

27 Delft en Westland

Delft * (257)
Midden-Delfland (258)
Westland * (259)

28 Oost-Zuid-Holland

Alphen aan den Rijn * (260)
Bergambacht (261)
Bodegraven (262)
Boskoop (263)
Gouda * (264)
Moordrecht (265)
Nieuwkoop (266)
Reeuwijk (267)
Rijnwoude (268)
Schoonhoven (269)
Vlist (270)
Waddinxveen (271)
Zevenhuizen-Moerkapelle (272)

29 Groot-Rijnmond

Albrandswaard (273)
Barendrecht (274)
Bernisse (275)
Binnenmaas (276)
Brielle (277)
Capelle aan den IJssel (278)
Cromstrijen (279)
Dirksland (280)
Goedereede (281)
Hellevoetsluis (282)
Korendijk (283)
Krimpen aan den IJssel (284)
Lansingerland (285)
Maassluis (286)
Middelharnis (287)
Nederlek (288)
Nieuwerkerk aan den IJssel (289)
Oostflakkee (290)
Oud-Beijerland (291)
Ouderkerk (292)
Ridderkerk (293)
Rotterdam * (294)
Rozenburg (295)
Schiedam * (296)
Spijkenisse * (297)
Strijen (298)
Vlaardingen * (299)
Westvoorne (300)

30 Zuidoost-Zuid-holland

Alblasserdam (301)
Dordrecht * (302)
Giessenlanden (303)
Gorinchem (304)
Graafstroom (305)
Hardinxveld-Giessendam (306)
Hendrik-Ido-Ambacht (307)
Leerdam (308)
Liesveld (309)
Nieuw-Lekkerland (310)
Papendrecht (311)
Sliedrecht (312)
Zederik (313)
Zwijndrecht (314)

31 Zeeuwsch-Vlaanderen

Hulst (315)
Sluis (316)
Terneuzen (317)

32 Overig Zeeland

Borsele (318)
Goes (319)
Kapelle (320)

Middelburg (321)
Noord-Beveland (322)
Reimerswaal (323)
Schouwen-Duiveland (324)
Tholen (325)
Veere (326)
Vlissingen (327)

33 West-Noord-Brabant

Bergen op Zoom (328)
Breda * (329)
Drimmelen (330)
Etten-Leur (331)
Geertruidenberg (332)
Halderberge (333)
Moerdijk (334)
Oosterhout (335)
Roosendaal * (336)
Rucphen (337)
Steenbergen (338)
Woensdrecht (339)
Zundert (340)

34 Midden-Noord-Brabant

Aalburg (341)
Alphen-Chaam (342)
Baarle-Nassau (343)
Dongen (344)
Gilze en Rijen (345)
Goirle (346)
Hilvarenbeek (347)
Loon op Zand (348)
Oisterwijk (349)
Tilburg * (350)
Waalwijk (351)
Werkendam (352)
Woudrichem (353)

35 Noordoost-Noord-Brabant

Bernheze (354)
Boekel (355)
Boxmeer (356)
Boxtel (357)
Cuijk (358)
Grave (359)
Haaren (360)
's-Hertogenbosch * (361)
Heusden (362)
Landerd (363)
Lith (364)
Maasdonk (365)
Mill en Sint Hubert (366)
Oss * (367)
Schijndel (368)
Sint Anthonis (369)
Sint-Michielsgestel (370)
Sint-Oedenrode (371)
Uden (372)
Veghel (373)
Vught (374)

36 Zuidoost-Noord-brabant

Asten (375)
Bergeijk (376)
Best (377)
Bladel (378)
Cranendonck (379)
Deurne (380)
Eersel (381)
Eindhoven * (382)
Geldrop-Mierlo (383)
Gemert-Bakel (384)
Heeze-Leende (385)
Helmond * (386)
Laarbeek (387)
Nuenen c.a. (388)
Oirschot (389)
Reusel-De Mierden (390)
Someren (391)
Son en Breugel (392)
Valkenswaard (393)
Veldhoven (394)
Waalre (395)

37 Noord-Limburg

Arcen en Velden (396)
Beesel (397)
Bergen (398)
Gennep (399)
Helden (400)
Horst aan de Maas (401)
Kessel (402)
Maasbree (403)
Meerlo-Wanssum (404)
Meijel (405)
Mook en Middelaar (406)
Sevenum (407)
Venlo * (408)
Venray (409)

38 Midden-Limburg

Echt-Susteren (410)
Leudal (411)
Maasgouw (412)
Nederweert (413)
Roerdalen (414)
Roermond (415)
Weert (416)

39 Zuid-Limburg

Beek (417)
Brunssum (418)
Eijsden (419)
Gulpen-Wittem (420)
Heerlen * (421)
Kerkrade (422)
Landgraaf (423)
Maastricht * (424)
Margraten (425)
Meerssen (426)
Nuth (427)
Onderbanken (428)
Schinnen (429)
Simpelveld (430)
Sittard-Geleen * (431)
Stein (432)
Vaals (433)
Valkenburg aan de Geul (434)
Voerendaal (435)

40 Flevoland

Almere * (436)
Dronten (437)
Lelystad * (438)
Noordoostpolder (439)
Urk (440)
Zeewolde (441)

house and year.[23] The yearly average of the number of municipalities in this price change dataset is 234 for apartments (RH: 412; CH: 375; SH: 395; DH: 401). The average time dimension across municipalities is 10 years for apartments (RH: 12; CH: 12; SH: 12; DH: 12). The descriptive statistics of this dataset are discussed in further detail in sections 4.6 and 4.7.

We also calculated the median price at a 4-digit zip code level (the second dataset).[24] Without any missing observations there would be about 281,050 observations (4,015 zip codes * 14 years * 5 types of houses). However, in some zip codes (years and types of houses) there have been no transactions.[25] In addition, we selected those median prices that are based on at least 4 transaction prices per zip code and we only included a municipality in the dataset if it had at least 4 zip codes with a non-missing median price (i.e. 16 transaction prices per municipality).[26] Finally, since we focus on price changes, the total number of observations in this dataset is 66,818.[27] [28] On average, the number of municipalities in this dataset is 89 for apartments (RH: 172; CH: 131; SH: 141; DH: 167). The yearly average number of zip codes per municipality is about 10 for apartments (RH: 8; CH: 7; SH: 6; DH: 6). The average time dimension across zip codes is 10 years for apartments (RH: 10; CH: 9; SH: 7; DH: 8). As a robustness check, we use this second dataset to calculate the volatility of house price changes based on the house price variation within municipalities (i.e. Figures 4.7 and 4.8, section 4.7).

Finally, we also used a repeat sales sample to estimate the equations in 4.8. Some descriptive statistics of this sample are reported in Table 4.1. About 1,267,984 of the 2,486,236 transaction prices are associated with repeat sales (at least 2 transactions). The number of repeat sales in this sample is 722,380. This is the number of observations used to estimate the equations in (4.8). The average total housing capital gains based on the repeat sales sample have been about 60,000 euro or 60.6 percent, which is substantial. These housing capital gains have been highest for detached houses. Against an average length of residence of 4.5 years, the yearly housing capital gains have been on average 15,741 euros. As mentioned,

[23] Figures 4.4-4.6, 4.9, and 4.10 are based on this dataset. Instead, Figures 4.2 and 4.3 are based on the median price level dataset (with the restriction of 10 observations per median price).

[24] There were 4,015 unique residential zip codes in the Netherlands in 2009. The average population per 4-digit zip code was about 4,100 persons on the 1st of January 2009. Source: Statistics Netherlands.

[25] In particular, there are only 180,156 median price observations available.

[26] Again, we imposed these restrictions to avoid disclosure of individual transaction prices and to obtain reliable estimates of the median price at a zip code level and house price risk at the municipal level. There were only 87,201 median transaction prices in this panel dataset.

[27] In particular, a municipality is also excluded from the analysis if the number of zip codes within this municipality decreases below 4 due to differencing.

[28] There are 11,089 price change observations for apartments (RH: 18,441 observations; CH: 12,538 observations; SH 10,891 observations; DH 13,859 observations).

these yearly housing capital gains are used as dependent variable in the repeat sales house price change model stated in (4.8).

Table 4.1: Descriptive statistics repeat sales, 1995-2008

	Ap.	Row	Corner	Semi-Det.	Detached	Total
Repeat sales sample: 722,380 obs.	255,611	253,202	88,136	67,985	57,446	722,380
Average housing capital gains (euros)	42,383	59,315	65,154	78,818	120,226	60,715
Average housing capital gains (percentage)	57.7	57.6	60.5	67.6	78.9	60.6
Length of residence (years)	4.0	4.8	4.8	4.9	4.8	4.5
Average yearly housing capital gains (euros)	13,230	14,227	15,649	18,982	29,839	15,741

4.6 Some stylized facts

This subsection discusses some stylized facts about house price levels and house price changes in the Netherlands.

Figure 4.2: Average house price (euros, in thousands)

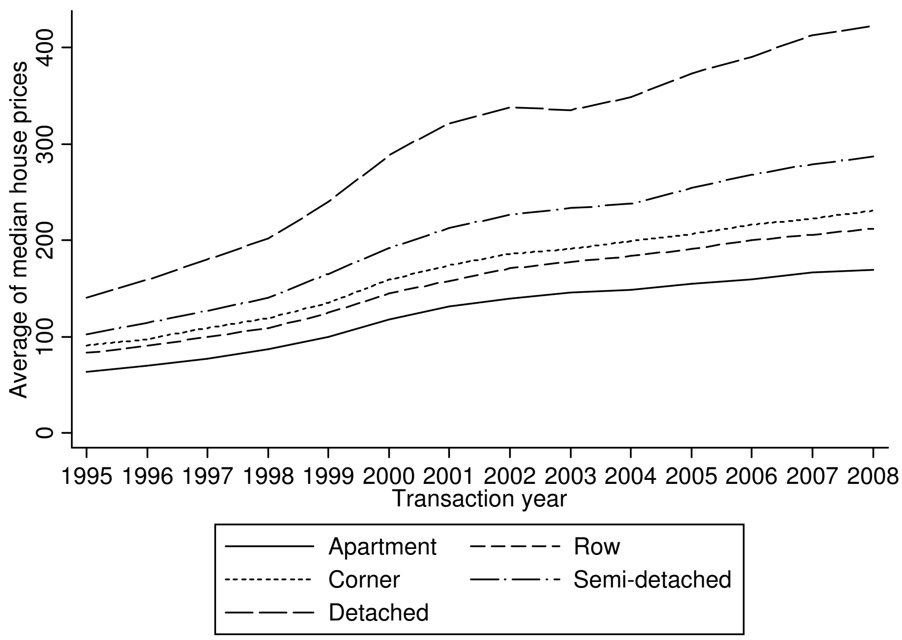


Figure 4.2 shows, per type of house and year, the average, $\overline{p}_{t,r}$, over $N_{t,r}$ municipalities of the median transaction price $p_{i,t,r}$,

$$\overline{p}_{t,r} = \frac{1}{N_{t,r}} \sum_{i=1}^{N_{t,r}} p_{i,t,r}. \qquad (4.9)$$

Figure 4.2 depicts two important aspects about house prices in the Netherlands. The first stylized fact is that the average house price between 1995 and 2008 was trending upwards in the Netherlands. Detached houses increased the most in price between 1995 and 2008, from 141,000 euros to 423,000 euros, while the price of apartments increased the least, from 64,000 euros to 170,000 euros. These results suggest that capital gains in the Netherlands have been sizeable. The second stylized fact is that there exists a property ladder in the Netherland. Detached houses are on average the most expensive (296,777 euros), while apartments are the least expensive (123,807 euros). The average house price of row houses (153,760 euros), corner houses (167,108 euros), and semi-detached houses (203,077 euros) are in between these two values.

Figure 4.3: Number of transactions (in thousands)

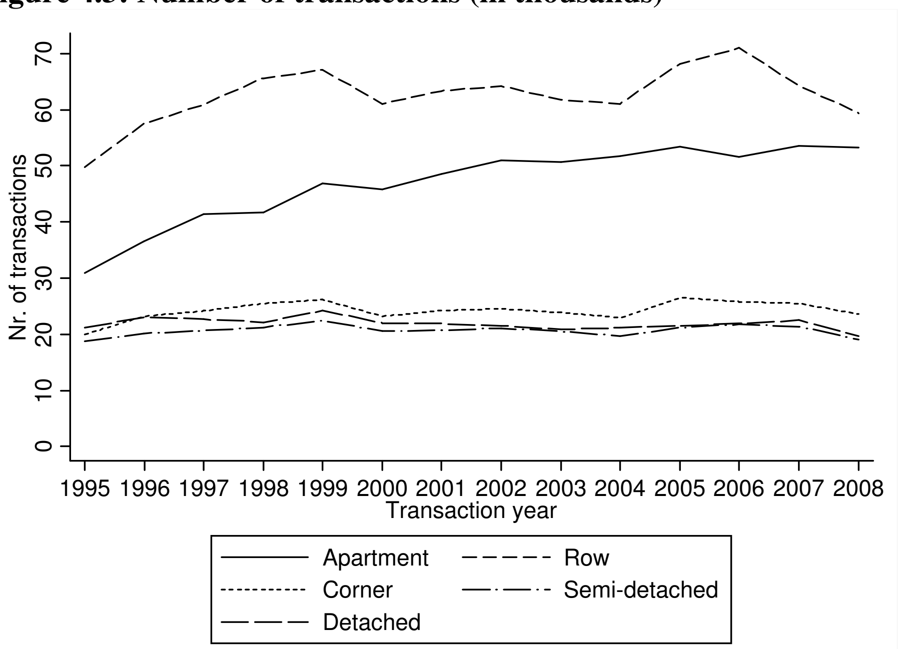
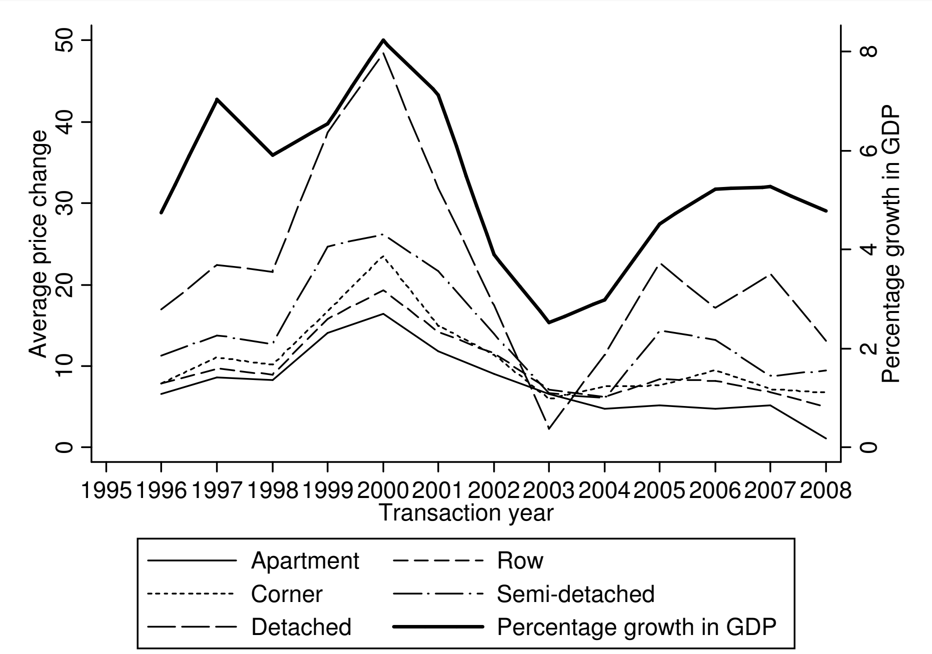


Figure 4.3 reports the total number of transactions across municipalities per type of house and year. The yearly average number of transactions between 1995 and 2008 has been about 47,500 for apartments (RH: 62,600; CH: 24,200; SH: 20,700; DH: 21,900). In accordance with the price trend reported in Figure 4.2, the total market value of these transactions has been steadily increasing in the Netherlands. This market value (i.e. sum of all transaction prices) was about 13 billion euros in 1995 and 44 billion euros in 2008. In comparison, nominal GDP was about 305 billion euros in 1995 and 596 billion euros in

2008.[29]

Figure 4.4: The business cycle and average house price changes (euros, in thousands)



Source GDP data: Statistics Netherlands. Notes: Based on GDP at market prices, current prices.

Finally, Figure 4.4 shows the business cycle in the Netherlands in terms of nominal GDP growth and the average, $\overline{\Delta p}_{t,r}$, over $M_{t,r}$ municipalities of the non-missing price changes $\Delta p_{i,t,r}$,

$$\overline{\Delta p}_{t,r} = \frac{1}{M_{t,r}} \sum_{i=1}^{M_{t,r}} (p_{i,t,r} - p_{i,t-1,r}). \tag{4.10}$$

Figure 4.4 suggests that the yearly average return is about 7,900 euros for apartments (RH: 9,900 euros; CH: 10,800 euros; SH: 14,100 euros; DH: 22,000 euros), which is somewhat lower than the average yearly price changes based on the sample of repeat sales. Price changes are the highest for detached houses, but also seem to be the most volatile. Price changes were relatively high in 1997 and 2000 (economic boom). Instead, price changes were relatively low in 2003 and 2008 (economic bust). This pattern is in accordance with the business cycle in the Netherlands.[30]

[29] GDP at market prices, current prices (Source: Statistics Netherlands).

[30] This pattern is similar if we delete the first and last percentile of the nominal price change (per year and type of house). We also obtained a similar pattern based on the average of the percentage (log-differences) house price change.

4.7 Results based on descriptive statistics

This section discusses the patterns in house price risk and the hedge against this risk based on some simple descriptive statistics. As mentioned, we formally test these patterns in the regression analysis (section 4.8).

4.7.1 The volatility of house price changes across and within municipalities

House price risk is characterized by the volatility of house price changes. We measure this volatility by the cross-sectional (over $M_{t,r}$ municipalities) standard deviation of price changes per year *t* and house type *r*,

$$sd_{(\Delta p)_{t,r}} = \left[\frac{1}{M_{t,r} - 1} \sum_{i=1}^{M_{t,r}} (\Delta p_{i,t,r} - \overline{\Delta p}_{t,r})^2 \right]^{0.5} . \qquad (4.11)$$

Hence, this measure omits the location of the house as a determinant of house price risk. The effect of location on volatility is discussed in more detail in the regression analysis. The results are depicted in Figure 4.5.

Figure 4.5 shows that the yearly average volatility of house price changes may be substantial and about 21,000 euros for apartments (RH: 11,000 euros; CH: 16,000 euros; SH: 25,000 euros; DH: 46,000 euros).[31] [32] Two times the average standard deviation divided by average price level (see section 4.6) suggests that the yearly maximum percentage of the housing investment at risk is about 34 percent for apartments (RH: 14 percent; CH: 19 percent; SH: 25 percent; DH: 31 percent).[33]

The results in Figure 4.5 also indicate that volatility seems to differ across market segments (rejection of hypothesis, 4.2). Interestingly, the volatility of price changes is highest for detached houses and lowest for row houses. These results may reflect that when markets are thin and goods are more heterogeneous (e.g. detached houses) arbitrage in those markets is less. Instead, market power and bargaining may play an important role in those markets (see Harding et al, 2003).

[31] Kramer (2010) empirically shows that leverage and a long investment horizon may substantially increase the "effective" volatility of house prices. From this perspective, this chapter may underestimate house price risk. Nevertheless, the study of Kramer (2010) only investigates house price risk based on an aggregate Dutch house price index, while especially the heterogeneity in price changes across locations (market segments) poses a risk to homeowners. As mentioned, this dissertation contributes to our knowledge about these differences.

[32] In comparison to other countries, the house price volatility in the Netherlands may be similar to the relatively volatile UK housing market, while the US is substantially less volatile (see Catte et al., 2004).

[33] In particular, two standard deviations may capture most of the below average price changes.

Figure 4.5: The volatility of house price changes (euros, in thousands)

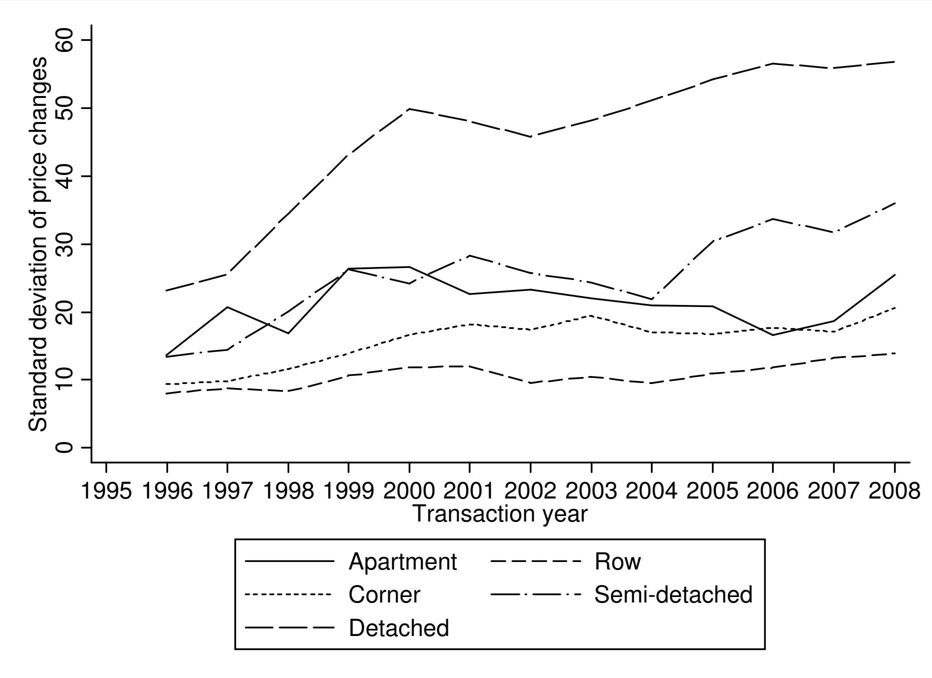


Figure 4.5 also suggests that the volatility of house price changes is not constant over time (rejection of hypothesis 4.3). In particular, the volatility of house price changes seems to have increased over the sample period for most types of houses. Moreover, house price risk shows a peak for apartments and row houses in 1997. In addition, this risk peaks around 1999-2001 for all house types. Moreover, the economic downturn in 2003 is associated with high a high volatility for row houses and corner houses. Furthermore, this risk seems to have increased in 2008 relative to 2007 for all types of houses, which may reflect the price uncertainty as a result of the financial crisis. In sum, these results suggest that there is some evidence of a boom-bust pattern in the volatility of house price changes.

Since risk is not without returns, Figure 4.6 divides the standard deviation of price changes (Figure 4.5) by the average yearly return (Figure 4.4) to calculate the coefficient of variation, which is a unitarized measure of risk,[34]

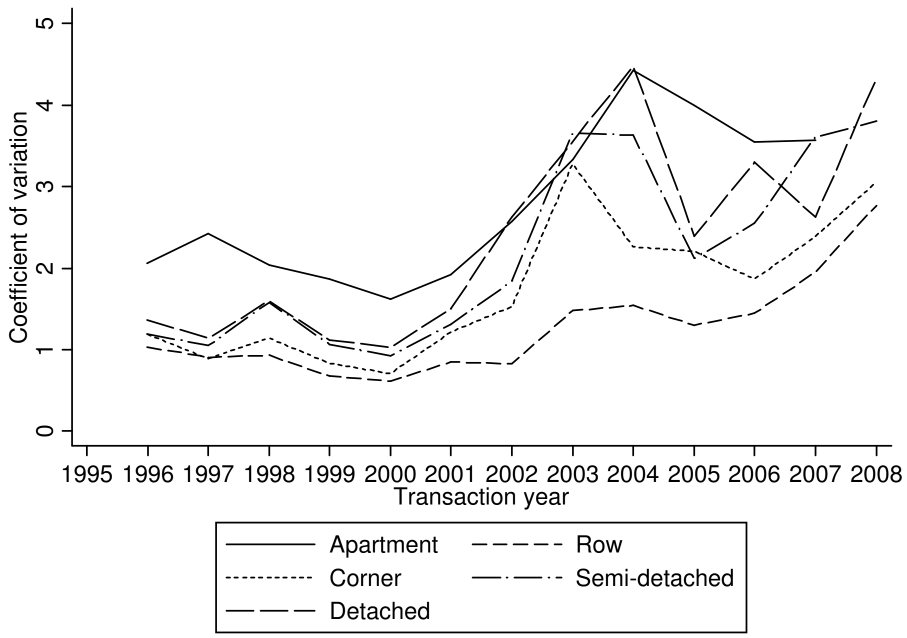
$$Coefficient\ of\ \ Variation = \frac{sd(\Delta p)_{t,r}}{\overline{\Delta p}_{t,r}}. \tag{4.12}$$

The average coefficient of variation is 2.8 for apartments (RH: 1.3; CH: 1.7; SH: 2.2; DH: 2.3).[35] Risk per unit of return seems to be highest for apartments (i.e. 2.8 euros per euro

[34] The inverse of this ratio resembles the Sharpe ratio, without a correction for the risk free rate of return.

return) and, in some cases, detached houses. This risk is again lowest for row houses. In line with previous results, the volatility of price changes per unit of price change is also not constant over time. The unitarized measure of risk shows clear peaks in 2003-2004 and in 2008. This pattern mainly reflects that returns in these years have been relatively low. Hence, especially during an economic downturn the risk per unit of return is relatively high. In particular, one euro of return in 2000 was associated with between 0.6 and 1.6 euros spread in returns across types of house. In 2003, this range was between 1.5 and 3.7 per euro return, and it was even higher in 2008 with the coefficient of variation ranging from 2.8 to 4.3. Hence, risk per unit of return seems to be two to three times higher during an economic bust than during an economic boom.[36]

Figure 4.6: The volatility of house price changes per unit of return (euros)



Since most households may move within the municipality of residence,[37] we also calculated the volatility of price changes per municipality based on the returns per 4-digit zip code using the same methodology as in equation (4.11). Figure 4.7 shows the average of this

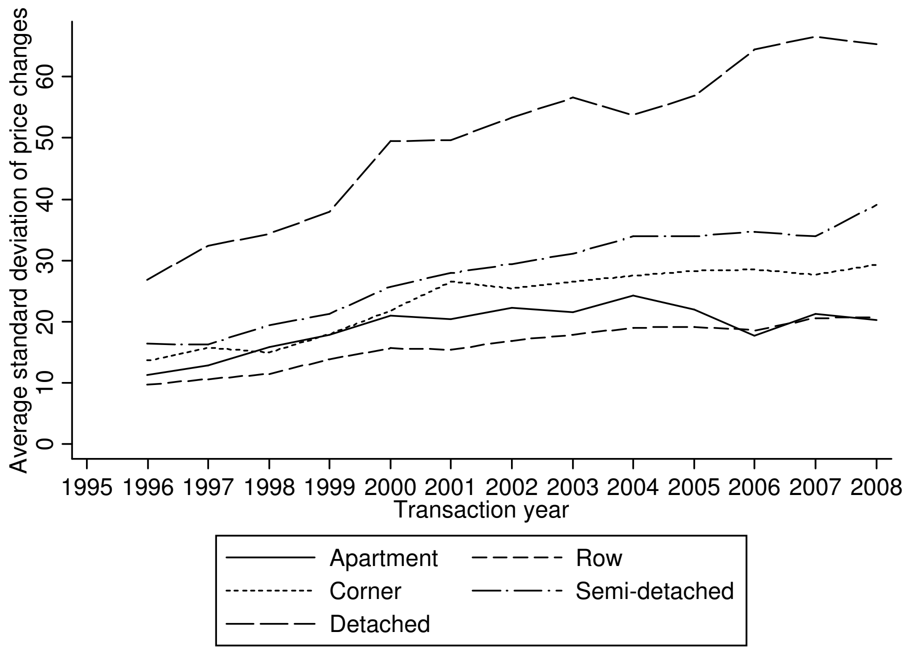
[35] The coefficient of variation for detached houses in 2003 and apartments in 2008 are 20.7 and 22.6, respectively. These values are excluded as outliers.

[36] The coefficient of variation based on percentage (log differences) price changes is 2.8 for apartments (RH: 1.2; CH: 1.7; SH: 2.0; DH: 2.0), where the coefficient of variation for detached houses in 2003 and apartments in 2008 are 9.5 and 20.6, respectively, and are excluded as outliers. These estimates seem to be similar to the estimates based on the nominal price changes presented in this section. In addition, the pattern in this coefficient of variation is similar to the pattern reported in Figure 4.6.

[37] About 60.6 percent of the total number of residential moves in the Netherlands in 2007 occurred within the municipalities. Source: Statistics Netherlands.

volatility across municipalities and Figure 4.8 again uses the average house price change reported in Figure 4.4 as benchmark.

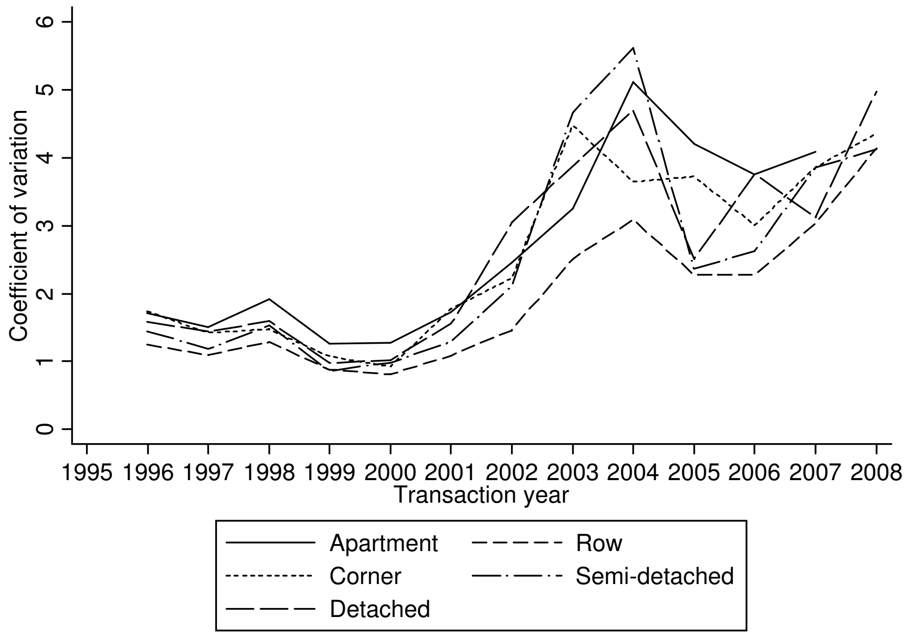
Figure 4.7: The volatility of house price changes within the municipality (euros, in thousands)



Figures 4.7 and 4.8 seem to be relatively similar to Figures 4.5 and 4.6. Hence, the previous conclusions remain largely unchanged. In particular, Figure 4.7 indicates that the yearly average standard deviation of price changes within a municipality is about 19,000 euros for apartments (RH: 16,000 euros; CH: 23,000 euros; SH: 28,000 euros; DH: 50,000 euros), which is between 2000 to 5000 euros higher than the volatility across municipalities. For apartments it is 2000 euros lower. Two times the average standard deviation divided by the average house price in the Netherlands suggest that the yearly average maximum percentage at risk is about 31 percent for apartments (RH: 21 percent; CH: 28 percent; SH: 28 percent; DH: 34 percent). These results indicate that homeowners who move within their current municipality of residence face at least as much volatility in house price changes as those homeowners who move between municipalities. In accordance with the previous results, the volatility of house price changes is highest for detached houses and lowest for apartments and it is not constant over time. Moreover, there is also a substantial heterogeneity of these estimates across municipalities. In particular, the yearly average standard deviation of the within municipal standard deviation is about 16,000 euros for apartments (RH: 12,000 euros; CH: 17,000 euros; SH: 22,000 euros; DH: 29,000 euros). This result implies that

location may also be an important determinant of the volatility of house price changes. We will discuss the spatial pattern in this volatility in further detail in the regression analysis.

Figure 4.8: The volatility of house price changes within the municipality per unit of return (euros)



As mentioned, Figure 4.8 again reports the coefficient of variation. The average coefficient of variation is 2.7 for apartments (RH: 1.9; CH: 2.6; SH: 2.5; DH: 2.5), which is fairly similar to the previous estimates.[38] In accordance with the previous results, the coefficient of variation is lowest for row houses and highest for detached houses and apartments. In addition, this coefficient mainly peaks in 2003-2004 and 2008 (economic bust) and it seems to be relatively low during the economic boom in 2000 (1997).

4.7.2 Alternative measures of house price risk

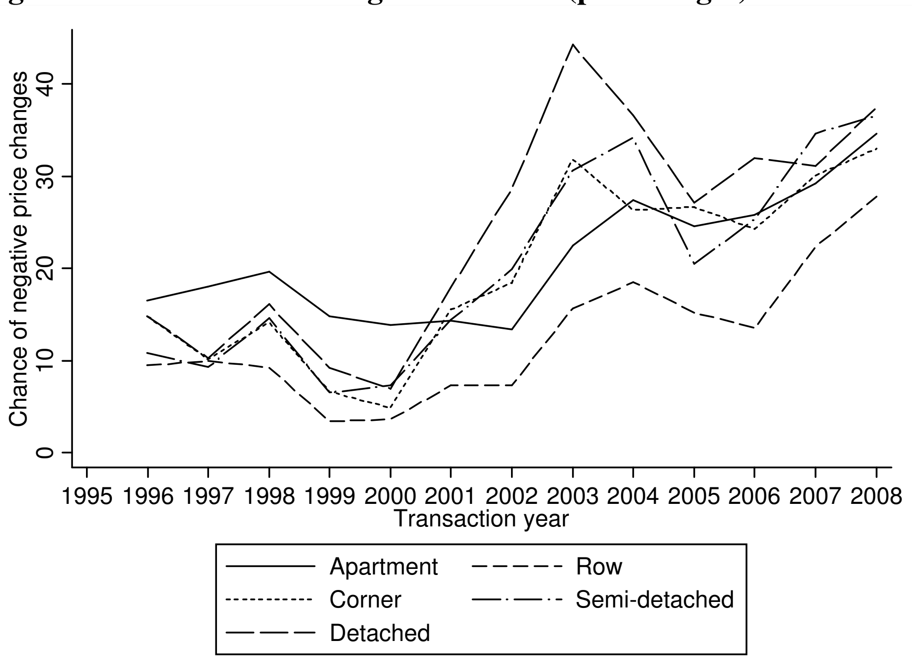
We also calculated two alternative measures of house price risk, the chance of negative returns and the value at risk.

The previous measures of house price risk are based on the idea that positive and negative price changes both contribute to risk. However, homeowners may especially dislike negative returns (i.e. downward price risk). As a result, Figure 4.9 reports the percentage of municipalities with negative house price changes per type of house and year. Figure 4.9

[38] The coefficient of variation for detached houses in 2003 and apartments in 2008 are 24.3 and 18.1, respectively. These values are excluded as outliers.

implies that the yearly average chance of negative returns may be substantial. In particular, this chance is about 21.1 percent for apartments (RH: 12.6 percent; CH: 19.8 percent; SH: 20.4 percent; DH: 24.0 percent). These results imply that about every 5 years an owner of an apartment, corner house, or semi-detached house should expect to have a negative return on his house. The expected time until a loss is 8 years for row houses and 4 years for detached houses. In accordance with previous results, the chance of negative returns seems to be highest around the years 2003 and 2008. In particular, in 2003 this chance was 28 percent for apartments (RH: 18 percent; CH: 26 percent; SH: 34 percent; DH: and 37 percent). In 2008, this chance was even higher 35 percent for apartments (RH: 28 percent; CH: 33 percent; SH: 37 percent; DH 37 percent). In comparison, the chance of negative returns in 2000 was only 14 percent for apartments (RH: 4 percent; CH: 5 percent; SH: 7 percent; DH: 7 percent). Hence, downward price risk also seems to be two to three times higher during an economic bust than during an economic boom, which is in line with the previous results.

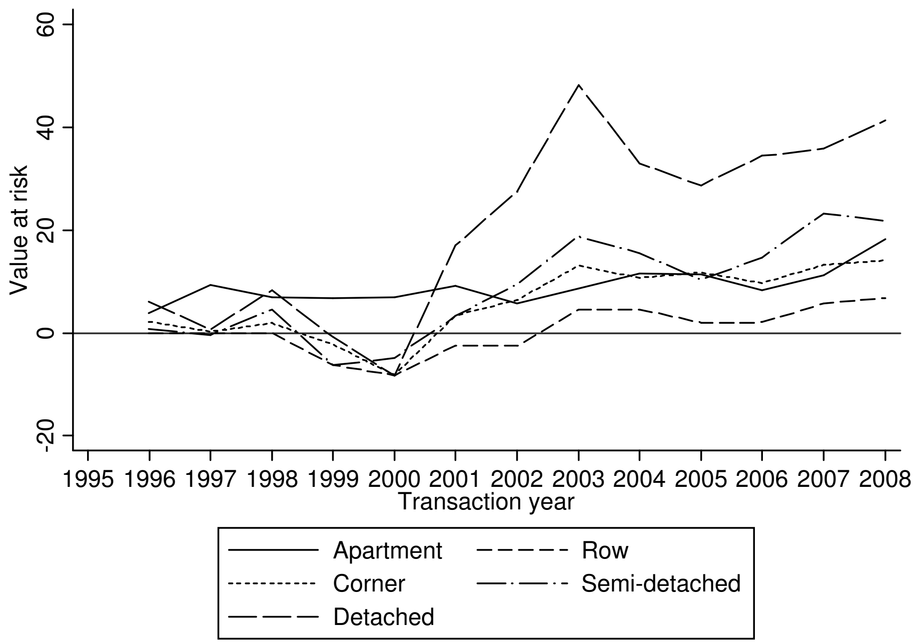
Figure 4.9: The chance of negative returns (percentages)



Finally, Figure 4.10 shows the value at risk a homeowner faces every 10 years. In particular, we calculated the (negative) percentage returns at the 10th percentile of lowest returns and multiplied this percentage with the housing investment (see Figure 4.2) per type of house and year. Hence, a homeowner should expect to lose *at least* the amount reported in Figure 4.10 in 10 percent of the cases on a yearly basis (i.e. 100%=10 years).

Figure 4.10 suggest that the average minimum loss every 10 years is 9,094 euros for apartments (RH: 487 euros; CH: 5,889 euros; SH: 8,549 euros; DH: 20,953 euros). Relative to the average price level in the Netherlands (the housing investment) this loss is 7 percent for apartments (RH: 0.3 percent; CH: 4 percent; SH: 4 percent; DH: 7 percent). Again, the value at risk is highest for apartments and detached houses and it is lowest for row houses. Especially in 2003 and 2008 this value at risk has been relatively high. Interestingly, the amount of loss has sometimes been positive (i.e. the year 2000), which mainly reflects that the housing market was booming in those years.

Figure 4.10: The value at risk, minimum loss every 10 years (euros, in thousands)



4.7.3 The hedging benefits of homeownership

The average accumulated housing capital gains between 1995 and 2008 have been about 102,000 euros for apartments (RH: 129,000 euros; CH: 140,000 euros; SH: 183,000 euros; DH: 285,000 euros). This result suggests that the cross-market segment hedge has not been perfect since there have been substantial differences in house price changes across market segments (rejection of hypothesis 4.5). In addition, the substantial amount of accumulated capital gains implies that the intertemporal hedge has also not been perfect (rejection of hypothesis 4.6).[39] Nevertheless, the accumulated capital gains may well have acted as a buffer against the price declines in the Netherlands in 2008 and 2009. This result implies that the homeowner who only sold his home and, for instance, rented a new home may not have necessarily been worse off in comparison to a homeowner who bought a new house and, consequently, had a cross-location hedge against house price risk.

[39] This result does not only apply to homeowners who bought their house in 1995 since average yearly returns have been positive over the entire sample period.

The cross-location hedge quality can be measured by the correlation between the house price time series per municipality. The average across all unique pairwise correlation coefficients is 0.739 for apartments (RH: 0.957; CH: 0.937; SH: 0.928; DH: 0.903).[40] Hence, the average quality of the hedge seems to be quite high. However, these high correlations may be largely the result of a common time trend in house prices across municipalities. Since the house price trend in the Netherlands may in itself not be risky, we also calculated the correlations between the price change series per municipality. The average correlation between these price changes is only 0.096 for apartments (RH: 0.205; CH: 0.127; SH: 0.127; DH: 0.113).[41] [42] In accordance with the results on the volatility of price changes, the row house also seems to be associated with the highest hedge quality. Nevertheless, this hedge quality is far from perfect since the average correlations are substantially lower than one (rejection of hypothesis 4.7).

The correlation coefficient provides information on the sign and size of the relationship between house price changes across municipalities; it does not quantify this relationship. As a result, we calculated the yearly price change of municipality *i* divided by the yearly price change in Amsterdam, the capital of the Netherlands,[43]

$$\text{Relative housing capital gains}_{i,t,r} = \frac{\Delta p_{i,t,r}}{\Delta p_{Amsterdam,t,r}}. \tag{4.13}$$

A ratio of one indicates that a homeowner is perfectly hedged against the price changes in Amsterdam. We calculated the average (excluding Amsterdam) of these ratios across municipalities (per type of house and year). In this chapter, we will only report the time average of this ratio since there was no discernable pattern in the average ratio per type of house across years (i.e. these ratios are highly volatile).

The yearly average of the relative housing capital gains is 0.65 for apartments (RH: 0.27; CH: 0.56; SH: 0.68; DH: 0.17).[44] Hence, homeowners have to some extent been hedged

[40] The maximum number of correlation coefficients per type of house is 97,020. We calculated 50,210 pairwise correlation coefficients for apartments (RH: 93,419 pairwise correlations; CH: 87,709 pairwise correlations; SH: 91,224 pairwise correlations; DH: 90,380 pairwise correlations).

[41] The maximum number of correlation coefficients per type of house is 97,020. We calculated 39,391 pairwise correlation coefficients for apartments (RH: 90,420 pairwise correlations; CH: 82,486 pairwise correlations; SH: 86,918 pairwise correlations; DH: 86,269 pairwise correlations).

[42] These correlations are substantially lower than the correlations between the house price growth series reported by Sinai and Souleles (2009). This result may be due the low scale of aggregation we use in our analysis.

[43] We do not report the relative capital gains between all municipality pairs since the average of this ratio converges to one. In addition, these ratios are highly sensitive to outliers since, in some cases, the denominators were close to zero (i.e. price changes close to zero).

[44] The average ratio of detached houses in 2002 and 2007 (137 and -4, respectively) were both excluded as outliers.

against the price changes in Amsterdam between 1995-2008. In particular, a 1 euro increase in housing capital gains in Amsterdam was associated with 0.17 to 0.68 euros outside of Amsterdam. These results imply that owning a home outside of Amsterdam may have provided a hedge against 17 to 68 percent of price changes in Amsterdam. In accordance with previous results, these findings suggest that there are substantial hedging benefits of homeownership, but the hedge quality is again not perfect. Consequently, additional tools to manage this risk may still be valuable to the homeowner.

We present two extensions with regard to the aforementioned relative capital gains ratios. First, we recalculated the ratios in equation (4.13) based on relative accumulated capital gains between 1995 and 2008. Again, the capital gains in Amsterdam are used as benchmark.[45] Since we use accumulated capital gains, the change in the ratios in comparison to the previous estimates may provide some useful insight into the effect of the holding period of the housing asset on the hedge quality. The average of these hedge ratios is highest for corner houses (0.88) and row houses (0.83), and it is lowest for apartments (0.63), detached houses (0.64), and semi-detached houses (0.70). In comparison to the previous estimates, the hedge quality increases to 63 to 88 percent. This result implies that homeowners who stay longer in their home before they buy a new home have had a higher hedge quality.

Finally, we weighted the ratios by the normalized inverse distance (in kilometers) to Amsterdam since many homeowners may prefer to move to a location nearby the current place of residence. If nearby housing markets are correlated, this may lead to a higher effective hedge quality. In accordance with the previous results, the weighted average hedge ratio is highest for corner houses (1.02) and row houses (0.95), and it is lowest for detached houses (0.77) and semi-detached houses (0.84). Apartments have an average hedge ratio that lies between these values (0.69). In comparison to the previous estimates, the hedge quality increases to about 69 to 102 percent. In accordance with Sinai and Souleles 2009, these results imply that household who move to nearby markets may have a higher hedge quality. The increase in the average hedge ratio due to the spatial weights also indicates that the capital gains further away from Amsterdam have been lower.[46] We will discuss this spatial pattern in further detail in the next section.

[45] The capital gains in Amsterdam between 1995 and 2008 have been 160,395 euros for apartments, 155,093 euros for row homes, 161,416 euros for corner houses, 260,076 euros for semi-detached homes, and 439,076 euros for detached houses.

[46] This global spatial pattern is also statistically significant at the 5 percent significance level since the Moran's I statistics is about 0.066 (z-value 8.9) for apartments (RH: 0.178 (z-value 47.2); CH: 0.168 (z-value 40.9); SH 0.198 (z-value 50.5); DH: 0.162 (z-value 42.2)).

4.8 Regression results

4.8.1 Main regression results

This section reports the estimates of the house price AR (1) model, equation (4.4), the price change (hedge) model, equation (4.5), and the volatility of price shocks model, equation (4.6). Based on these estimates, we examine whether the previously reported differences across types of houses, years, and municipalities in the volatility of house price changes and the hedge against house price risk are also statistically significantly different.

Table 4.2: The persistence in house prices, 1995-2008, equation (4.4)

Second Stage Results	**Difference in median prices** (per municipality, house type, and year)
Lagged difference in median prices (per municipality, house type, and year)	0.975*** (0.068) (95% CI [0.841 - 1.108])
Centered R-squared	0.10
Joint significance time dummies (Chi2)	834.03***
AR(1) in residuals, rho coefficient	-0.665*** (0.011)
AR(2) in residuals, rho coefficient	0.165*** (0.025)
AR(3) in residuals, rho coefficient	-0.015 (0.028)
First Stage Results	
Third lag in median prices	0.058** (0.023)
Fourth lag in median prices	0.012 (0.026)
Instrumental relevance (F-value)	309.94***
Instrumental validity (1 overidentifying res.), Hansen J statistic (Chi2)	1.167

Notes: Robust (clustered) standard errors are in parentheses. ***, **, *, 1%, 5%, 10% significance, respectively. Observations 17,315. Estimated with two-step GMM, Arellano-Bond method. The instruments are the third and fourth lag of median prices (per municipality, house type, and year). House type and municipal fixed effects are differenced out. Only 9 time dummies are included (2000-2008) due to the differencing, the use of lagged instruments, and the inclusion of the intercept, which has an estimated coefficient of 10452.41 (1088.373). The residual of the second stage regression is regressed on its first lag or second lag or third lag to obtain the partial autocorrelation function.

Table 4.2 reports the estimates of the persistence parameter based on equation (4.4). It is well known that this persistence parameter cannot be consistently estimated using the standard fixed effects or first differences method if the time dimension of the dataset is small. Hence, we estimated equation (4.4) along the lines of the Arellano-Bond (1991) method. In particular, we estimate equation (4.4) in first differences. As a result, the house type-specific intercept and municipality-specific intercept are differenced out. Subsequently, the lagged differenced price is instrumented by the third and fourth lag of the median house price.[47] We estimate the parameters of the model by means of the two-step GMM estimator. We utilize

[47] Consequently, the estimation is only based on 17,315 observations instead of 23,627 observations.

the third (and fourth lag), since there seems to be first and second order autocorrelation in the differenced error term (i.e. AR(1) in levels).

The results in Table 4.2 suggest that the instruments are relevant (F-value of 310) and valid (the Hansen J-statistic is equal to 1.17). In accordance with hypothesis 4.1, the results in Table 4.2 provide evidence that house prices may be highly persistent since the estimated φ coefficient is 0.975 and the value 1 is within the 95 percent confidence interval. Although we cannot formally test the persistence in house prices with for instance a Dickey-Fuller type of test (due to the small time dimension), these results suggest that house price shocks may have a persistent effect on house prices. As a result, we continue with the price change model stated in equation (4.5).

Table 4.3, panel A, reports the regression estimates (column 1) of the price change model stated in equation (4.5). In addition, the squared residuals of that model are used as dependent variable (column 2) in the volatility of price shocks model stated in equation (4.6). Panel B and Panel C show the tests on the parameters of these models.

We start with a discussion of the volatility of price changes model reported in column 2. In accordance with the previous results, the regression estimates in column 2 seem to suggest that there are statistically significant differences in the volatility of price changes across market segments (see Panel C, F-value of 60). In particular, the volatility of price shocks for apartments, the reference group, differs significantly from the other types of houses, except for corner houses. In addition, the null hypothesis that the coefficients are jointly equal is rejected (F-value of 46). The conditional volatility of price changes is again highest for detached houses and lowest for terraced houses. Consequently, we formally reject hypothesis 4.2.

The test results reported in panel C suggest that the volatility of house price shock also varies over time (joint significance time dummies, F-value of 13), such that hypothesis 4.3 is rejected. In particular, the volatility of price shocks in all years except 2006 and 2007 is statistically significantly different from the base year 1996. In addition, all of the coefficients on the year dummies are statistically significantly different from each other (F-value of 13). Moreover, the volatility of price shocks was relatively high in 2000, 2003, and 2008 which is in accordance with the previous results (i.e. boom-bust movement of risk).

With regard to location, the test results in panel C strongly support that location is a determinant of risk. In particular, the municipality dummies are highly statistically significant (F-value of $2.5*10^{24}$) and the equality of the municipal fixed effects is also rejected ($3.2*10^{6}$). Hence, hypothesis 4.4 is also formally rejected. The municipality dummies with Amsterdam

Table 4.3: The hedge quality and the volatility of price changes, 1995-2008, equations (4.5) and (4.6)

Panel A: regression results	Equation (4.5) **Difference in median prices** (euros, in thousands, per municipality, house type, and year)		Equation (4.6) **Squared residual** (from difference in median prices model, in millions)	
Housetype2 (1 if row)	3.288***	(0.338)	-155**	(66)
Housetype3 (1 if corner)	3.996***	(0.360)	-38	(71)
Housetype4 (1 if semi-detached)	7.916***	(0.496)	479***	(113)
Housetype5 (1 if detached)	15.941***	(0.691)	1,980***	(236)
Timedummy3 (1 if year=1997)	3.266***	(0.637)	89***	(24)
Timedummy4 (1 if year=1998)	2.438***	(0.671)	211***	(48)
Timedummy5 (1 if year=1999)	12.520***	(0.805)	490***	(70)
Timedummy6 (1 if year=2000)	17.483***	(0.820)	670***	(97)
Timedummy7 (1 if year=2001)	9.305***	(0.888)	647***	(89)
Timedummy8 (1 if year=2002)	2.741***	(0.784)	603***	(74)
Timedummy9 (1 if year=2003)	-4.412***	(0.822)	739***	(89)
Timedummy10 (1 if year=2004)	-2.745***	(0.843)	681***	(94)
Timedummy11 (1 if year=2005)	2.040***	(0.897)	805***	(109)
Timedummy12 (1 if year=2006)	0.886	(0.877)	910***	(133)
Timedummy13 (1 if year=2007)	0.035	(0.897)	823***	(114)
Timedummy14 (1 if year=2008)	-2.581***	(0.901)	983***	(167)
Intercept	8.713***	(0.591)	584***	(137)
R-squared	0.10		0.13	
Panel B: Tests on the hedge (F-values), equation (4.5)				
Significance house type dummies	172.61***		-	
Equality coefficients house type dummies	229.85***		-	
Significance time dummies	125.66***		-	
Equality coefficients time dummies	130.47***		-	
Sum of coef. on time dummies equals zero	63.42***		-	
Significance municipality dummies	$5.3x10^4$***		-	
Equality coefficients municipality dummies	$2.0x10^5$***		-	
rho coefficient, AR(1) in residuals	-0.389***	(0.018)	-	
rho coefficient Ap.–Row	0.273***	(0.055)	-	
rho coefficient Row–Corner	0.225***	(0.020)	-	
rho coefficient Corner–Semi-det.	0.050***	(0.017)	-	
rho coefficient Semi-det.–Det.	0.053***	(0.017)	-	
rho coefficient Mun. –Amsterdam (Average)	0.006***	(0.098)	-	
Panel C: Tests on the volatility of price shocks (F-values), equation (4.6)				
Significance house type dummies	-		60.38***	
Equality coefficients house type dummies	-		46.26***	
Significance time dummies	-		12.89***	
Equality coefficients time dummies	-		12.79***	
Significance municipality dummies	-		$2.5x10^{24}$***	
Equality coefficients municipality dummies	-		$3.2x10^6$***	

Notes: Robust (clustered) standard errors are in parentheses. ***, **, *, 1%, 5%, 10% significance, respectively. Observations 23,627 in both specifications. Both models are estimated with OLS. A full set of municipality dummies is included with Amsterdam as benchmark (i.e. 437 dummies since the estimates for Vlieland, Schiermonnikoog, and Rozendaal are missing). Apartments are the reference group for the house type effects. The year 1996 is the reference group for the year effects.

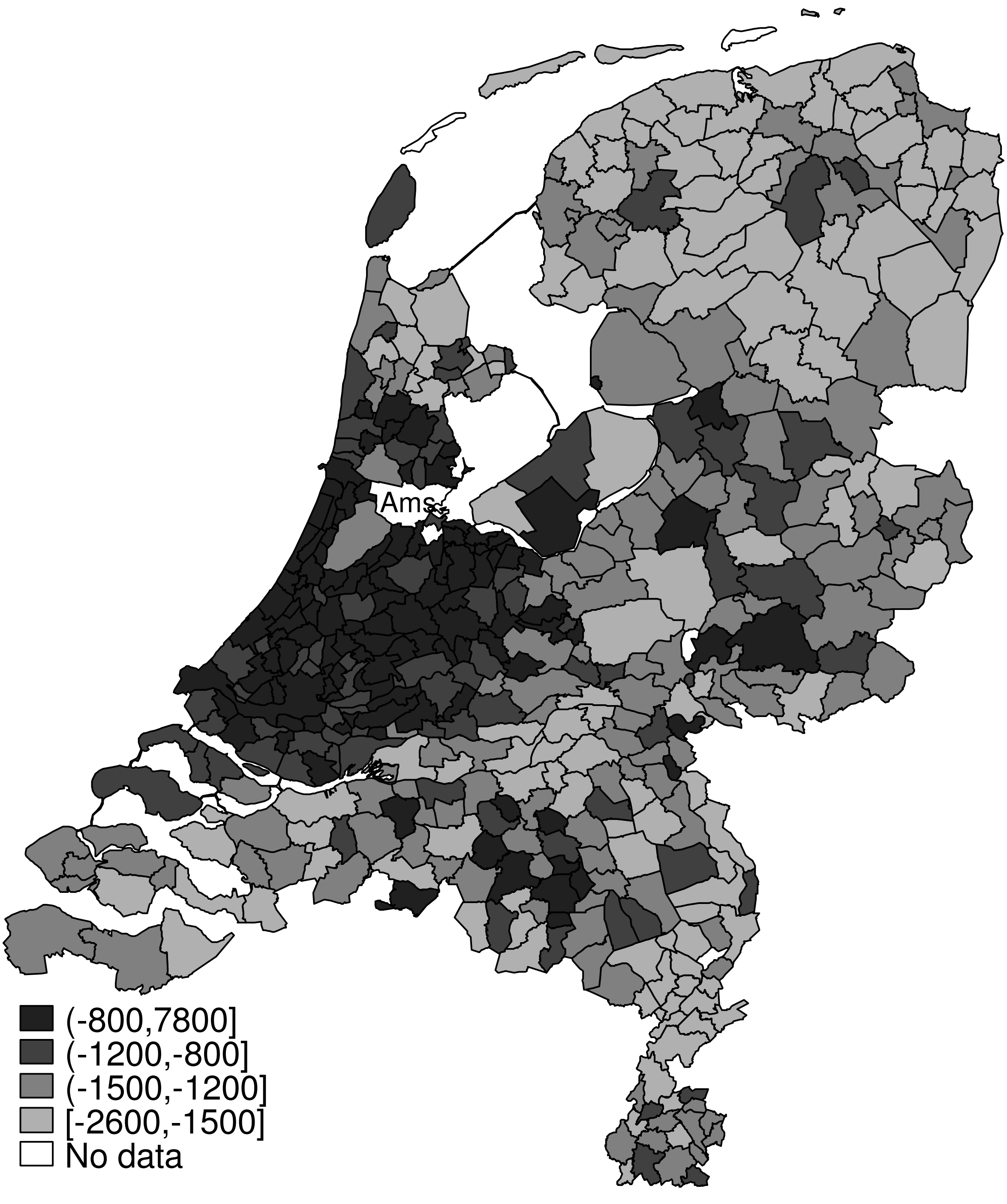
as benchmark have an average coefficient of -954. Hence, the volatility of shocks was on average (954 variance in millions) lower in other parts of the Netherlands than in Amsterdam, ceteris paribus. In particular, only in 44 out of 437 municipalities, excluding Amsterdam, the volatility of price shocks was higher than in Amsterdam, ceteris paribus. The five municipalities with the highest estimated price shock volatility relative to Amsterdam are Wassenaar, Bloemendaal, Blaricum, Reeuwijk, and Amstelveen. The lowest estimated volatility is in Kessel, Dantumadiel, Bellingwedde, Slochteren, and Marum.

In addition, the normalized inverse distance weighted average estimated fixed effect coefficient is -512, which is higher than the unweighted average of -954. These results suggest that there is a core-periphery pattern in the volatility of house price shocks (house price risk). This pattern is also clearly visible in Figure 4.11, which depicts the fixed effects estimates. In particular, the homeowners whose current or future new house was in the core of the Netherlands (the Randstad) may have had to deal with a relatively high volatility of house price shocks. A possible explanation of this results is that housing supply restrictions in these areas (see Vermeulen and Rouwendal, 2007) may have amplified the impact of housing demand shocks on house prices (see Glaeser et al., 2005).

Finally, we report some summary statistics of the squared residuals to give an indication of the size of the volatility of house price shocks. In particular, the square root of the average volatility of price shocks (i.e. the standard deviation) is about 22,000 euros for apartments (RH: 11,000 euros; CH: 16,000 euros; SH: 26,000 euros; DH: 46,000). These results are almost similar to the previously reported estimates in the descriptive statistics section. These results imply that a homeowner who would know the differences in price changes across municipalities, time periods and type of houses, would still have to deal with a large house price risk. In particular, these results may reflect that there is still a substantial amount of unexplained variation in house price changes, for instance due to local market factors, that are not captured by equation (4.5). Further research about the impact of these local market factors would, therefore, be extremely interesting, but is out of the scope of this text.

To investigate and test the different dimensions of the hedge against house price risk, Table 4.3, column 1, reports the coefficient estimates of the price changes model, equation (4.5). The coefficients on the house type dummies suggest that row homes have a yearly estimated return that is 3,300 euro higher than apartments, corner houses have a 4,000 euro higher return than apartments, semi-detached homes have a 7,900 euro higher return than apartments, and detached homes have a 16,000 euros higher return than apartments, ceteris paribus. These differences between market segments are highly statistically significant (see panel B, F-value of 173). In addition, the null hypothesis that the coefficients are jointly equal

Figure 4.11: The spatial distribution of the estimated yearly volatility of price changes across municipalities relative to Amsterdam, 1995-2008 (variance, in millions)



Notes: This figure plots the estimated coefficients on the municipality dummies from the volatility of price changes model, equation 4.6. Amsterdam (Ams) is the reference group (coded as missing). The estimates for Vlieland, Roozendaal, and Schiermonnikoog are missing due to lack of data.

is rejected (F-value of 230). As a consequence, hypothesis 4.5 is rejected. These results imply that a homeowner who decides to move between market segments will have a hedge that is of less quality.

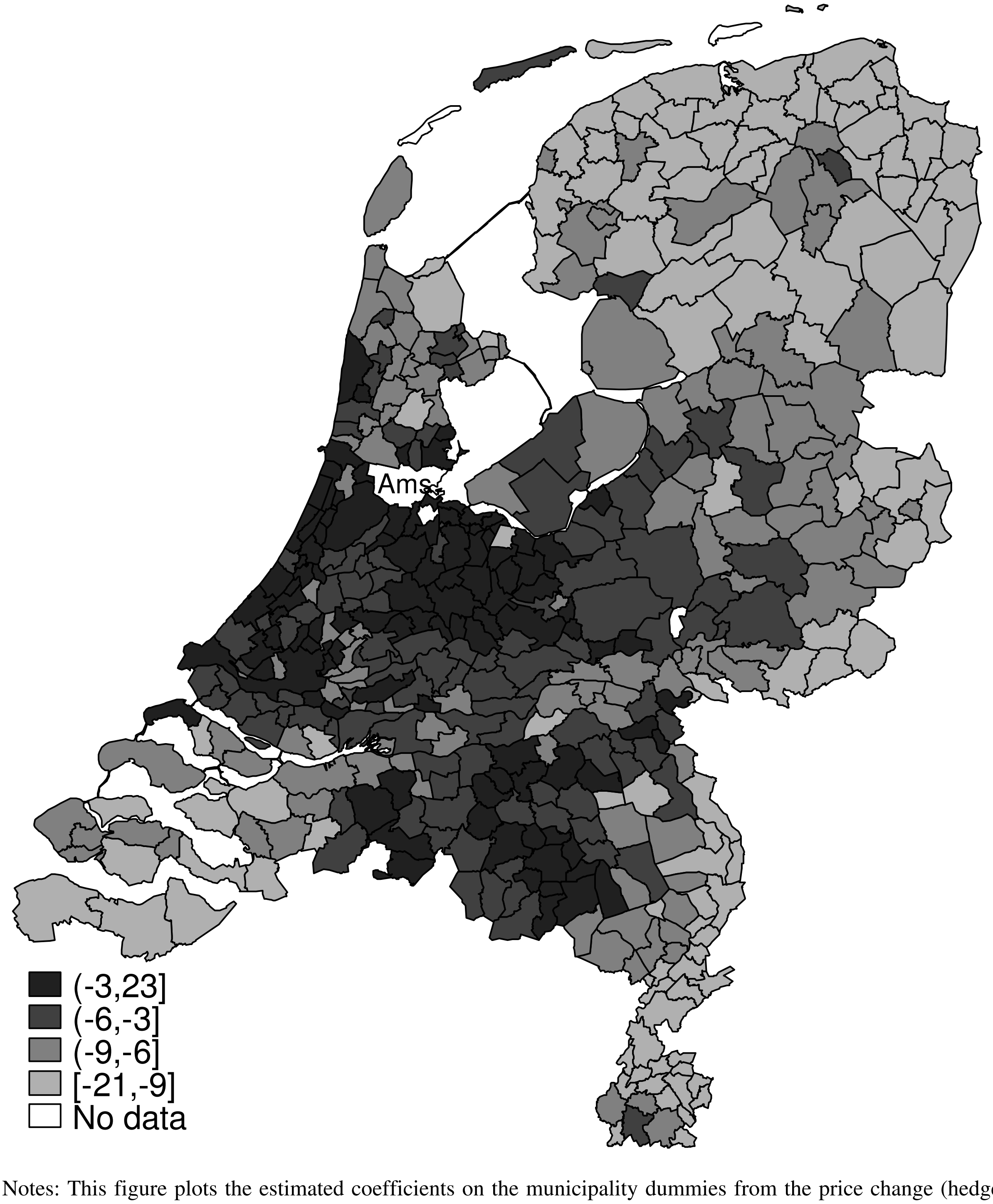
The coefficients on the year dummies indicate there is also a cyclical pattern in returns similar to the pattern depicted in Figure 4.4. The estimated yearly return from 1995 to 1996 is 8,712 euros.[48] Based on this estimate and the estimates of the time dummy coefficients, the estimated accumulated capital gains have been 154,232 euros. In particular, the sum of the time dummy coefficients is statistically significantly different from zero (F-value of 63). Moreover, the time dummy coefficients are (jointly) statistically significantly different from 1996 (F-value of 126) and from each other (F-value of 130). In accordance with previous results, these outcomes suggest that the intertemporal hedge against price changes has not been perfect, hypothesis 4.6 is rejected. Nevertheless, as mentioned, a homeowner who sells his current home and buys a new home is perfectly hedged against these common price changes.

With regard to the location component of returns, the test results stated in Table 4.3, panel B, suggest that the municipality dummies are highly statistically significant (F-value of $5.3*10^4$) and are statistically significantly different from each other (F-value of $2.0*10^5$). Hence, the cross-location hedge may again not have been perfect. In accordance with the previous results, we can reject hypothesis 4.7. The municipality dummies with Amsterdam as benchmark have an average coefficient of -5.562. Hence, the yearly returns were on average about 5,600 euros lower in other parts of the Netherlands than in Amsterdam, ceteris paribus. In particular, only in 49 out of 437 municipalities, excluding Amsterdam, the yearly returns were higher than in Amsterdam, ceteris paribus. The five municipalities with the highest estimated yearly price changes relative to Amsterdam are Bloemendaal, Wassenaar, Heemstede, Muiden, and Blaricum. The lowest estimated returns are in Kessel, Reiderland, Scheemda, Loppersum, and Het Bildt.

In addition, the normalized inverse distance weighted average estimated fixed effect coefficient is -3.203, which is higher than the unweighted average of -5.562. In accordance with previous results, there also seems to exist a core-periphery pattern with respect to yearly price changes (i.e. the hedge). Again, this spatial pattern is depicted in Figure 4.12. In particular, it seems that housing capital gains have been relatively high in the neighborhood of Amsterdam, the core of the Netherlands (the Randstad, but also Brabant), versus the rest of

[48] This number is equal to the coefficient estimate on the time dummy for 1996 in equation (4.5) without a constant.

Figure 4.12: The spatial distribution of estimated yearly returns across municipalities relative to Amsterdam, 1995-2008 (euros, in thousands)



Notes: This figure plots the estimated coefficients on the municipality dummies from the price change (hedge) model, equation 4.5. Amsterdam (Ams) is the reference group (coded as missing). The estimates for Vlieland, Roozendaal, and Schiermonnikoog are missing due to lack of data.

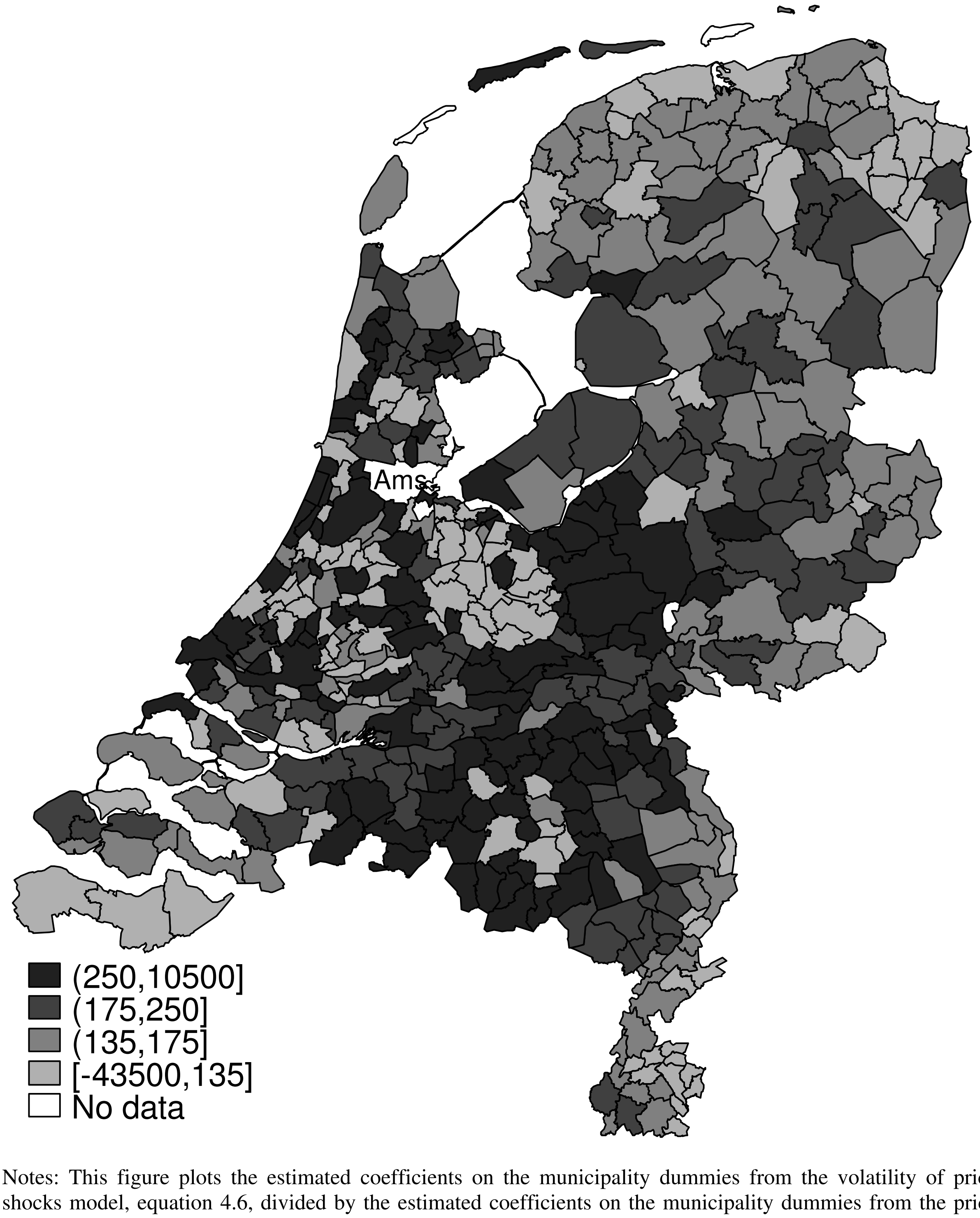
the Netherlands (the periphery). Again, this result may be due to housing supply restrictions (see Vermeulen and Rouwendal, 2007), but it may also reflect the accumulation of labor and economic activity in the core of the Netherlands (see Van Oort et al., 2008). These results imply that those homeowners who move within the core or periphery may have a relatively good hedge quality. Instead, those homeowners who move from the periphery to the core may be underhedged. A possible implication of this result is that a homeowner who wants to move from the periphery towards to the core may well be financially constrained to realize such a move due to the relatively low returns in the periphery.

A further issue is that risk and returns may be related. In particular, Bloemendaal and Wassenaar, for instance, have a high volatility of price changes, but they also have high returns. Specifically, the correlation between the fixed effects estimates based on equation (4.5) and equation (4.6) is 0.75. As a result, we divided the estimated fixed effects from equation (4.6) by the fixed effects from equation (4.5). This measure resembles the previously reported coefficient of variation.

The five municipalities with the highest estimated relative fixed effects measure are Wageningen, Renswoude, Baarle-Nassau, Rotterdam, and Lansingerland. The lowest volatility per unit of return is in Amersfoort, Bunnik, Teylingen, Velsen, and Capelle aan den IJssel. In addition, the average of the relative fixed effects is 114, while the distance weighted average is only 33. Hence, the risk per unit of return seems to be relatively low close to Amsterdam. This spatial pattern is also visible in Figure 4.13. In particular, only in 402 out of 437 municipalities, excluding Amsterdam, this measure seems to be higher than in Amsterdam, ceteris paribus. These results reflect that close to Amsterdam there are some pockets of low coefficient of variation estimates (e.g. nearby Utrecht), while the East and South (i.e. Brabant) of the Netherlands have a relatively high risk per unit of return. In addition, the North (Noord-Holland and nearby Groningen), South East (Limburg) and South West (Zeeland) of the Netherlands still have a relatively low volatility (per unit of return), which is in accordance with previous results. These results imply that, although a homeowner in the core of the Netherlands faces substantial uncertainty in returns on his house, the return he is likely to receive is relatively good.

Finally, we argued in the methodology section (i.e. section 4.4.4) that the hedge against house price shocks, instead of whether total price changes are similar across municipalities, time periods, and types of houses, may be of interest to the homeowner. As a result, we also report some regressions (i.e. see equation (4.7)) based on the residuals from the price change model, equation (4.5) (see Panel B). In particular, we find that the AR(1) serial

Figure 4.13: The spatial distribution of the estimated yearly volatility of price changes divided by the estimated yearly returns, relative to Amsterdam, 1995-2008 (euros, in thousands)



Notes: This figure plots the estimated coefficients on the municipality dummies from the volatility of price shocks model, equation 4.6, divided by the estimated coefficients on the municipality dummies from the price change (hedge) model, equation 4.5. Amsterdam (Ams) is coded as missing since it is the reference group. Vlieland, Roozendaal, and Schiermonnikoog are also missing due to lack of data.

correlation coefficient is about -0.389.[49] This result suggests that a 1 euro decrease in return due to a price shock in a particular year is hedged by an increase of 0.389 euros in return the next year. Hence, the intertemporal hedge against price shocks is about 39 percent. In addition, we regressed the residuals between different types of houses on each other. As mentioned, we only report the coefficients based on the ordering implied by the property ladder (Apartment–Row, Row–Corner, Corner–Semi-detached, Semi-detached–Detached, see Figure 4.2). A positive association across types of houses is beneficial for a homeowner who moves up or down the property ladder. The rho coefficient for the Apartment–Row combination is 0.273, for the Row–Corner combination 0.225, for the Corner–Semi-detached combination 0.050, and for the Semi-detached–Detached combination 0.053. These results suggest that a homeowner who moves from, for instance, an apartment to a row house is hedged against 27 percent of the price changes in the row house. Hence, based on these estimates, the quality of the cross-market segment hedge ranges between 5 percent to 27 percent, depending on the type of house. Of course, the hedge quality for a homeowner who would skip steps in the property ladder may be substantially lower.[50] Finally, we regressed the residual per municipality on the residuals of Amsterdam. The average coefficient of these estimates was 0.006. Hence, the yearly cross-location hedge against price changes in Amsterdam is again not very high (only 0.6 percent). In particular, it is substantially lower than the cross-location hedge reported in the descriptive statistics part of this chapter. In sum, these additional results on the hedge quality suggest that hypotheses 4.5-4.7 are still rejected, which is in accordance with the previous results.

4.8.2 Regression results based on repeat sales

As an extension, we re-estimated equation 4.5 and 4.6 based on a sample of repeat sales (see equation (4.8)). The results are stated in Table 4.4.[51] We will focus the discussion on whether the previously stated hypotheses are still rejected and whether the volatility of house price shocks and the hedge quality changes if we use a sample of repeat sales.

The main conclusion based on Table 4.4 is that hypotheses 4.2-4.7 are still rejected based on the repeat sales sample, even though there is substantial more heterogeneity in the house price returns across houses (i.e. a decrease in R-squared). In particular, the estimated

[49] The second and third lags are insignificant at the 5 percent significance level.

[50] In particular, the coefficient on the other house type combination are low (ranging from -0.015 to 0.037) and statistically insignificant at the 5 percent significance level.

[51] In comparison to the regressions in Table 4.3, the specifications in Table 4.4 also include a dummy for the year 1996 (the year 1995 is the reference group) and a full set of month of sale dummies (not reported).

Table 4.4: The hedge quality and the volatility of price changes based on a sample of repeat sales, 1995-2008, equation (4.8)

Panel A: regression results	Equation (4.8), part 1 **Yearly housing capital gains per house** (euros, in thousands)		Equation (4.8), part 2 **Squared residual** (from housing capital gains model, in millions)	
Housetype2 (1 if row)	4.512***	(0.632)	426	(620)
Housetype3 (1 if corner)	6.194***	(0.688)	624	(687)
Housetype4 (1 if semi-detached)	10.696***	(0.892)	4,555***	(1,342)
Housetype5 (1 if detached)	22.366***	(1.278)	22,412***	(4,451)
Timedummy2 (1 if year=1996)	-7.291	(5.922)	-17,633***	(5,101)
Timedummy3 (1 if year=1997)	-10.656*	(5.505)	-25,104***	(5,111)
Timedummy4 (1 if year=1998)	-12.416**	(5.473)	-26,846***	(4,607)
Timedummy5 (1 if year=1999)	-8.856	(5.489)	-26,752***	(4,589)
Timedummy6 (1 if year=2000)	-6.691	(5.468)	-21,029***	(4,857)
Timedummy7 (1 if year=2001)	-8.127	(5.526)	-25,325***	(4,539)
Timedummy8 (1 if year=2002)	-10.365*	(5.581)	-25,799***	(4,626)
Timedummy9 (1 if year=2003)	-13.042**	(5.566)	-24,564***	(5,484)
Timedummy10 (1 if year=2004)	-14.805***	(5.589)	-28,658***	(4,572)
Timedummy11 (1 if year=2005)	-15.905***	(5.582)	-28,654***	(4,595)
Timedummy12 (1 if year=2006)	-16.410***	(5.565)	-28,736***	(4,584)
Timedummy13 (1 if year=2007)	-16.277***	(5.521)	-27,344***	(4,662)
Timedummy14 (1 if year=2008)	-17.061***	(5.495)	-27,325***	(4,589)
Intercept	37.449***	(5.491)	38,722***	(4,638)
R-squared	0.0164		0.0015	
Panel B: Tests on the hedge (F-values), equation (4.8), part 1				
Significance house type dummies	86.03***		-	
Equality coefficients house type dummies	110.65***		-	
Significance time dummies	71.51***		-	
Equality coefficients time dummies	76.54**		-	
Sum of coef. on time dummies equals zero	4.82**		-	
Significance municipality dummies	$2.2x10^5$***		-	
Equality coefficients municipality dummies	$2.9x10^5$***		-	
Significance month of sale dummies	3.09***		-	
Equality month of sale dummies	3.40***		-	
rho coefficient, AR(1) in residuals	0.002	(0.016)	-	
rho coefficient Ap.–Row	0.131***	(0.047)	-	
rho coefficient Row–Corner	0.011	(0.029)	-	
rho coefficient Corner–Semi-det.	-0.012	(0.029)	-	
rho coefficient Semi-det.–Det.	0.012*	(0.016)	-	
rho coefficient Mun. –Amsterdam (Average)	0.009	(0.089)	-	
Panel C: Tests on the volatility of price shocks (F-values), equation (4.8), part 2				
Significance house type dummies	-		8.15***	
Equality coefficients house type dummies	-		10.68***	
Significance time dummies	-		7.46***	
Equality coefficients time dummies	-		5.19***	
Significance municipality dummies	-		$2.3x10^5$***	
Equality coefficients municipality dummies	-		$2.1x10^5$***	
Significance month of sale dummies	-		1.69*	
Equality month of sale dummies	-		1.65*	

Notes: Robust (clustered) standard errors in parentheses. ***, **, *, 1%, 5%, 10% significance, respectively. Observations 722,380 in both specifications. Both models are estimated with OLS. A full set of month of sale dummies are included with January as benchmark. A full set of municipality dummies is included with Amsterdam as benchmark. Apartments are the reference group for the house type effects. The year 1995 is the reference group for the year effects.

returns and the volatility of those returns seem to be substantially larger than the previous estimates. With regard to the type of house, the returns are again highest for detached houses. Moreover, we find that (semi) detached houses are associated with statistically significantly more volatility than apartments, which is in line with the previous results. With regard to the time dimension of house price changes, the results still imply that house price change do not cancel out. Although the year 2000 is associated with relatively high returns and 2008 was characterized by low returns, the business cycle pattern in returns is less visible in Table 4.4, column 1. With regard to the volatility of price shocks, the results again indicate that the volatility of price shocks was again relatively high (i.e. low negative coefficient) in 2000, 2003, and 2008, which is in accordance with the previous results on the boom-bust movement of price volatility. In addition, the results in Table 4.4, columns 1 and 2, still imply that risk and returns statistically significantly differ across municipalities.[52]

We again report some summary statistics of the squared residuals from the price change model to give an indication of the size of the volatility of house price shocks. In particular, the square root of the average volatility of price shocks (i.e. the standard deviation) is about 50,000 euros for apartments (RH: 37,000 euros; CH: 38,000 euros; SH: 65,000 euros; DH: 145,000), which is substantially higher than the previous estimates. Two standard deviations relative to the average house price in the Netherlands (i.e. see again section 4.6) implies that the maximum amount of risk relative to the housing investment is 81 percent for apartments (RH: 42 percent; CH: 45 percent; SH: 64 percent; DH: 143 percent). These results suggest that the previous estimates may have grossly underestimated the true volatility of price changes since it did not take into account the heterogeneity in individual returns.

Finally, we investigated the structure in the error term in the price changes model (the hedge against house price shocks) in further detail. We again use the residuals from the price changes model. Since the residuals are house specific, we cannot use the previous methodology.[53] As a result, we used the average residuals per municipality (type of residence and year) to recalculate the hedge quality using the same methodology as in the previous section. The results are reported in Table 4.4, Panel B. In comparison to the previous results, there does not seem to be much statistically significant evidence of a hedge against house price shocks. In particular, the intertemporal hedge and the cross-location hedge are both not

[52] The plotted coefficients still showed a similar spatial pattern in risk and returns as before.

[53] For instance, the residual associated with the sale of an apartment cannot be directly linked to the same observation of a different type of house since the observation is unique to the apartment (i.e. the data is house specific). Only with regard to the serial correlation coefficients we could have used the repeated repeat sales structure of the data. Nevertheless, we decided to use averages per municipality for the serial correlation coefficient to keep the methodology the same throughout this chapter.

statistically significantly different from zero. Only the cross-market segment hedge between apartments and row houses and between semi-detached and detached houses is about 13 percent and 1 percent, respectively. These results imply that the hedging benefits of homeownership against house price shocks are low based on the sample of repeat sales.

4.9 Conclusion

This chapter has provided novel evidence with regard to house price risk and the hedging benefits of homeownership. In particular, based on a dataset consisting of all transaction prices of existing homes that were sold in the Netherlands between 1995 and 2008, this chapter investigaged the volatility of price changes and the hedge quality across municipalities, years, and types of houses.

The results in this chapter have indicated that house price risk may be substantial. In particular, we have found that the yearly maximum percentage of the housing investment at risk, based on the volatility of price changes across municipalities, is between 14 to 34 percent (depending on the type of house). The outcome of the regression analysis (house price shocks) were relatively similar. We have argued that these results imply that knowledge about the municipality, time, and house type component of house price changes may not reduce house price risk. In addition, our findings have suggested that the risk for those homeowners who moved within the municipality of residence may be as large as 21 to 34 percent. Moreover, we have found that every 4 to 8 years a homeowner should expect to have a negative return on his home and every 10 years the homeowner may expect to lose between 0.3 and 7 percent of the housing investment. Based on a sample of repeat sales, we showed that the aforementioned estimates may have grossly underestimated house price risk. In particular, the repeat sales estimates have indicated that the yearly maximum percentage of the housing investment at risk is more likely to be close to 42 to 143 percent. Further results showed that house price risk may be relatively low for frequently traded, homogenous house types (row houses). Instead, it is relatively high for detached houses, but also for apartments. In addition, the risk per unit of return was two to three times higher during the economic downturn in 2003 and 2008 than during the economic boom in 2000. Moreover, there seems to be a core-periphery pattern in house price risk.

With regard to the hedging benefits of homeownership, we showed that owning a home outside of Amsterdam may have provided an average (cross-location) hedge against 17 to 68 percent of price changes in Amsterdam. The hedge quality increased to 63 to 88 percent from a long term perspective. We have argued that if a homeowner moves to a nearby market, for whatever reason, and nearby markets are correlated the effective hedge may be even higher. In particular, the hedge quality is to 69 to 102 percent if it is weighted by distance between housing markets. Moreover, the regression estimates have suggested that the intertemporal hedge against price shocks is about 39 percent, the quality of the cross-market segment hedge ranges between 5 percent to 27 percent and the yearly cross-location hedge against price shocks in Amsterdam is only 0.6 percent. Again, based on a sample of repeat sales we did not find much evidence of the hedging benefits of homeownership (only a 13 percent cross-market segment hedge between apartments and row houses), which reflects the substantial volatility in price changes across houses. Further results suggested that the cross-location hedge quality was highest for frequently traded, homogenous house types. In addition, we have found that especially homeowners who moved between the periphery and the core of the Netherlands may have had a low hedge quality.

The results in this chapter imply that there are some hedging benefits of homeownership, but that the hedge quality in most cases is far from perfect. Sinai and Souleles (2009) have suggested that the hedging benefits of homeownership may explain why a derivatives market based on house prices (i.e. see Case et al., 1991, and Shiller, 2008) has failed to take off. Our study implies that additional tools to manage and reduce house price risk may still be valuable to homeowners.

The sub prime crisis has provided us with a clear example that owning a home does not always lead to golden eggs. The results in this chapter have suggested that house price risk may be substantial and the hedge against this risk is not always perfect. As a consequence, there seems to be a potential role for governments in increasing the homeowner's awareness about house price risk. In particular, the supplier of an investment product in the Netherlands is required to warn an investor about the potential risks associated with the investment. A notable example is that an advertisement about a financial investment broadcasted on the Dutch radio always ends with a risk statement and the request to read the financial brochure associated with the investment. Hence, a similar warning or a property financial brochure/risk label on the house may be beneficial to the homeowner. Realtors could help to provide this financial brochure. In sum, information on house price risk could increase the opportunity of homeowners to make an informed housing investment decision.

Further research should focus on the underlying determinants of house price risk, the interdependency between this risk and other types of risks (e.g. the risk of default), and the financial instruments to manage those risks. Finally, house price risk may differ across countries. We could learn from those differences to arrive at policies to mitigate this risk.

Chapter 5

The Diversification Benefits of Free Trade in House Value

5.1 Introduction

The recent downturn in housing markets in many countries has served as a reminder that house price risk may be substantial. This risk is relatively high for a homeowner in comparison to a standard (institutional) investor since homeowners cannot adequately diversify the housing investment across locations or market segments.[1] One of the main reasons for this lack of diversification is the enormous transaction costs associated with investing in a diversified housing market portfolio. As a result, Shiller (2008) and Case et al. (1991) have advocated the establishment of derivatives markets for home prices. In particular, homeowners can sell house price futures or buy put options to hedge away house price risk. Although the establishment of derivative markets deals with the problem of transaction costs, it still ignores another main reason as to why house price risk is relatively high for homeowners. In particular, the indivisibility of the housing investment also impairs the homeowners' investment allocation since the typical homeowner has only limited wealth to invest in housing. Both of these housing market features make the housing investment illiquid (i.e. a lumpy investment).

The aim of Chapter 5 is to investigate the diversification benefits if the value of the house could be freely traded among homeowners. In particular, homeowners could freely trade in the value of the house if the housing investment would be divisible and transaction costs would be low. Free trade could, for example, be achieved through a stock market based on the value of the house.[2] Free trade would allow homeowners to invest in each other's property and, consequently, to reduce (share) house price risk. A reduction in house price risk would increase the homeowner's welfare since households in general dislike risk and the consequences of house price risk may be severe (e.g. default, future housing consumption/pension is at risk). Moreover, the results in this chapter are also interesting for other investors in real estate (e.g. realtors, housing corporations) since they may have highly

[1] Diversification may be extremely valuable since the value of real estate is about 20 trillion dollars in the US alone (Shiller, 2008).

[2] This chapter does not discuss in detail how such a stock market should look like. Rather, our results are simply meant to provide empirical evidence about the usefulness of a financial market to deal with house price risk.

localized housing portfolios as well. Since free trade in house value currently does not exist, the analysis in this chapter is a counterfactual analysis.

Although it is common in the finance literature to investigate diversification benefits and hedging effectiveness using Capital Asset Pricing Method (CAPM) and Arbitrage Pricing Theory (APT) models, these methods have not been widely applied in a housing market setting.[3] To quantify the diversification benefits, we estimate simple CAPM and APT models based on a dataset of house price return series per municipality and type of house in the Netherlands between 1995 and 2008. The main advantages of this dataset are twofold. First, this dataset contains information on the type of house. As a result, we can also investigate diversification across market segments. Second, the Netherlands is comparable to large MSAs such as the New York MSA. Hence, this study is comparable to a within-MSA investigation. Previous studies have mainly focused on cross-MSA price variation (e.g. Sinai and Souleles, 2009; Case et al., 2009). However, MSA-level house price return series may mask the substantial volatility of returns within MSAs.

Besides the diversification benefits of free trade in house value, we also discuss the effectiveness of an alternative strategy, hedging with house price futures. The diversification benefits are expected to be high based on a country-wide portfolio of houses. Instead, the hedging effectiveness of futures may increase if those futures are based on highly disaggregate (regional) price series. Hence, our research also provides novel evidence about the risk-reducing benefits of diversification versus the hedging effectiveness of house price futures.

The remainder of this chapter is organized as follows. Section 5.2 discusses the previous literature. Section 5.3 presents the data and methodology. Section 5.4 reports the regression results. Section 5.5 concludes.

5.2 Previous literature

In a remarkable feat of foresightedness, Case et al. (1991) already advocated the establishment of derivative markets for home prices during the 1990s:

"We need instead some other medium, that allows real estate owners to hedge the risk or their real estate while at the same time owning the real estate. What is needed is some market that stands between individual property owners and broader portfolio investors, allowing the portfolio investors to share the risk of the property without owning it. What is needed, inherently, are future and option markets cash settled on indexes of real estate prices." (Case et al, 1991, p. 6)

[3] In a notable exception, Case et al. (2009) estimate housing CAPM models and APT models based on quarterly MSA house price returns. They show that market returns in the US can explain those MSA returns and that there is a strong positive risk-return relationship in the US housing market.

In recent years, this idea has gained renewed momentum as a result of the impact of the subprime crisis (i.e. see Shiller, 2008). To some extent, homeowners could have reduced their house price risk by option or futures contracts based on house price indices.[4] [5] In particular, the long sides of the option or futures contracts should be taken by (institutional) investors, while the short side is taken by the homeowner as a hedge against house price risk. Bertus et al. (2008) show that such a strategy (trade of futures on the Chicago Mercentile Exchange (CME)) could have reduced the homeowner's house price risk by about 88 percent in Las Vegas over the period 1994-2006. In addition, Quigley (2006) finds that futures markets in house price indexes could have increased portfolio returns for European investors by several percentage points at the same level of risk.

It is fair to say that real estate derivative markets are still not widely used by homeowners. In many countries these markets do not exist (anymore) or they are still of minor importance.[6] De Jong et al. (2008) provide a possible reason why the house price derivatives market has failed to take off. They argue that futures based on the Case-Shiller city price index in the US may not be effective hedging instruments since the expected returns on these futures is positive (and homeowner would in general short sell futures) and the idiosyncratic risk is too large within a city to use futures as an effective hedging strategy.

An alternative explanation for the absence of a fully functioning derivatives market based on house prices may relate to the hedging benefits of homeownership (i.e. see Sinai and Souleles, 2009). In particular, a change in the price of the current home may be hedged by the change in the price of the future home. Selling futures may lead to a similar negative exposure as buying a new home. As a result, the use of both hedging instruments may easily "unhedge" the homeowner (see Sinai and Souleles, 2009). In addition, although on average the hedge quality may be quite good, Chapter 4 showed that this hedge in many cases is not perfect. As a consequence, there may still be scope for a financial stock/derivatives market based on house prices.

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[4] Deng and Quigley (2008) discuss how futures in the US could for instance be based on the OFHEO indices. One of the problems with this indices is that every quarter they are revised, which would effect settlement prices.
[5] Hinkelman and Swidler (2008) show that existing CME futures contracts do not provide an effective hedge. As a result, they argue that futures based on house price indices may provide homeowners with a valuable hedging opportunity. Alternatively, Englund et al. (2002) find that homeowners can also hedge their lumpy investment in housing (i.e. in Stockholm) with stock and bonds.
[6] In 2001, the firm City Index introduced spread betting based on house prices in London, while IG Index launched its own spread betting in 2002. Both markets were closed by 2004. In May 2006, the CME introduced house price options and futures. However, until November 2007 the notional value of these contracts only reached about 612 million dollars (see Shiller, 2008). In March 2009, the Frankfurt-based Eurex started its trade in house price futures (for commercial real estate). Until August 2009, the value of the traded future contracts was only 15 million euros (Piazolo, 2010).

In addition, there are two notable differences between hedging with futures and hedging with the current/future house. First, a futures contract needs to be financed by own cash/savings, while a new home may be partly financed by the old home (and a rollover strategy with regard to the mortgage). Since the housing investment is usually too large to be fully paid by the homeowner himself, the homeowner may not have enough additional private wealth to fully hedge his exposure to house price risk with futures.

A second difference is that the choice of investing in a house is also based on housing consumption. In particular, there may be a consumption demand and an investment demand for housing (i.e. see Ioannides and Rosenthal, 1994). Specifically, part of housing demand may be hedging demand (i.e. see Cocco, 2000; Han, 2008; Sinai and Souleles, 2009). As a result, the natural hedge against house price risk is likely to be imperfect since the investment decision may well be distorted by the housing consumption choice.

Finally, Caplin et al. (2003) have argued for insurance against downward price changes. The problem with this approach is that the investment and the risk associated with this investment may be so substantial that it is questionable whether homeowners can afford the insurance premium to insure against house price risk. In addition, if there is a market bust, the financial burden on insurance companies may become too high to bear. Consequently, it may be too risky to provide such insurance to homeowners in the first place.

The studies mentioned above discuss some of the possibilities to reduce house price risk. In particular, a homeowner has invested in his current home and he may insure, hedge, or diversify (with other assets), his exposure to house price risk. Nevertheless, all of these studies are based on the fact that the housing investment is fixed. That is, the housing investment itself is not diversified. In particular, two standard features of housing market models are that selling or buying a home is associated with substantial *transaction costs* and that the housing investment is *indivisible* (e.g. see Flavin and Nakagawa, 2008; Han, 2008). The second housing market feature suggests that homeowners need to invest a large sum of money to obtain a house at a particular location. Given the limited wealth of a household, a household may not freely diversify the housing investment across locations. Transaction costs add to the distortion in the investment allocation. As mentioned, this chapter investigates the diversification benefits of free trade in house value. As such, we do not necessarily argue for trade between individual homeowners and broader portfolio investors (i.e. Case et al., 1991), but we also emphasize the benefits of trade between individual homeowners.[7]

[7] If a homeowner could directly trade futures contracts based on the price of his house, he could also obtain the diversification benefits of free trade in house value using futures.

5.3 Data and methodology

This chapter uses quarterly house price changes in the Netherlands between 1995 and 2008.[8] These price changes are based on the median house price per municipality, type of house, and time. We used all administrative transaction prices of existing homes between 1995 and 2008 to calculate the median prices.[9] The median prices are based on at least 4 transaction prices. There are 5 types of houses available in the dataset: apartments, row/terraced houses, corner houses, semi-detached houses, detached houses. In what follows, we use for these types of houses the abbreviations AP, RH, CH, SH, DH, respectively. There are 441 municipalities (NUTS-5 classification used by the European Commission) in the Netherlands. Therefore, if there would be no missing observations, there should be 121,275 price change observations (55 quarters * 5 types of houses * 441 municipalities). However, due to missing values and differencing there are only 84,038 price change observations available in the dataset. There are on average across time 188 municipalities with a non-missing house price change for apartments (RH: 376; CH: 303; SH: 326; DH: 334). The average time dimension of the return series is about 32 quarters for apartments (RH: 48; CH: 40; SH: 43; DH: 43).

Table 5.1: Descriptive statistics house price changes and controls, 1995-2008

	Mean	Std. dev.	p25	p50	p75	Nr. Obs.
Return series						
$\Delta \log p_{i,t,r=1}$ (x100%) *Apartments*	1.9	23.7	-4.2	1.5	7.8	10,327
$\Delta \log p_{i,t,r=2}$ (x100%) *Row houses*	1.7	10.7	-2.7	1.7	6.2	20,704
$\Delta \log p_{i,t,r=3}$ (x100%) *Corner houses*	1.7	13.8	-5.5	1.6	8.8	16,692
$\Delta \log p_{i,t,r=4}$ (x100%) *Semi-detached houses*	1.8	18.2	-6.8	1.7	10.2	17,922
$\Delta \log p_{i,t,r=5}$ (x100%) *Detached houses*	2.0	22.3	-10.5	2.0	14.3	18,393
$\Delta \log p_{i,t,r}$ (x100%) *All house types*	1.8	17.7	-5.5	1.7	9.1	84,038
Controls						
$\Delta \log GDP_t$ (x100%)	1.3	4.4	-2.5	2.3	5.8	84,038
I_t (Euribor, percentage)	3.8	1.2	2.7	3.8	4.5	84,038

Source: Houses prices are from the Kadaster, the GDP data is from Statistics Netherlands (GDP at market prices, current prices), the 3-month Euribor interest rate is taken from the OECD. Notes: All variables are in percentages. The Euribor interest rate is a quarter-specific rate that is annualized.

[8] In contrast to the previous chapter, Chapter 5 uses quarterly data to ensure that the time dimension is sufficiently large to run time series regressions per municipality.

[9] By law, these prices were recorded by the Kadaster. The Kadaster provided the dataset to Statistics Netherlands. Statistics Netherlands granted us access to this dataset (“Bestaande Koopwoningen 200812V1”).

Table 5.1 reports the descriptive statistics of the price changes per type of house and two control variables: GDP growth and the 3-month Euribor. Table 5.1 suggests that the average quarterly percentage return on the house is about 1.8 percent. This return seems to be relatively high for detached houses (2.0 percent) and apartments (1.9 percent). In addition, the spread of returns for these two types of houses is also relatively high. Moreover, Table 5.1 shows that the quarterly nominal GDP growth is 1.3 percent and the quarterly 3-month Euribor interest rate (annualized) is 3.8 percent.

In this chapter, we will also use regional house price returns. In particular, we use 40 standard regions (40 COROPs, NUTS-3 classification used by the European Commission) in the Netherlands.[10] These regions are in accordance with regional labor/housing markets in the Netherlands. The spatial distribution of the COROP regions are depicted in Figure 5.1. The averages per COROP and type of house are reported in Table 5.2.

Table 5.2 suggests that there is substantial heterogeneity in returns across regions. In particular, returns for apartments are highest at Kop van Noord-Holland (5.6 percent) and lowest at Noord-Drenthe (-2.1 percent). With regard to row houses, the quarterly price changes are highest at the region Het Gooi en Vechtstreek (2.2 percent) and lowest at Delftzijl en omgeving (1.1 percent). Corner houses seem to have a high return in Oost-Groningen (2.2 percent) and a low return in Zuid-West Friesland (-0.1 percent). Moreover, the region Noordoost-Noord Brabant has a relatively high return with regard to semi-detached houses (2.6 percent), while Delft en Westland has a relatively low return (-0.4 percent). Finally, the price changes of detached houses are highest at Delftzijl en omgeving (3.27 percent) and lowest at IJmond (-1.07 percent).

To investigate the diversification benefits of free trade in the value of the house, we estimate the following CAPM type of models:

$$\Delta \log p_{i,t,r} = \beta_{0,i,r} + \beta_{1,i,r} \overline{\Delta \log p_{t,r}} + \varepsilon_{i,t,r}, \qquad (5.1)$$

where $\Delta \log p_{i,t,r}$ is the difference in the logarithm (approximate percentage change) of the median transaction price at municipality *i*, time *t*, and of house type *r*, the term $\overline{\Delta \log p_{t,r}}$ is the cross-sectional average across municipalities, and $\varepsilon_{i,t,r}$ is the error term. To avoid endogeneity, the cross-sectional average house prices are corrected for the right hand side

[10] The acronym COROP is named after the commission that defined these regions in 1971.

Figure 5.1: COROP regions in the Netherlands

COROP: **1** O.-Groningen, **2** Delftzijl en omgeving, **3** Groningen (overig), **4** N.-Friesland, **5** ZW.-Friesland, **6** ZO.-Friesland, **7** N.-Drenthe, **8** ZO.-Drenthe, **9** ZW.-Drenthe, **10** N.-Overijssel, **11** ZW.-Overijssel, **12** Twente, **13** Veluwe, **14** Achterhoek, **15** Arhem/Nijmegen, **16** ZW.-Gelderland, **17** Utrecht, **18** Kop van N.-Holland, **19** Alkmaar en omgeving, **20** IJmond, **21** Agglomeratie Haarlem, **22** Zaanstreek, **23** Groot-Amsterdam, **24** Het Gooi en Vechtstreek, **25** Agglomeratie Leiden en Bollenstreek, **26** Agglomeratie 's-Gravenhage, **27** Delft en Westland, **28** O.-Z.-Holland, **29** Groot-Rijnmond, **30** ZO.-Z.-Holland, **31** Zeeuwsch-Vlaanderen, **32** Overig Zeeland, **33** W.-N.-Brabant, **34** Middel-N.-Brabant, **35** NO.-N.-Brabant, **36** ZO.-N.-Brabant, **37** N.-Limburg, **38** Middel-Limburg, **39** Z.-Limburg, **40** Flevoland.

Table 5.2: Quarterly average percentage returns per type of house and region, 1995-2008

Regions	Apartment	Row	Corner	Semi-Det.	Detached
COROP 1	2.2	1.7	2.2	1.9	2.2
COROP 2	1.5	1.1	1.7	1.8	3.3
COROP 3	2.5	1.6	1.6	2.2	2.2
COROP 4	1.4	1.5	1.8	1.9	2.1
COROP 5	3.7	1.9	-0.1	1.0	2.0
COROP 6	2.0	1.6	1.1	2.3	2.1
COROP 7	-2.1	1.8	2.1	1.7	2.0
COROP 8	0.4	1.2	2.2	1.5	2.2
COROP 9	1.2	1.9	1.5	1.8	2.2
COROP 10	1.1	1.3	2.1	2.1	2.0
COROP 11	2.6	1.9	1.5	1.9	2.0
COROP 12	2.1	1.9	1.6	1.7	2.0
COROP 13	1.9	1.6	1.4	1.9	2.0
COROP 14	2.3	1.6	1.5	1.7	1.7
COROP 15	1.5	1.8	1.9	1.9	1.8
COROP 16	2.7	1.7	1.8	1.7	2.1
COROP 17	1.7	1.8	1.9	1.8	2.6
COROP 18	5.6	1.9	1.8	1.6	2.3
COROP 19	1.8	2.0	1.5	2.1	1.6
COROP 20	1.9	1.9	1.9	1.8	-1.1
COROP 21	1.6	1.9	2.0	2.3	-0.7
COROP 22	3.2	1.8	1.2	1.5	1.2
COROP 23	1.7	1.8	2.0	1.3	3.0
COROP 24	1.4	2.2	1.6	2.1	2.3
COROP 25	1.4	1.7	1.9	1.9	1.9
COROP 26	1.6	1.6	1.7	1.3	1.5
COROP 27	2.0	1.8	1.5	-0.4	0.3
COROP 28	0.8	1.5	1.6	1.8	0.5
COROP 29	2.1	1.8	1.8	1.1	2.3
COROP 30	1.9	1.6	1.8	1.4	2.9
COROP 31	2.1	1.7	1.2	2.2	1.7
COROP 32	0.5	1.8	1.7	2.0	2.3
COROP 33	2.5	1.6	1.7	1.5	2.1
COROP 34	2.1	1.6	1.8	2.0	2.2
COROP 35	2.8	2.2	1.9	2.6	2.0
COROP 36	2.5	2.0	1.6	2.0	2.1
COROP 37	0.4	1.2	1.2	1.3	1.5
COROP 38	2.0	1.6	1.5	1.4	1.7
COROP 39	1.5	1.3	1.0	1.4	1.7
COROP 40	2.1	1.5	1.7	2.1	1.7
TOTAL	1.9	1.7	1.7	1.8	2.0

Notes: The regional returns are in percentages (log-differences*100%). COROP: **1** O.-Groningen, **2** Delftzijl en omgeving, **3** Groningen (overig), **4** N.-Friesland, **5** ZW.-Friesland, **6** ZO.-Friesland, **7** N.-Drenthe, **8** ZO.-Drenthe, **9** ZW.-Drenthe, **10** N.-Overijssel, **11** ZW.-Overijssel, **12** Twente, **13** Veluwe, **14** Achterhoek, **15** Arhem/Nijmegen, **16** ZW.-Gelderland, **17** Utrecht, **18** Kop van N.-Holland, **19** Alkmaar en omgeving, **20** IJmond, **21** Agglomeratie Haarlem, **22** Zaanstreek, **23** Groot-Amsterdam, **24** Het Gooi en Vechtstreek, **25** Agglomeratie Leiden en Bollenstreek, **26** Agglomeratie 's-Gravenhage, **27** Delft en Westland, **28** O.-Z.-Holland, **29** Groot-Rijnmond, **30** ZO.-Z.-Holland, **31** Zeeuwsch-Vlaanderen, **32** Overig Zeeland, **33** W.-N.-Brabant, **34** Middel-N.-Brabant, **35** NO.-N.-Brabant, **36** ZO.-N.-Brabant, **37** N.-Limburg, **38** Middel-Limburg, **39** Z.-Limburg, **40** Flevoland.

variable $\Delta \log p_{i,t,r}$ throughout this chapter. We estimate equation (5.1) per municipality and type of house (i.e. time series regressions).

The size of $\beta_{1,i,r}$ captures the sensitivity of the house price changes per municipality to the fluctuations in the market returns. Specifically, our estimates will suggest whether the housing investment in a municipality is an aggressive ($|\beta_{1,r,i}| > 1$) or defensive investment ($|\beta_{1,r,i}| < 1$) relative to the returns in the market. In addition, if a futures contract is based on this market return, the total housing investment divided by the beta coefficient equals the total amount that an investor (e.g. homeowner) would need to invest in futures to fully hedge his exposure to house price risk (i.e. to hedge against the variation in $\Delta \log p_{i,t,r}$).[11]

The diversification benefits of free trade in house value can be quantified by means of the coefficient of determination. In particular, the variation in returns that is associated with the variation in market returns, $R_{i,r}^2$, captures the undiversifiable (market/country/systematic) risk. By contrast, $1 - R_{i,r}^2$ is our measure of the diversifiable (idiosyncratic) risk.[12] This measure captures the reduction in the variation of house price returns if the homeowner could invest the value of his house in a market portfolio of houses. Hence, if we find a low $R_{i,r}^2$ the diversification benefits of free trade in the value of the house are high. Instead, the hedging effectiveness of futures is exactly opposite to the diversification benefits of free trade in house value. In particular, a high $R_{i,r}^2$ is associated with a high hedging effectiveness. As mentioned, we will compare the diversification benefits of free trade in house value with the hedging effectiveness of futures to examine which one is more effective in reducing house price risk.

We also estimate several extensions to the basic CAPM model. In particular, equation (5.1) investigates the diversification benefits of a homeowner who owns a house of type *r* and would invest the value of this house in a market portfolio of houses of type *r*. However, it may be interesting to examine whether this homeowner could obtain additional diversification benefits if he would diversify across market segments. As a consequence, we also estimate an

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[11] We do not use the futures price since futures based on house prices do not exist in the Netherlands. Instead, we use the market return since the price of a futures contract converges to the spot price at maturity (for a discussion see Bertus et al., 2008).

[12] This approach does not deviate substantially from the method used by Case et al. (2009). In particular, they use the standard deviation of the residuals as a measure of diversifiable risk. Since the residuals have an expected value of zero by construction, this measure is equal to the Sum of Squared Residuals (SSR). The measure we use benchmarks the SSR to the total variation in returns (SST).

extended CAPM model where the returns per municipality i are regressed on the aggregate returns of all types of houses r: [13]

$$\Delta \log p_{i,t,r} = \theta_{0,i,r} + \sum_{1}^{r} \theta_{1,i,r} \overline{\Delta \log p}_{t,r} + \eta_{i,t,r}, \tag{5.2}$$

where the summation part of equation (5.2) captures the market returns for the 5 types of houses and $\eta_{i,t,r}$ is the error term. Again, we will estimate this model per municipality and type of house.

A further issue is that equation (5.1) does not take into account additional systematic risk factors. As a result, we also estimate APT type of models. In particular, we include GDP growth $\Delta \log GDP_t$ and the Euro Interbank Offered Rate (3-month Euribor) I_t as additional control variables in equation (5.1):[14]

$$\Delta \log p_{i,t,r} = \lambda_{0,i,r} + \lambda_{1,i,r} \overline{\Delta \log p}_{t,r} + \lambda_{2,i,r} \Delta \log GDP_t + \lambda_{3,i,r} I_t + \mu_{i,t,r}, \tag{5.3}$$

where $\mu_{i,t,r}$ is again the error term. Although there may be other determinants of risk and returns, we argue that these two control variables may capture additional risk factors associated with owning a home (i.e. such as the risk of default).

Finally, equation (5.1) examines the diversification benefits if the owner of a home invests his housing wealth in a Dutch housing market portfolio. However, it is also interesting to investigate the diversification benefits if a homeowner could simply invest in a regional portfolio of houses. In particular, the diversification benefits based on a regional portfolio of houses may be less than the diversification benefits of investing in a total market portfolio since a regional portfolio would not cover against the cross-regional variation in house price changes. However, futures based on regional house prices may be more effective since these returns are more likely to be similar to the homeowner's returns than the highly aggregated Dutch housing market returns.[15] As such, it is interesting to examine whether in this case

[13] The returns on the other types of houses than the type of house under consideration are not interpreted as a systematic risk for this type of house (i.e. APT model). Instead, we focus on a homeowner who invests in a new market portfolio consisting of all 5 types of houses.

[14] The Euribor interest rate may also be a proxy for the riskless rate of return. The mortgage interest rate is this return plus a risk premium, which depends on the riskiness of the mortgage.

[15] Preferably, futures should be based on the individual homeowner's house price returns (tailor made). However, given the heterogeneity in returns, these contracts would no longer be standardized, which would impair the trade in those contracts. As a consequence, city/regional (average) housing returns may be more suitable to base the futures price on.

futures would be more effective than free trade in reducing house price risk. As a consequence, we also estimate CAPM models based on regional average returns:

$$\Delta \log p_{i,t,r} = \delta_{0,i,r} + \delta_{1,i,r} \overline{\Delta \log p}_{t,r,g} + \omega_{i,t,r}, \tag{5.4}$$

where $\overline{\Delta \log p}_{t,r,g}$ is the average price per time *t*, type of house *r*, and region *g* (again this average excludes $\Delta \log p_{i,t,r}$ for each *i*), and $\omega_{i,t,r}$ is the error term. As mentioned, we use 40 standard regions.

5.4 Regression results

Table 5.3 reports some descriptive statistics (average slope coefficient, average R-squared) of the estimates of equations (5.1) to (5.4). The first panel in Table 5.3 shows the basic CAPM model estimates per type of house (see equation (5.1)). These estimates suggest that on average a house is a relatively defensive investment relative to the market returns. In particular, the average slope coefficients are less than one across all types of houses. That is, the municipal-specific returns do not seem to be very sensitive to changes in the market return. Specifically, the average coefficient ranges from 0.50 for apartments to 0.71 for row houses. This result implies that a homeowner who would like to hedge his exposure to house price risk/housing market risk would need to sell 1.4-2.0 euros in futures contracts to hedge his exposure to this risk. Although the average coefficients are below one, there are a substantial amount of municipalities, between 45 to 55 percent of the total number of municipalities, in which the house is a relatively aggressive investment. Figure 5.2 shows the slope coefficients per type of house for the 50 largest municipalities (G50) in the Netherlands (based on the population at the 1st of January 2009). This figure implies that there may also be substantial heterogeneity in the regression coefficients across locations and the types of houses.[16]

Based on the CAPM estimates it is also possible to quantify the extent to which (undiversifiable) house price risk is priced. The difference in the annualized market returns and the 3-month Euribor (risk free rate) times the average slope coefficient per type of house suggests that the yearly risk premium on housing is about 4.6 percent for apartments

[16] The average slope coefficient for the 50 largest municipalities (G50) is 0.23 for apartments (RH: 0.87; CH: 0.81; SH: 0.68; DH: 0.84). This average is higher than the average for the Netherlands (except for apartments). This result implies that especially in the G50 (urban areas) the house is a relatively aggressive investment, which suggest that there may be an urban-rural pattern in the aggressiveness of the housing investment.

Table 5.3: Housing CAPM models and 3 extensions, 1995-2008, equations (5.1)-(5.4)

Apartments (r=1)	**Row houses** (r=2)	**Corner houses** (r=3)	**Semi-det. Houses** (r=4)	**Detached houses** (r=5)
CAPM models, Equation (5.1)				
$\overline{\beta}_{1,r}=0.50$ $\overline{R_r^2}=0.08$ $N_r=284$ $\beta1\ sig.=6\%$ $\lvert\beta1\rvert>1=45\%$ a) $R^2>0.5=4\%$	$\overline{\beta}_{1,r}=0.71$ $\overline{R_r^2}=0.04$ $N_r=423$ $\beta1\ sig.=14\%$ $\lvert\beta1\rvert>1=45\%$ a) $R^2>0.5=0.2\%$	$\overline{\beta}_{1,r}=0.66$ $\overline{R_r^2}=0.04$ $N_r=397$ $\beta1\ sig.=10\%$ $\lvert\beta1\rvert>1=53\%$ a) $R^2>0.5=0.8\%$	$\overline{\beta}_{1,r}=0.63$ $\overline{R_r^2}=0.04$ $N_r=408$ $\beta1\ sig.=10\%$ $\lvert\beta1\rvert>1=55\%$ a) $R^2>0.5=0.5\%$	$\overline{\beta}_{1,r}=0.68$ $\overline{R_r^2}=0.04$ $N_r=412$ $\beta1\ sig.=10\%$ $\lvert\beta1\rvert>1=48\%$ a) $R^2>0.5=0.2\%$
Extended CAPM models, Equation (5.2)				
$\overline{\theta}_{1,r=1}=0.54$ $\overline{\theta}_{1,r=2}=0.31$ $\overline{\theta}_{1,r=3}=0.028$ $\overline{\theta}_{1,r=4}=0.29$ $\overline{\theta}_{1,r=5}=-0.12$ $\overline{R_r^2}=0.21$ $N_r=245$ $\theta1\ sig.=7\%$ $other\ \theta1\ sig.=16\%$ $R^2>0.5=8\%$	$\overline{\theta}_{1,r=1}=0.007$ $\overline{\theta}_{1,r=2}=0.27$ $\overline{\theta}_{1,r=3}=0.28$ $\overline{\theta}_{1,r=4}=0.18$ $\overline{\theta}_{1,r=5}=0.020$ $\overline{R_r^2}=0.15$ $N_r=406$ $\theta1\ sig.=10\%$ $other\ \theta1\ sig.=19\%$ $R^2>0.5=1\%$	$\overline{\theta}_{1,r=1}=-0.02$ $\overline{\theta}_{1,r=2}=0.32$ $\overline{\theta}_{1,r=3}=0.51$ $\overline{\theta}_{1,r=4}=-0.17$ $\overline{\theta}_{1,r=5}=0.18$ $\overline{R_r^2}=0.16$ $N_r=377$ $\theta1\ sig.=8\%$ $other\ \theta1\ sig.=16\%$ $R^2>0.5=4\%$	$\overline{\theta}_{1,r=1}=0.08$ $\overline{\theta}_{1,r=2}=0.64$ $\overline{\theta}_{1,r=3}=-0.13$ $\overline{\theta}_{1,r=4}=0.04$ $\overline{\theta}_{1,r=5}=0.41$ $\overline{R_r^2}=0.16$ $N_r=386$ $\theta1\ sig.=10\%$ $other\ \theta1\ sig.=16\%$ $R^2>0.5=2\%$	$\overline{\theta}_{1,r=1}=-0.15$ $\overline{\theta}_{1,r=2}=0.43$ $\overline{\theta}_{1,r=3}=-0.08$ $\overline{\theta}_{1,r=4}=0.55$ $\overline{\theta}_{1,r=5}=0.36$ $\overline{R_r^2}=0.16$ $N_r=388$ $\theta1\ sig.=11\%$ $other\ \theta1\ sig.=18\%$ $R^2>0.5=3\%$
APT models, Equation (5.3)				
$\overline{\lambda}_{1,r}=0.81$ $\overline{\lambda}_{GDP}=0.003$ $\overline{\lambda}_{I}=-0.16$ $\overline{R_r^2}=0.14$ $N_r=263$ $\lambda1\ sig.=6\%$ $\lvert\lambda1\rvert>1=44\%$ a) $\lambda gdp\ sig.=10\%$ $\lambda I\ sig.=0\%$ $R^2>0.5=5\%$	$\overline{\lambda}_{1,r}=0.70$ $\overline{\lambda}_{GDP}=-0.033$ $\overline{\lambda}_{I}=0.10$ $\overline{R_r^2}=0.08$ $N_r=414$ $\lambda1\ sig.=14\%$ $\lvert\lambda1\rvert>1=45\%$ a) $\lambda gdp\ sig.=10\%$ $\lambda I\ sig.=0\%$ $R^2>0.5=1\%$	$\overline{\lambda}_{1,r}=0.60$ $\overline{\lambda}_{GDP}=-0.07$ $\overline{\lambda}_{I}=0.16$ $\overline{R_r^2}=0.10$ $N_r=386$ $\lambda1\ sig.=6\%$ $\lvert\lambda1\rvert>1=50\%$ a) $\lambda gdp\ sig.=11\%$ $\lambda I\ sig.=1\%$ $R^2>0.5=3\%$	$\overline{\lambda}_{1,r}=0.51$ $\overline{\lambda}_{GDP}=-0.07$ $\overline{\lambda}_{I}=0.08$ $\overline{R_r^2}=0.08$ $N_r=397$ $\lambda1\ sig.=5\%$ $\lvert\lambda1\rvert>1=50\%$ a) $\lambda gdp\ sig.=11\%$ $\lambda I\ sig.=1\%$ $R^2>0.5=1\%$	$\overline{\lambda}_{1,r}=0.59$ $\overline{\lambda}_{GDP}=-0.09$ $\overline{\lambda}_{I}=0.08$ $\overline{R_r^2}=0.09$ $N_r=402$ $\lambda1\ sig.=7\%$ $\lvert\lambda1\rvert>1=51\%$ a) $\lambda gdp\ sig.=10\%$ $\lambda I\ sig.=0.4\%$ $R^2>0.5=1\%$
CAPM models based on regional average returns, Equation (5.4)				
$\overline{\delta}_{1,r}=0.19$ $\overline{R_r^2}=0.07$ $N_r=282$ $\delta1\ sig.=10\%$ $\lvert\delta1\rvert>1=17\%$ a) $R^2>0.5=2\%$	$\overline{\delta}_{1,r}=0.12$ $\overline{R_r^2}=0.04$ $N_r=423$ $\delta1\ sig.=12\%$ $\lvert\delta1\rvert>1=13\%$ a) $R^2>0.5=0.4\%$	$\overline{\delta}_{1,r}=0.13$ $\overline{R_r^2}=0.05$ $N_r=401$ $\delta1\ sig.=11\%$ $\lvert\delta1\rvert>1=13\%$ a) $R^2>0.5=2\%$	$\overline{\delta}_{1,r}=0.06$ $\overline{R_r^2}=0.05$ $N_r=407$ $\delta1\ sig.=13\%$ $\lvert\delta1\rvert>1=14\%$ a) $R^2>0.5=0.5\%$	$\overline{\delta}_{1,r}=0.13$ $\overline{R_r^2}=0.05$ $N_r=414$ $\delta1\ sig.=14\%$ $\lvert\delta1\rvert>1=13\%$ a) $R^2>0.5=1\%$

Notes: This table reports some descriptive statistics of the municipal-specific regressions (average beta and r-squared). Heteroskedasticity robust standard errors are used in each regression. With regard to the CAPM models, *Nr* is the number of municipal regressions on which the results are based. *β1 sig.* is the percentage of slope coefficients that are significant at a 5% significance level across municipalities. *|β1|>1* is the percentage of slope coefficients that are in absolute terms larger than 1. $R^2>0.5$ is the percentage of municipal-specific regressions with an R-squared larger than 0.5. These statistics are also reported in the 3 extensions. With regard to the extended CAPM model, *other θ1 sig.* is the percentage of municipalities that have jointly significant coefficients (other than the type of house under consideration) at a 5% significance level. In addition, in the APT models, *λgdp sig.* is the percentage of significant coefficients on GDP growth and *λI sig.* is the percentage of significant coefficients on the 3-month Euribor. We excluded regressions with an R-squared of one. In the CAPM models, for r=1 outliers are excluded at 66<β1<-41, r=2 at 10<β1<-27, r=3 at 11<β1<-24, r=4 at 12<β1<-10, r=5 at 12<β1<-12. In the extended CAPM models, for r=1 outliers are excluded at 19<θ11<-36, 38<θ12<-38, 64<θ13<-43, 46<θ14<-44, 23<θ15<-48, r=2 at 19<θ11<-18, 28<θ12<-36, 15<θ13<-18, 18<θ14<-12, 10<θ15<-14, r=3 at 11<θ11<-20, 24<θ12<-35, 25<θ13<-55, 18<θ14<-59, 33<θ15<-20, r=4 at 11<θ11<-11, 34<θ12<-24, 14<θ13<-28, 18<θ14<-37, 32<θ15<-17, r=5 at 7<θ11<-35, 37<θ12<-36, 38<θ13<-36, 42<θ14<-29, 20<θ15<-20. In the APT models, for r=1 outliers are excluded at 36<λ1<-22, 17<λgdp<-13, 35<λI<-60, r=2 at 7<λ1<-18, 5<λgdp<-7, 26<λI<-12, r=3 at 13<λ1<-33, 5<λgdp<-7, 17<λI<-13, r=4 at 14<λ1<-14, 10<λgdp<-10, 15<λI<-20, r=5 at 16<λ1<-14, 10<λgdp<-8, 25<λI<-18. In the regional CAPM models, for r=1 outliers are excluded at 11<δ1<-11, r=2 at 6< δ1<-13, r=3 at 42< δ1<-12, r=4 at 5< δ1<-4, r=5 at 5< δ1<-4. a) Most of these coefficients where larger than 1.

(i.e. (1.9^4 - 3.8) * 0.5), 3.2 percent for row houses, 3.0 percent for corner houses, 4.2 percent for semi-detached houses, and 8.3 percent for detached houses. These results indicate that especially apartments and detached houses are relatively risky to invest in (i.e. also see Chapter 4).

Finally, the first panel in Table 5.3 shows that only 6 percent to 10 percent of the regression coefficients across types of houses are statistically significant at the 5 percent significance level. This result is also reflected in the relatively low average R-squared coefficient per type of house. This finding is a first indication that the diversification benefits of free trade in house value may be substantial.

As mentioned, we estimate the diversification benefits of free trade in the value of the house by one minus the R-squared. The R-squared estimates with regard to the basic CAPM models suggest that the owner of a type of house *r* could reduce his house price risk by 92 to 96 percent if he would reinvest his housing wealth in a market portfolio of houses of type *r*.[17] [18] The remaining 4 to 8 percent of the variation in house price changes represents the systematic risk a homeowner cannot diversify against. Specifically, this risk is the result of country-wide shocks (e.g. financial crisis). In addition, the low average R-squared suggests that futures based on market prices would have a relatively low hedging effectiveness. In particular, the hedging effectiveness only dominates the diversification benefits in 0.2 to 4 percent of the municipal-specific regressions (R-squared>0.5). Figure 5.3 depicts one minus the R-squared per type of house for the 50 largest municipalities in the Netherlands. Figure 5.3 implies that the diversification benefits are high for the G50, but that there are also some differences in these benefits across municipalities and types of houses.[19]

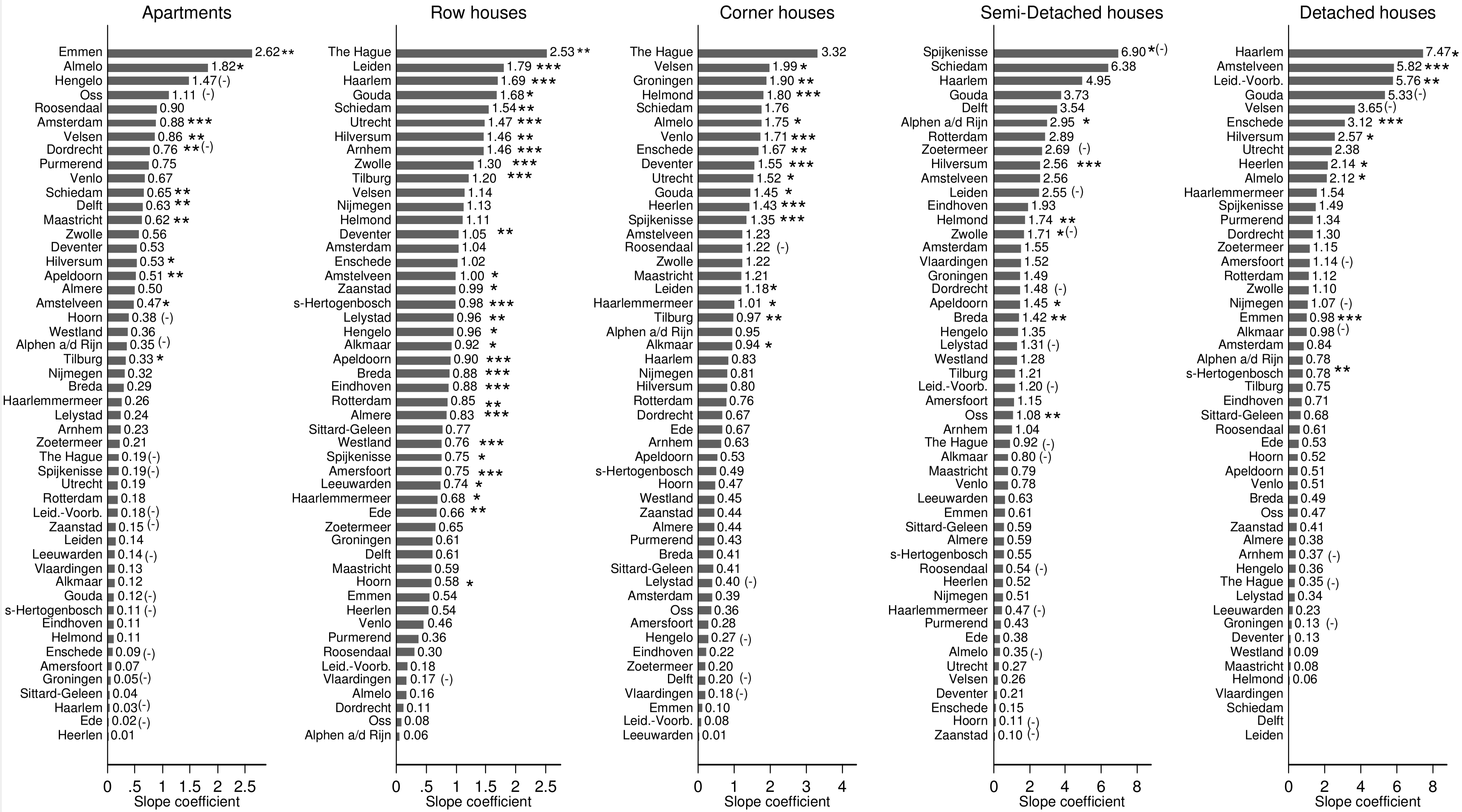
The extended CAPM model estimates (see equation (5.2)) reported in the second row in Table 5.3 are used to estimate the diversification benefits if, for instance, the owner of an apartment diversifies his housing investment across all types of houses. Table 5.3 suggests that the diversification benefits in this case would be 79 to 85 percent, which is lower than the simple CAPM estimates. Hence, diversification across types of houses would not lead to

[17] These diversification benefits may be understated since we ignore the substantial variability of house price returns within the municipality (i.e. see Chapter 4).

[18] Case et al. (2009) estimated similar CAPM models for the US. If we apply the R-squared interpretation as it is used in this chapter, the results of their simple housing CAPM model suggest that about 81 percent of the MSA return variation may be diversifiable. Their regression results corroborate our finding that there may be substantial diversification benefits as a result of free trade in the value of the house.

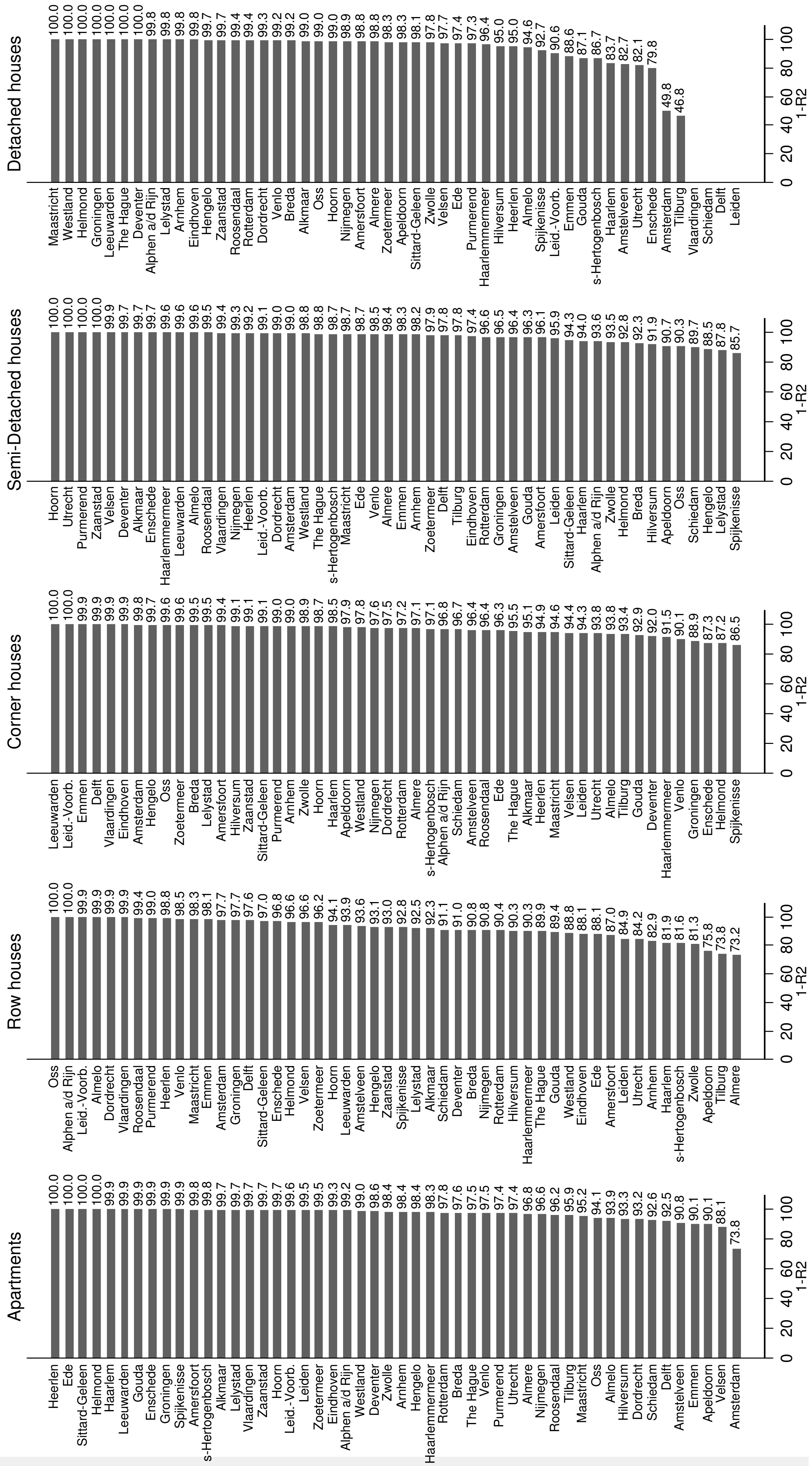
[19] The average diversification benefits for the 50 largest municipalities (G50) is 97 percent for apartments (RH: 92 percent; CH: 96 percent; SH: 97 percent; DH: 94 percent). The average for the G50 is almost the same as the average for the Netherlands. For apartments the average benefits is somewhat lower and the average benefits are higher for row houses. These results imply that there is not much evidence of an urban-rural pattern in the diversification benefits.

Figure 5.2: The aggressiveness of the housing investment for the 50 largest municipalities, 1995-2008, per type of house



Notes: ***, **, *, 1%, 5%, 10% significance, respectively. This figure reports the estimated slope coefficient of the market return in equation (5.1). (-) indicates that the coefficient is negative.

Figure 5.3: The diversification benefits for the 50 largest municipalities (percentages), 1995-2008, per type of house



Notes: This figure reports one minus the R-squared of the estimates based on equation (5.1).

additional diversification benefits. These results reflect that investing in a portfolio consisting of different types of houses may introduce additional systematic risk that a homeowner cannot diversify against. In addition, the idiosyncratic risk still seems to be the most important part of the variation in the price changes per municipality. Moreover, further results indicate that the municipal-specific return of a particular type of house seems to be mainly positively related to the market return of that type of house.

The third type of estimates that is summarized in Table 5.3 is based on the APT model stated in equation (5.3). The APT estimates suggest that both the growth in GDP and the 3-month Euribor interest rate mainly have a positive effect on house price changes, ceteris paribus. However, in most cases these estimates are economically and statistically insignificant. In addition, there are less statistically significantly coefficients on the aggregate market returns in comparison to the standard CAPM model. Only with regard to apartments, the coefficient on the market return seems to be substantially higher due to the inclusion of the control variables. With regard to the diversification benefits of free trade in the value of the house, our findings indicate that the diversification benefits are between 86 and 92 percent, which is somewhat lower than the standard CAPM estimates. This result again reflects the broader interpretation of systematic risk in comparison to the standard CAPM model. Nevertheless, these results still seem to suggest that the addition of the two controls does not change our main finding that the diversification benefits may be substantial.[20]

Finally, we estimated the CAPM model based on regional returns (see equation (5.4)). As mentioned, we use the average returns for 40 COROP regions. In comparison to the standard CAPM estimates, the results in Table 5.3 indicate that the significance of the coefficient estimates has increased. In particular, between 10 percent and 14 percent of the estimates are significant. Nevertheless, the average of the coefficients ranges between 0.06 and 0.16, which is lower than the basic CAPM estimates. This results implies that a homeowner would need to sell more futures contracts based on regional prices (between 5.3 and 16.7 euros) than futures contracts based on the aggregate Dutch house price to hedge the exposure to house price risk. In addition, this result is also reflected in the fact that in only 13 to 17 percent of the municipalities the house is an aggressive investment. With regard to the diversification benefits of free trade, the average R-squared per type of house suggests that a homeowner could reduce the variation in house prices by 93 to 96 percent if this homeowner

[20] As a robustness check, we also estimated the APT models based on the 10-year Dutch government bond yield. In this case, the diversification benefits decreased to 75 to 89 percent. Only with regard to apartments the interest rate had an economically sizeable negative effect on house price changes. Instead, this interest rate had an economically significant positive effect on the returns of corner houses and detached houses.

invests his housing wealth in a regional portfolio of houses. These results imply that the average hedging effectiveness does not increases if futures are based on regional house price indices instead of country house price indices (the R-squared is of the same size as with the basic CAPM estimates). In addition, diversification of the housing investment across regions would not result in substantial additional diversification benefits. In accordance with the previous results, the diversification benefits of free trade in house value dominates the risk-reducing benefits of futures contracts.

5.5 Conclusion

House price risk is high for homeowners since the typical homeowner invests in a house at a single location only. This result reflects the indivisibility of the housing investment (in combination with the limited wealth of homeowners) and high transaction costs in the housing market. By contrast, this chapter has investigated the diversification benefits if homeowners could freely trade in the value of the house among each other. In particular, we focussed on the question whether homeowners could reduce house price risk by re-investing the value of the house in a market portfolio of houses in the Netherlands.

The results in this chapter suggest that the diversification benefits of free trade in house value may be substantial. In particular, our basic CAPM model estimates have indicated that a homeowner could reduce the variation in house price changes by as much as 93 to 96 percent (depending on the type of house) if he would reinvest his housing wealth in a market portfolio of houses. In addition, we have found that diversification across types of houses or regions would not lead to additional diversification benefits. By contrast, the hedging effectiveness of house price futures is only about 4 to 7 percent of the variation in house price changes. In addition, we have found that the risk premium on the housing investment is between 3.0 percent (corner houses) to 8.3 percent (detached houses). Finally, the results in this chapter have indicated that the diversification benefits of free trade in house value dominates the hedging benefits of futures in most cases. These results imply that the idiosyncratic risk in local housing markets may be too high to make hedging with futures an effective hedging strategy (also see De Jong et al., 2008).

As mentioned, homeowners are also naturally hedged against house price risk if they buy a new home and sell the old home. This hedge is not always perfect since homeowners also buy a house to enjoy the housing consumption it provides and there may be substantial heterogeneity in price changes. Instead, house price futures and a financial stock market based on the value of the house may offer two complementary tools to the homeowner to manage house price risk.

A financial (stock) market based on house prices could facilitate free trade in the value of the house. Such a market would allow homeowners to trade stocks based on the value of the home. As a result, homeowners could reduce house price risk by investing in a diversified market portfolio (houses of other homeowners). Alternative ways to obtain the diversification benefits would be that homeowners jointly buy houses (albeit with substantial transaction costs) or that the homeowner could sell his house to the government or housing corporations.

A financial stock market based on the value of the house does not exist today. In particular, there may be several issues with implementing such a market. The following discussion briefly mentions some of these issues. First, the financial literacy of households may play an important role in the usefulness of a financial stock market based on house prices. In particular, if homeowners are unaware of house price risk, its implications, or if they do not know how to deal with this risk, these markets would not be widely used by homeowners. As a result, there is a potential role for governments/economist to increase the awareness about house price risk.

A second issue relates to the tradability of stocks based on the value of the house. In particular, it may be too costly to create stocks (stock emission) for each individual homeowner. Moreover, there would need to be a "critical mass" of homeowners that sell stocks to make the trade in house value viable. The stocks could, for instance, be pooled in a fund per city (municipality/region) to enhance the tradability of those stocks.

A third problem may be the ownership structure of the house. In particular, most homeowners use the house as collateral for the mortgage. That is, a mortgage provider is also a stakeholder in the house. Selling the (excess) value on the house would introduce additional stakeholders, which could potentially lead to problems if there are differences in the interest of those stakeholders (for instance in case of default).

Finally, although free trade in house value may substantially mitigate house price risk, it clearly cannot fully shelter the homeowner against market risk (e.g. the subprime crisis). As a consequence, homeownership may still be associated with a substantial amount of house price risk even if a stock market based on house value would exist.

In sum, this chapter has emphasized the potential risk-reducing benefits of a financial market based on house value, but further research should focus on how such financial markets could be implemented and what the effect of this implementation would be on the functioning of the housing market.

Chapter 6

Conclusion

This dissertation has examined the uncertainty in house prices in the Netherlands from a homeowner's perspective. This thesis focused on two topics that are directly related to house price uncertainty. In particular, this dissertation first investigated the sale price expectations of Dutch homeowners in relation to mortgage commitment and residential mobility. Secondly, I tried to answer how large the uncertainty in house prices (house price risk) is and whether this risk could be reduced if homeowner could invest in each other's property.

6.1 Summary of the findings

Chapter 2 investigated the homeowner's self-reported home value, sale price expectations, in the Netherlands. One of the key contributions of this chapter is that it reformulated the housing market model of Stein (1995) to include mortgage commitment based on the loan payment-to-income (LTI) ratio since homeowner in the Netherlands face an income constraint in loan qualification instead of a down-payment constraint. In accordance with Stein's fishing hypothesis, the results have shown that an increase in the LTI ratio decreases the chance that a homeowner wants to move within two years, while it increases owner-reported home values. That is, a homeowner seems to compensate for his inability to move due to the mortgage constraint. These results suggest that Dutch homeowners act as price-setters in the housing market. Not only fundamental factors, such as the characteristics of the house, but also institutions and the individual behavior (characteristics) of homeowners play an important role in the homeowner's price expectation formation. From a policy perspective, this chapter also investigated the impact of removing the government's net subsidy on owning a house (i.e. mortgage tax deductibility) on sale price expectations and residential mobility. Although removing this net subsidy increases the LTI ratio, the estimates in this chapter suggested that the direct impact of this change on sale price expectations and residential mobility may be negligible. Further research should focus on the long term impact of such a policy change.

Chapter 3 analyzed the impact of sale price expectation (expected housing capital gains) on residential mobility. In particular, many studies in the housing market literature have found that an increase in housing capital gains has a positive effect on housing demand and residential mobility in the presence of minimum down-payment requirements. In this chapter, I showed a "bare bones" microeconomic housing consumption model that explained that this standard result may not necessarily hold in a setup without down-payment constraints. Specifically, Chapter 3 formalized that an increase in house price may increase housing capital gains, but for the typical homeowner it also increases the cost of buying a new home. If this cost effect dominates the capital gains effect, house price increases may have a negative effect on housing demand. I argued that this result is especially likely to occur for those homeowners who want to trade up the property ladder. Instead, housing demand may well be upward sloping for those homeowners who decide to trade down. I found empirical evidence of these effects based on the variation in whether homeowners want to move within two years. These results suggest that the price expectations of homeowners play an important role in residential mobility (i.e. the main allocation mechanism in the housing market). These results may be interesting for governments, or realtors for that matter, since they play a crucial role in the formation (managing) of such expectations through, for instance, the mortgage tax deductibility or assessed value of the house (i.e. see Chapter 2).

Chapter 4 investigated the size of house price risk. The results in Chapter 4 have indicated that this risk may be substantial. In particular, Chapter 4 showed that house price risk, based on the volatility of yearly house price changes between 1995 and 2008, may be as large as 42 percent (row houses) to 143 percent (detached houses) of the housing investment. Especially for detached houses and apartments this risk may be relatively high, while it is relatively low for row houses. In addition, the findings in this chapter showed that the risk per unit of return was two to three times higher during the economic downturn in 2003 and 2008 than during the economic boom in 2000 and that there is a clear core-periphery pattern in risk and returns. In this chapter, I also discussed the hedging benefits of homeownership. In particular, the uncertainty in the price of the current home may cancel out against the uncertainty in the price of the future home if a homeowner buys a new home. The results in this chapter suggested that a homeowner may be hedged against 69 percent (apartments) to 102 percent (corner houses) of the house price changes in Amsterdam. This result especially applies to homeowners with a relatively long investment horizon or homeowners who move to nearby correlated housing markets. Instead, this chapter did not find much evidence of the natural hedging benefits of homeownership based on yearly price changes per house. Hence, these results imply that there may be some hedging benefits of homeownership, but that the hedge quality is in many cases far from perfect. As a result, there may still be a potential role for other methods to reduce house price risk, such as insurance products and a financial (derivatives) market based on house prices. From a policy perspective, these results also suggest that it may be beneficial to inform the homeowner about the potential financial (house price) risk of owning a home. I argued that this could be achieved by a financial property brochure/risk label on each home.

Finally, Chapter 5 discussed free trade in the value of the house among homeowners as a possible method to reduce house price risk. Specifically, owning a home is risky since most homeowners invest their wealth at a single location. Instead, if homeowners could invest in each other's property, house price risk would be substantially reduced since homeowners would share house price risk. This chapter showed that the diversification benefits of free trade in the value of the house are substantial. In particular, based on standard CAPM model estimates, I showed that the reduction in house price risk could be as large as 93 to 96 percent. In most cases, these risk-reducing benefits of free trade dominated the hedging benefits of house price futures. I argued that free trade could be facilitated by a financial market based on the value of the house. In addition, the diversification benefits could also be obtained if homeowners would jointly buy houses or if they would sell their houses to, for instance, the government or housing corporations. Further results indicated that house price risk (market risk) is also priced. In particular, this chapter showed that the yearly risk premium on housing is between 3.0 percent (corner houses) and 8.3 percent (detached houses) on top of the average risk free rate of 3.8 percent.

In sum, the results in this dissertation suggest that the paradigm that owning a home is profitable only may be a risky perspective to take. I do not mean to imply that households or other investors in real estate should not own houses, but just that, in doing so, they should be aware about the price risk associated with owning a home.

6.2 Limitations and suggestions for future research

This dissertation has investigated several aspects of the uncertainty in house prices. However, the results in this dissertation may be interpreted as part of a broader framework of analysis. In particular, I discuss five directions for future research.

First, I examined the price expectations of homeowners and whether they wanted to move within two years. That is, this thesis studied homeowners at the beginning of the transaction process. This reflects the focus of this dissertation on house price uncertainty. Specifically, house prices are uncertain before the final transaction price has been realized. Therefore, an important extension that would increase our understanding about the decision-making process of households would be to analyze the full transaction process (e.g.

interaction between buyers and sellers, realtors), from price expectations to final transaction prices, in more detail.

Second, I studied the patterns in house price changes and the volatility of those changes (house price risk). As such, I provided a simple framework to analyze those patterns. This framework could easily be extended to include some determinants of house price risk. For instance, in Chapter 4, I hinted at the effect of supply restrictions on house price changes and house price volatility. A regional approach that would investigate this issue would, to my opinion, be valuable to homeowners, realtors, and local governments. Moreover, this framework could for instance also be used to examine the impact of the financial crisis on house price risk. This study provided some simple methods and measures that could substantially benefit such research.

Third, this dissertation also discussed the natural hedging benefits of homeownership, housing stocks, and house price futures to reduce house price risk. A more structural analysis of these and other alternatives (e.g. insurance, financial markets) may be extremely helpful to understand how to manage this risk.

Fourth, although this thesis focused on house price risk, there may be other risks associated with owning a home (e.g. default risk, interest rate risk, lock-in risk, housing consumption risk), and there may also be other financial risks (e.g. pension risk) than only house price risk. A model or study that would combine these different risks could increase our knowledge about the possible interdependencies between those risks. In addition, such an approach would allow us to examine the relative magnitude (importance) of those risks.

Fifth, the first part of this dissertation has investigated the housing decisions of individuals, while the second part of this thesis examined house price risk. Therefore, a natural extension would be to combine both analyses. That is, it would be interesting to investigate the effect of house price uncertainty on housing decisions. There have been some recent advances in understanding the implications of house price risk for the tenure choice and housing demand (i.e. see Sinai and Souleles, 2009; Han, 2010, respectively). However, there is still not much known about this issue.

Although there is an increasing body of literature on the uncertainty in house prices, there are to my opinion still many aspects of this uncertainty that are unknown to economists and policy makers. In this dissertation, I highlighted several aspects of house price risk, but I also emphasized that further research on this topic would be invaluable to homeowners and other investors in real estate.

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Samenvatting (Summary in Dutch)

Huizenprijzen zijn tot voor kort flink gestegen. Deze prijsstijgingen hebben het huis, naast een consumptiegoed, ook tot een winstgevende investering gemaakt. Het bezitten van een huis is echter niet alleen winstgevend, maar ook riskant. Huizenprijzen kunnen immers dalen of een huis kan minder opbrengen dan verwacht. Kortom, de opbrengsten op een huis zijn onzeker. In dit proefschrift wordt de onzekerheid in huizenprijzen in de Nederlandse woningmarkt vanuit het perspectief van de huiseigenaar onderzocht. Het proefschrift bestaat uit twee delen.

In het eerste deel van dit proefschrift (hoofdstuk 2 en 3) staan de verkoopprijsverwachtingen van huiseigenaren centraal. Huiseigenaren vormen verwachtingen over de verkoopprijs omdat deze onzeker is. In dit proefschrift worden dergelijke prijsverwachtingen in relatie tot de hypotheek en de verhuisbeslissing geanalyseerd. Gegeven dat (prijs)verwachtingen een belangrijke rol spelen in het functioneren van de huizenmarkt, is het van fundamenteel belang voor bijvoorbeeld beleidsmakers of makelaars om te begrijpen hoe dergelijke verwachtingen worden gevormd en hoe deze verwachtingen de beslissingen van huiseigenaren beïnvloeden.

In het tweede deel van dit proefschrift (hoofdstuk 4 en 5) wordt onderzocht hoe groot de volatiliteit (onzekerheid) in huizenprijzen is, wat de patronen hierin zijn en of het mogelijk is om deze volatiliteit te reduceren. Omdat het huis veelal een substantieel deel is van het totale netto vermogen van huishoudens, kunnen onverwachte prijsveranderingen een groot effect hebben op het vermogen, en dus de welvaart, van deze huishoudens. Vandaar is het van cruciaal belang om te onderzoeken hoe groot het prijsrisico is dat huiseigenaren lopen.

In hoofdstuk 2 staat de vorming van verkoopprijsverwachtingen van huiseigenaren centraal. In dit hoofdstuk ligt de focus met name op het effect van de hypotheek op deze verwachtingen. De resultaten in dit hoofdstuk laten zien dat huiseigenaren die veel van hun maandelijkse inkomen kwijt zijn aan rentebetalingen op de hypotheek, en dus moeite hebben om eventueel te verhuizen, de neiging hebben hiervoor te compenseren via een hogere (verwachte) verkoopprijs van het huis. De resultaten in dit hoofdstuk impliceren dat, naast de fysieke karakteristieken van het huis, de karakteristieken van de huiseigenaar ook een belangrijke rol spelen in verkoopprijsverwachtingen. Kopers moeten dus niet alleen letten op wat ze kopen, maar ook van wie ze kopen. Verder wordt in dit hoofdstuk behandeld wat het effect zou zijn op prijsverwachtingen en verhuismobiliteit als de fiscale aftrekbaarheid van het huis zou worden afgeschaft. De resultaten in dit hoofdstuk tonen aan dat het directe effect van het afschaffen van de fiscale aftrekbaarheid beperkt zou zijn. Niettemin kunnen er grote indirecte/lange termijn effecten zijn, maar daar zou toekomstig onderzoek uitsluitsel over moeten geven.

In hoofdstuk 3 wordt onderzocht hoe de verwachte prijsopbrengst op het huis de vraag naar een nieuw huis, de verhuisbeslissing, beïnvloedt. De standaard literatuur over dit onderwerp is voornamelijk gebaseerd op onderzoek in de Verenigde Staten. In deze literatuur wordt beargumenteerd dat een stijging in de huizenprijs een positief effect heeft op de keuze om te verhuizen. De stijging in de overwaarde van het huis kan namelijk gebruikt worden om een aanbetaling op een nieuw huis te doen. Een dergelijke aanbetalingverplichting geldt echter niet direct in Nederland. De vraag die dan dus ook in dit hoofdstuk wordt gesteld is of een stijgende huizenprijs ook een positief effect heeft op de verhuismobiliteit van huiseigenaren in Nederland. Op basis van een eenvoudig micro-economisch model laat dit hoofdstuk zien dat een stijging in huizenprijzen niet persé de keuze om een nieuw huis te kopen positief beïnvloedt. Een prijsstijging betekent immers dat het huidige huis meer oplevert bij verkoop, maar ook dat het kopen van een nieuw huis duurder is. Met name voor huishoudens die naar een groter huis in de toekomst willen verhuizen kan zodoende het effect van een prijsstijging een negatieve impact hebben op hun bereidheid om te verhuizen. De huizenvraag zal in alle waarschijnlijkheid echter stijgen voor die mensen die naar een kleiner huis willen verhuizen. Dergelijke effecten worden ook empirisch teruggevonden. De resultaten in dit hoofdstuk impliceren dat prijsverwachtingen een cruciale rol spelen in verhuismobiliteit, het voornaamste allocatiemechanisme in de huizenmarkt. Dit is met name interessant voor overheden/makelaars omdat zij een belangrijke rol spelen in de vorming van dergelijke verwachtingen via bijvoorbeeld de hypotheekrenteaftrek of de WOZ waarde (zie hoofdstuk 2). Het effectief managen van (prijs)verwachtingen, zoals dat bijvoorbeeld ook door centrale banken wordt gedaan, zou dus mogelijk een belangrijke bijdrage kunnen leveren aan het beter laten functioneren van de huizenmarkt.

In hoofdstuk 4 wordt onderzocht hoe groot het prijsrisico is dat huiseigenaren lopen en of hierin patronen te vinden zijn met betrekking tot bijvoorbeeld het type huis. In dit hoofdstuk worden een aantal eenvoudige maatstaven geïntroduceerd om het prijsrisico te kwantificeren. De resultaten in dit hoofdstuk laten zien dat het prijsrisico substantieel kan zijn. Er wordt bijvoorbeeld gevonden dat het maximale prijsrisico gebaseerd op de volatiliteit in jaarlijkse opbrengsten tussen 1995 en 2008 varieert van 42 procent (rijtjeshuizen) tot 143 procent (vrijstaande huizen) van de totale gemiddelde investering in het huis. Het prijsrisico is vooral hoog in de Randstad, als het economisch slecht gaat, voor vrijstaande huizen en appartementen. In hoofdstuk 4 wordt ook de "natuurlijke" dekking tegen dit risico besproken. Een prijsstijging in het toekomstige huis kan immers afgedekt worden door een waardestijging van het eigen huis. De resultaten in dit hoofdstuk tonen aan dat de kwaliteit van deze dekking gemiddeld tussen de 69 procent (appartementen) en 102 procent (hoekwoningen) relatief tot de prijsstijgingen in Amsterdam ligt. Dit geldt voornamelijk voor die huiseigenaren die tussen huizenmarkten met gelijkende prijsontwikkelingen verhuizen en die een relatief lange investeringshorizon hebben. In veel gevallen echter is de dekking tegen prijsrisico verre van perfect. Zodoende wordt er in dit hoofdstuk beargumenteerd dat er ruimte is voor andere methoden om dit risico te beperken. Hierbij kan men denken aan verzekeringen of een financiële markt gebaseerd op huizenprijzen (financiële derivaten). Tevens wordt in dit hoofdstuk gesteld dat het belangrijk is om huiseigenaren te informeren over het prijsrisico dat ze lopen, zoals dat bij veel andere investeringen al verplicht is. Dit zou kunnen gebeuren door een financiële brochure bij de verkoop van het huis of een risicolabel op het huis.

In hoofdstuk 5 wordt beargumenteerd dat vrijhandel in de waarde van het huis tussen huiseigenaren het prijsrisico dat zij lopen zou kunnen reduceren. Het prijsrisico is immers groot omdat huiseigenaren in veel gevallen maar op één locatie investeren. Als huiseigenaren in elkaars huis zouden kunnen investeren zouden ze het prijsrisico samen kunnen delen. De resultaten in dit hoofdstuk tonen aan dat een dergelijke strategie de volatiliteit in de opbrengst op het huis (prijsrisico) met 93 tot 96 procent zou kunnen reduceren. Vrijhandel in de waarde van het huis zou gerealiseerd kunnen worden door een financiële (aandelen)markt gebaseerd op de waarde van het huis. Ook zouden huiseigenaren samen huizen kunnen kopen of hun huis kunnen verkopen aan de overheid of woningcorporaties om het prijsrisico te verminderen. Verder wordt er in dit hoofdstuk gevonden dat het risico in de Nederlandse huizenmarkt (marktrisico) ook een prijs heeft. De resultaten in hoofdstuk 5 tonen aan dat de risicopremie op het huis bovenop de risicovrije rentevoet van gemiddeld 3.8 procent (1996-2008) varieert van 3.0 procent (hoekwoningen) tot 8.3 procent (vrijstaande huizen).

In dit proefschrift wordt benadrukt dat het bezitten van een huis weliswaar winstgevend kan zijn, maar dat er ook een prijsrisico aan een dergelijk bezit verbonden is. Er wordt niet geclaimd dat huishoudens of andere investeerders geen huizen moeten kopen, maar dat huiseigenaren (beter) bewust moeten zijn van het prijsrisico dat ze lopen door het bezit van een eigen woning. In dit proefschrift zijn enkele aspecten van dit prijsrisico onderzocht. Verder onderzoek zou echter van grote waarde zijn voor huiseigenaren en andere investeerders in vastgoed.

Curriculum Vitae

Martijn Isidoor Dröes was born in Utrecht, the Netherlands, on September 19, 1983. He graduated from high school (gymnasium) at St. Bonifatiuscollege in 2002. He studied Economics with a minor Social Sciences at Utrecht University School of Economics (USE) from 2002-2005. After he received his Bachelor's degree (cum laude), he enrolled in the Master's Program International Economics and Business at USE. He wrote his master thesis entitled "The effect of oil prices on output of industrialized net oil importing countries from 1988-2005 in a panel data setting" during an internship at TNO, Built Environment and Geosciences, in Delft. After he graduated with honors (cum laude) in 2006, he became a PhD student at USE. His PhD position was partly financed by TNO. As of January 2011, he works as a researcher/lecturer at TNO and USE.

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