The price responsiveness of housing supply in the Netherlands

Master Thesis in Finance

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Abstract

This study examines the price responsiveness of housing supply for seven different categories of dwellings in the Netherlands on a national aggregate level and its twelve provinces separately. Based on the Engle and Granger two-step estimation procedure a regression model of the housing market is estimated within an error correction framework. The model exists of a supply and demand equation on the long-run and on the short-run. Estimates suggest that the price elasticity of housing supply on the long-run is mostly inelastic, except for Drenthe, Utrecht, Noord-Holland and Zuid-Holland. Inflexible housing supply due to policy setting might cause the price elasticity to be inelastic. The exceptions found for four provinces could be caused by more flexibility on a local level. In addition it is hard to find a pattern in the price elasticity of housing supply on the short-run. Most of the estimates are insignificant, what might indicate that housing supply is not flexible on the short-run and the price effect might be irrelevant. Furthermore, these results could be of practical use to policymakers when setting new policy.

Key words: Housing supply, Housing markets, House prices

Table of Contents

1. Introduction

Statistics Netherlands (CBS) announced on February 22, 2017 that the amount of newly issued building permits has increased with thirty percent in 2017 compared to 2016[1]. This equals a total amount of issued building permits of approximately 70.000. The level of building permits issued is getting closer to the level before the 2008 financial crisis, with an amount of on average 80.000 during the period 2000 - 2008. The total construction costs of issued permits show the same trend. There has been an increase of twenty-six percent, which equals an investment of approximately 16.9 billion euros. This is an enormous stimulator for the economy. The average processing time after these building permits are granted is still 2 years and according to the press release of January 11, 2018[2] of the NVM, the largest Dutch association of brokers and appraisers, there is an enormous shortage on the housing market in the Netherlands.

Despite a growing recognition of the importance of supply conditions for the level and volatility of house prices, empirical work on housing supply outside the US is scarce. There are some studies, but almost all of them are on a national level. Vermeulen and Rouwendal (2007) and Swank, Kakes and Tieman (2002) were one of the few to study housing supply in the Netherlands, however this was on a national level as well. This study investigates the housing market on a regional level. It takes a closer look at the demand and supply in the different provinces in the Netherlands.

The housing market is very important for a good economy to function well. Rising house prices can stimulate consumption. This is mainly due to a phenomenon called the real estate wealth effect. Homeowners feel richer if house prices rise, which stimulates consumption. A study by Campbell and Cocco (2007) shows that rising house prices indeed stimulate consumption. Many studies find similar evidence, see amongst others Bhatia (1987), Benjamin, Chinloy and Jud (2004), Case, Quigley and Shiller (2005) and Muellbauer and Murphy (1990). This stresses again the importance of the housing market for the economy in general. However, if this market does not work efficient it might cause negative consequences such as bubbles (Glaeser, Gyourko & Saiz, 2008).

CBS announced on December 5, 2011 that housing associations own one in three Dutch homes[3], which is the equivalent of 2.3 million houses. On December 13, 2016 CBS announced that the percentage of homes owned by housing associations in 2014 decreased a bit to thirty percent, which still equals 2.3 million houses[4]. This implies that the total stock of dwellings increased during that period. Since these housing associations fall under the Dutch housing law and because these associations own a large share of the total Dutch housing market, the Dutch government potentially has a lot of influence on the Dutch housing market.

[1] https://www.cbs.nl/nl-nl/nieuws/2018/08/stijging-aantal-vergunde-nieuwbouwwoningen
[2] https://www.nvm.nl/actueel/persberichten/2018/woningmarkt2017q4
[3] https://www.cbs.nl/en-gb/news/2011/49/housing-associations-own-one-in-three-dutch-homes
[4] https://www.cbs.nl/nl-nl/nieuws/2016/50/corporatiebezit-neemt-af

Besides this, the Dutch government makes use of a zoning system. The zoning system implies a segmentation of land markets and essentially turns the supply of residential land into a policy outcome.

Currently there is an enormous shortage on the Dutch housing market, hence research related to the relation between price and supply on this market is relevant and might help the Dutch government to understand the consequences of its policy setting in this respect. Although the price responsiveness of housing supply in 21 OECD countries (Caldera & Johansson, 2013) and in the Netherlands (Vermeulen and Rouwendal, 2007) (Swank et al., 2002) has been studied before, these types of research draw more general conclusions based on national averages. This study will include regional effects by looking at housing supply at a provincial level. In addition this study investigates the different responses of housing supply for different categories of dwellings. Moreover, the data used in this study is more recent, covering the period from the first quarter of 1995 to the fourth quarter of 2012. A model of the housing market will be estimated based on the Engle and Granger two-step estimation procedure.

The above explains why this study focuses specifically on the housing supply in the Netherlands and the main research question is therefore:

Main research question:

What is the effect of house prices on housing supply in the Netherlands?

This study first provides an overview of relevant literature. This will make the reader familiar with the problem and literature available. Various papers which discuss housing prices and housing supply will be compared and discussed. An analysis of the history of the development of the house prices in the Netherlands will also be part of this overview. The section will be finished by the formulation of the hypotheses. Section 3 gives an overview of the data used. The empirical methodology and the results are presented in Section 4 and Section 5 concerns the discussion. Section 6 contains the conclusion and suggestions for further research.

2. Literature review and hypotheses

2.1 Historical house prices in the Netherlands

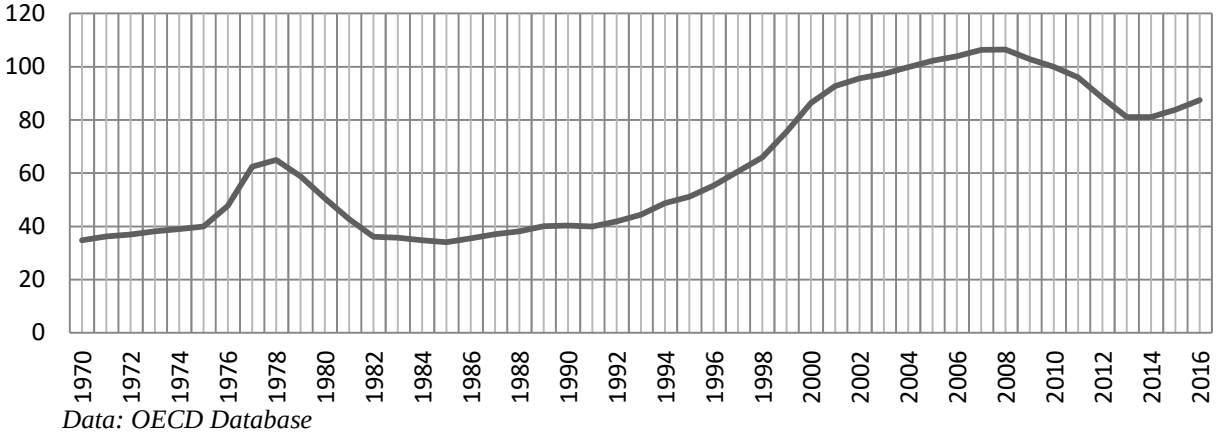
House prices move up and down over time. An analysis of the history of the development of the house prices can help in getting a better understanding of the movement of these prices. Boelhouwer (2000) studied the development of the house prices in the Netherlands from 1965 till 1998 in an international perspective. Boelhouwer (2000) distinguishes four different phases in this period. However, one should keep in mind that his study is based on national averages. Since the housing market is a regional market, it is possible that particular areas might diverge from these figures and show a different pattern.

According to Boelhouwer (2000) the first phase is from 1965-1972, during which the development of the prices, corrected for inflation, was stable. Figure 1 illustrates this view.

The second phase covers the years 1973 to 1982. A strong price increase took place in these years which reached its peak in 1979. At that point, the prices started to decline at the same pace. By 1983 the real level of 1973 was reached. Boelhouwer (2000) mentions three reasons for the increase. First the influence of government and other institutions. In 1972 the Dutch Central Bank (DNB) decided to abolish the controls on credit. This gave the possibility in particular to the commercial banks to expand their mortgage portfolio. In 1972 the municipal mortgage guarantees were introduced for existing dwellings. These guarantees were expanded in the following period. Besides that, the rules for banks on which they decide whether or not to write a mortgage were extended considerably. Now, in some cases, banks could go as high as 125 percent of the market value of a dwelling for a loan. Before, banks were limited to only 70 percent of the market value. This led to an enormous grow in demand for owner-occupied dwellings. The second reason of the house price increase was the development of a number of economic variables. During the mid-seventies the economic circumstances were very positive. Incomes were rising and in addition the mortgage interest rates were low and decreasing. The third reason for the growth of the house prices is the dynamic of the market mechanism, specifically the effect of speculation which will be further elaborated on in section 2.2.

Figure 1

Real House Price Development in the Netherlands (2010 is 100)



Data: OECD Database

The decrease, which started in 1979, was mainly due to the second oil crisis, which caused income growth to stagnate and mortgage interest rates to rise. The government policy and the policy set by banks worsened the situation. The aforementioned conditions for mortgage lending and the expanded municipal mortgage guarantees were therefore tightened again. The bubble, which was due to the speculative effect, burst and led to a sharp decline in prices. According to Boelhouwer (2000) phase three, from 1983 to 1985, shows a different picture. Nominal housing prices stabilized, while real housing prices dropped further till the level of 1972 was roughly reached. After this a period of growth started.
Phase four, 1986 - 1998, shows a positive development of both nominal and real prices. Only during the Gulf War, which was fought from 1990 to 1991 and caused economic instability, there was a decline in prices. After the war ended prices started to rise again in 1992. The analysis of Boelhouwer stops at 1998, but Figure 1 shows that two other phases can clearly be detected. First, phase four continues to run till 2008. Phase five runs during the economic crisis, from 2008 to 2013, and shows a sharp decrease in prices. Phase six runs from 2014 onwards and shows the start of the recovery of the financial crisis on the housing-market in the Netherlands.

2.2 Influencing factors on the housing price

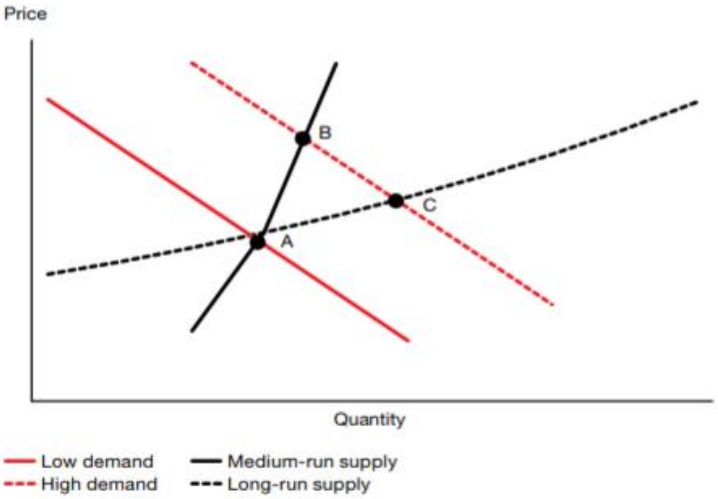
Literature shows that there are numerous factors that influence housing prices of which some have been mentioned in the preceding section. The following section discusses the most commonly found factors in literature.

Theoretical explanation

According to the classical law of demand and supply, the demand for houses will decrease when the house prices increase and the housing supply will increase.
Applying the theory of law and demand to the housing market, is particularly suitable for liberalized housing markets where supply and demand are not likely to be obstructed by regulations or other restrictions, as for example the availability of sufficient land to build on. However, it is possible that there are shifts in demand or supply, which can lead to a movement of the entire demand or supply curve. One of these so called shifts is the future expectation. If producers think they can make more profit on their product in the future, they will hold back supply now and increase supply later. If the market is not in equilibrium, there can be either a surplus or a shortage. A surplus means that the quantity supplied is greater than the quantity demanded. A shortage, on the contrary, means that the quantity demanded is greater than the quantity supplied. Theoretically, both of these situations will shift back to equilibrium by a change in the price. However, it should be kept in mind that the supply of housing adjusts slowly. There is time required for planning, to adjust the capacity of the construction industry and it may take several years to complete a building plan. This production lag makes it possible to see heavy price fluctuations in the short-run, which average out in the long-run. Figure 2 illustrates this view. The dotted lines represent the long-run supply and demand curve, in respectively black and red, while the bold lines represent the medium/short-run curves.

Figure 2

Supply and demand in the medium-run and long-run



Source: Peterson & Zheng (2011)

Suppose there is a demand shift which shifts the long-run demand line upwards from the bold one to the dotted one. Since the supply of housing adjusts slowly, the equilibrium in the short-run moves from A to B, which leads to a heavy increase in the price. In the long-run the supply adjusts to the new demand and the quantity increases, which causes the price to move back to the long-run equilibrium, point C.

In literature there is supportive evidence for this theory. Abraham and Henderschott (1994) studied the real house price movements in 30 cities in the United States in the period from 1977 to 1992. They find a decline in prices on the long-run after an initial sharp rise in price. For some cities there was an initial decline, which was reversed on the long-run by an increase in house prices. Abraham and Henderschott estimate that 3 to 6 years after the boom in price has ended, the most intense decline finds place, with the possibility of a very long period of adjustment. Positive economic developments can significantly reduce this effect. Hort (1997) similarly finds real appreciation rates to be positively correlated in the short-run and negatively correlated in the long-run. Her study was related to 20 urban areas in Sweden in the period from 1967 to 1992 and the reverting pattern applies to all of these areas. This impression is shared by Ball and Grilli (1997) as shown in their study of the relation between housing market developments and the economic convergence in Europe. Their study covers the years 1970 to 1994 and for most countries they observe short periods of strong price increases, followed by longer periods of decreasing prices, respectively the boom and bust period. Ball and Grilli suggest that the strong rise in prices is the effect of impulses caused by the demand, to which the supply can only respond to a limited extent. The boom period is much shorter than the bust period, which indicates that price increases are in general thought of as flexible and price decreases are inflexible.

Demographic factors

Next, demographic factors are one of the conventional fundamental determinants of the development of the house prices where literature agrees upon. Égert and Mihaljek (2007) studied the determinants of house prices in eight transition economies of Central and Eastern Europe and 19 OECD countries. The main question they tried to answer is whether the conventional fundamental determinants have driven the observed house prices in Central and Eastern Europe. Their main result is that these factors, including demographic factors, indeed are important determinants of the house prices in this region. They find a positive relation between the coefficient of the share of the working-age population in total population and the demand for houses. This implies that more people in the working-age group relative to the total population leads to higher demand for houses, hence higher prices.

Mankiw and Weil (1990) studied the impact of major demographic changes on the housing market in the United States. In the fifties the number of births increased heavily, which was followed by a decline in the seventies. These periods, respectively the baby boom and baby bust, are widely recognized as the most important changes in the United States with regard to demographics. Mankiw and Weil conclude that these major events cause large and predictable changes in the demand for housing, which in turn causes large fluctuations in prices. Especially ageing of the baby boom generation led to a heavy increase in prices between 1970 and 1980. However, their model about the development of the housing market was entirely based on the development of the demographic factors. This shows that the demographic factor is indeed of importance to explain the movement in housing prices but cannot explain this on its own.

Speculative effects

The speculative effect is an effect that appears in general on the short-run on housing markets, when the relation between supply and demand is out of balance. This currently seems to be the case in the Netherlands according to the press releases mentioned before. The speculative effect suggests that future demand is influenced by the price development in the recent past. This causes the predictability of house prices. Since housing is a complex and durable good, it cannot be delivered immediately to the market. Therefore production lags could be to a certain extent responsible for the predictability of house prices (Case & Shiller, 1989). On the housing market this means that if house prices rise, consumers act quickly and buy or invest in owner-occupied dwellings. On the contrary, consumers postpone their decision to buy or invest when prices drop. The result of the possible presence of a speculative effect is that the price development of the preceding period is incorporated as an independent variable in econometric models in studies with regard to the housing market.

Meen (1998) found supportive evidence for this view. He proved that house prices in the most recent four quarters could be explained partially by the price trend of the preceding four quarters. Muellbauer and Murphy (1994) have a slightly different theory which explains why the price development in the recent past influences the demand in the near future on the housing market. Increasing house prices result in an increase of the assets of the owners of dwellings. This makes

it possible for homeowners to take the next step with respect to their housing career. Therefore the increased demand causes prices to keep on rising.

Reichert (1990) finds the presence of a speculative effect in the United States for the period 1975 – 1987 on a national level. The study of Abraham and Henderschott (1994) about the real house price movements in 30 cities in the United States in the period from 1977 to 1992 has incorporated the speculative price in their model. As mentioned before they find a reverting pattern on the long-run. They tried to explain the price fluctuations on the short-run by the speculative effect. However, they only could prove this effect in the coastal area where the equilibrium has also been disturbed by market imperfection since there is a scarcity of land. Levin and Wright (1997) found that speculation is a possible determinant of house prices in London and in the United Kingdom as a whole for the period 1969 – 1995. As mentioned before the effect of speculation has been found in the Netherlands for the period 1973 – 1982 (Boelhouwer, 2000). Especially during the strong changes in price during the period 1976–1983 this effect was clearly noticeable (Boelhouwer, Conijn & de Vries, 1996).

Hort (1997), on the other hand, finds no evidence for a speculative effect on the Swedish house market. She identifies a cointegrated relationship between real house prices, real total income, real user costs and real construction costs. In the period from 1967 to 1992 the house price fluctuated heavily in Sweden and her study investigates whether part of these fluctuations can be explained by speculative behaviour in the housing market. The fluctuations are well explained by the variations in fundamental demand and supply conditions. Therefore, there is no basis to conclude that the fluctuations are due to speculative behaviour.

Institutional policy

A more structural factor that influences the movement of house prices is institutional policy. With regard to institutional policy, one could think of for instance, the policy of the government and large institutions like central banks. As stated before the institutional policy had a large influence for the house prices in the Netherlands in the period from 1973 to 1982, with the conditions for mortgage lending and municipal mortgage guarantees (Boelhouwer, 2000). However, Meen (1998) points out that since the eighties the trend in the United Kingdom and the United States has been to liberalize the financial market, which made the influence of restrictive rules on mortgage lending to decline and the influence of conventional fundamental determinants like demographical factors, income and interest rate to rise.

In their study about booms and busts in the housing market in the United Kingdom Muellbauer and Murphy (1997) find that, not only unfavorable demographic trends, high levels of debt and high real after tax interest rate have a dampening effect on future booms, but the greater awareness of default risk by mortgage lenders as well. By making use of interest rate policy institutions can still exert influence.

In international literature the above mentioned imperfection on the availability of sufficient land to build on is also often found as an explanatory variable related to the development of house prices. In line with this Monk and Whitehead (1996) took a closer look at the spatial planning system in the United Kingdom. They find that the planning system comes with significant costs,

like an increase in rising prices in economically good times without being capable to generate higher housing output during a recession. Besides that, they find evidence that the planning system restricts the choice available to consumers because it narrows the range of housing types down. Ho and Ganesan (1998) studied the development of the house prices in Hong Kong. They find that, next to the traditional demographic and economic variables, the speculative effect and land supply also influence the housing prices, even though the regression coefficient for these two factors are small. The empirical results suggest that an increase in land supply will cause the housing prices to decrease.

Economic developments

The effects of the aforementioned factors could be strengthened or weakened by favourable or unfavourable economic developments. Many studies include macroeconomic variables as exogenous control variables in their models. This could be for example the gross domestic product (GDP), inflation, unemployment or interest rates.

Especially income and the interest rate development are found to be two of the most common factors in the empirical models trying to explain the development of housing prices. McQuinn and O'Reilly (2008) find supportive evidence for this view by concluding that two of the key drivers of the boost of the house prices in Ireland during 1995 to 2005 are the rise in income and the favourable interest rate environment. In line with this, Kau and Keenan (1980) found that the interest rate has a negative relationship with the demand for houses, while income has a positive relationship. In the aforementioned study of Égert and Mihaljek (2007) of the determinants of house prices in eight transition economies, central and eastern Europe and 19 OECD countries, they find that these factors, including per capita GDP and real interest rates, indeed are important determinants of the house prices in these regions and they show the expected respectively positive and negative sign. Ball and Grilli (1997) studied the relation between the house prices and the macro-economic developments in Europe. Specifically for house prices they find a relation in all countries with the development of national income. They conclude that the general economic developments have a large impact on the housing market in the long-run. However, in the short-run they find the relation to be less clear.

However, many empirical models have difficulty to incorporate the effect of the interest rate movements and find reliable results. As McQuinn and O'Reilly (2008) note, studies with regard to the housing price development often find a coefficient which is of the counterintuitive sign or insignificant.

2.3 Housing supply

A crucial factor of the functioning of the housing market is the responsiveness of housing supply to price changes. Housing supply is not a thoroughly researched field in academic literature. Housing is supplied in various types of dwellings. In the Netherlands these dwellings can be broadly divided into two main categories, namely single-family houses and apartments. The following section discusses the main findings about housing supply in literature.

Influencing factors

The factor which is most commonly found to influence the development of the housing supply is the housing price. As mentioned before the law of supply can be applied to the housing market. This law suggests that the housing supply will increase, when the price goes up. This is because an increase in price, gives an incentive to produce more houses as these can be sold for higher prices. Hence the supply curve is upward sloping. Restrictive land use policies might increase the steepness of the supply curve, which enhances the sensitivity of prices to demand shocks. Since housing is a complex and durable good, it is well known that the supply of housing adjusts slowly to price changes. This causes that the supply curve is steeper on the short-run than on the long-run. See for instance Hanushek and Quigley (1979) and Case and Shiller (1989). This is also illustrated before by Figure 2.

In literature there has been ample evidence for the relation between house prices and housing supply. Égert and Mihaljek (2007) state that housing supply depends usually on the profitability of the construction business, which depends positively on house prices and negatively on the real costs of construction. Gyourko and Saiz (2006) argue that the cross-sectional variation between construction costs in the United States housing markets in 56 different metropolitan areas is primarily due to supply shifts like the unionization within the local construction sector, local wages, the local regulatory environment and local topography in terms of the presence of high hills and mountains. Moreover there is greater heterogeneity between these different housing markets in the United States in house prices than in construction costs. Besides that, the high degree of construction volatility, as observed in high growth markets, is compatible with lower building costs in these markets.

Saiz (2010) shows supportive evidence that geographic factors, like the availability of land to build on, also has an impact on the housing supply. Caldera and Johansson (2013) state that housing supply does not only depend on national geographical and urban characteristics but on policies as well. They find the time it takes before one obtains a building permit to be of influence as well. The longer it takes, the lower the elasticity tends to be.

Saiz (2010) shows that land available to build on increases the elasticity of the housing supply. Glaeser et al. (2008) and Gyourko (2009) found evidence that in supply-constrained housing markets most of the adjustments appear in the housing price instead of in expanding housing supply. Glaeser and Gyourko (2003) looked at the effects of land-use controls, specifically zoning, on housing supply in the United States. Zoning is the process of dividing land into zones, where certain land uses are permitted or prohibited, for example residential zones or industrial zones. As a consequence the supply of residential land is not decided by the market but by the government. Glaeser and Gyourko (2003) find that the lack of supply which causes high house prices is due to land-use controls, like zoning. In most of the places they took into consideration in their study, land costs are low or reasonable and house prices are close to the costs of new construction. In places where housing is more expensive this seemed to be caused by building restrictions. They find suggestive evidence that measures of zoning strictness are found to be highly correlated with high prices. However they did not take any benefits caused by zoning into

account. Stricter regulatory policy is also associated with fewer permits to be issued. This relationship is less clear, since unregulated areas also have shown low levels of issued permits, but there is still a strong relationship between the building activity and the degree of regulation (Gyourko & Glaeser, 2008).
To summarize literature agrees upon the fact that land use regulations are a restrictive factor on the supply of new housing units, which causes prices to rise. Furthermore the house prices and construction costs are important factors that influence the development of housing supply.

The consequences of elastic versus inelastic supplied housing markets

The elasticity of housing supply also affect how bubbles would form and how they work out in markets (Glaeser et al., 2008). In areas where supply is inelastic bubbles on the housing price market are more common, larger and last longer. This is due to the fact that inelastic supply makes it more likely that prices confirm the expectations of increasingly rapid price appreciation, which is necessary for a bubble to continue. However, even in elastic housing supply markets bubbles can form, but they are likely to be shorter. Glaeser et al. (2008) also find that the volatility of house prices is higher in more inelastic markets, where supply is constrained by regulations.
Evidence from Grimes and Aitken (2006) suggests that, after a demand shock a relatively small increase in prices follows in regions with elastic housing supply. The responsiveness of the supply also matters for the volatility of house prices and economic stability. An unresponsive housing supply can increase the sensitivity of house prices to demand shocks and therefore influence private consumption patterns and residential investment.
Glaeser, Gyourko and Saks (2005) relate urban growth to the elasticity of the housing supply in their study. In places with higher elasticity it is more likely to have higher population levels when productivity increases. While inelastic places will be more likely to let the population levels be relatively unchanged, when the productivity increases. However, in these places this will lead to higher levels of income and higher house prices.
Saks (2008) shows that the elasticity of the housing supply influences the labor market in metropolitan areas in the United States. She found evidence that employment growth is lower in more inelastic places. She also suggests that the difference in elasticity between regions may also influence the composition of the population within regions. In more inelastic regions the price is likely to be higher, so it might lead to the fact that only rich people can move in. Since young people and minorities have a higher tendency to move, areas with inelastic supply may end up with a smaller share of these people in their population. This can lead to higher income inequality in inelastic regions.
In line with this Glaeser and Tobio (2007) found evidence that the population growth since 1980 in the Sunbelt region in the United States is not due to the sun-related conveniences of living in this region, but to the elasticity of the housing supply. Additionally the housing supply growth has been enormous and the prices are generally increasing slower than in the rest of the United States. This shows that the elasticity of the housing supply is not only influencing how much housing costs, but also plays a role in determining where people can live and how urban growth

appears. Summarizing, it is clear that inelasticity of housing supply can have a lot of possible negative effects.

Responsiveness of housing supply

An essential factor of the functioning of the housing market is the responsiveness of housing supply to price changes, or in other words, the elasticity of housing supply to house prices. Most of the previous literature on the elasticity of housing supply makes use of national data and empirical work on housing supply outside the US is scarce.

The widely recognized study of Topel and Rosen (1988), which uses quarterly data covering the years 1963 – 1983, estimates the elasticity of the housing supply of the United States as a national aggregate. They found the supply to be elastically, more specifically the estimated elasticities of housing supply to the house price was between 1 and 3 in the long-run and about 1 in the short-run. This is in line with the findings of Blackley (1999). She uses United States annual data covering the period 1950 – 1994 and finds estimates for the long-run elasticity of 0.8 to 3.7, depending on the dynamic specification of the model.

These studies are both on a national level. However, housing markets can very well differ between regions in a country. Saiz (2008) shows this by investigating the housing supply elasticity of 95 metropolitan areas in the United States. He estimates these elasticities by making use of satellite-generated data to precisely estimate the amount of developed land in each area. The range of these local elasticities is consistent with the national aggregate findings of Topel and Rosen (1988) and Blackley (1999). The five most inelastic markets all have a supply elasticity under 0.7 and the five most elastic markets all have an elasticity of over 2.9. More recently Caldera and Johansson (2013) studied the long-run price elasticity of new housing supply among twenty one OECD countries including the Netherlands. They find suggestive evidence that the elasticity varies significantly, in the range from 0.15 in Switzerland to 2.0 in the United States, between the different countries in the period 1980 to 2007. North America and a number of Nordic countries have for example more price elastic markets than the continental European countries and the United Kingdom, which are more rigid markets. The results of the United States are in line with previous studies.

Responsiveness of housing supply in the Netherlands

Literature on the elasticity of housing supply in the Netherlands is scarce. Vermeulen and Rouwendal (2007) were one of the few to look at the housing supply in the Netherlands. Based on national aggregate data covering the period 1970 – 2005 they find the elasticity of housing supply to be almost fully inelastic in the short-run, with an elasticity of 0.04. In the long-run they find an elasticity of 0.1. These elasticities may arguably be considered as negligible for any practical purposes. This is in line with the results of Swank et al. (2002), they could not find evidence for a price elasticity different from zero. Caldera and Johansson (2013) find a slightly higher elasticity of 0.19 for the Netherlands in the long-run and 0.47 in the short-run. According to Vermeulen and Rouwendal (2007) this might be an explanation of the higher growth and volatility of house prices in the Netherlands compared to most other countries.

Vermeulen and Rouwendal (2007) also find the elasticity of the housing supply to the demographic variable, measured as the total number of households, to be greater than the elasticity of the supply to prices. They argue that this is due to the fact that the Dutch government traditionally used the concept of "housing need". The housing need is estimated with stated preference data and demographic models. Since the Second World War there was a large shortage on the housing market, which led to the fact that production quantities were planned. In 1965 this evolved into the Spatial Planning Act (Wet op de Ruimtelijke Ordening). The Spatial Planning Act forms a top – down process going from the national government, who provides rough guidelines to the provinces and finalized by municipal zoning plans. These plans have to be updated approximately every ten years. This happens during a process that may take again several years. The zoning plans are legally binding and the procedure to make amendments is lengthy. In this system the supply of residential land is a policy outcome instead of a market outcome. Market signals can have effects, limited to the extent that government institutions are sensitive to them. Furthermore, even if these governmental institutions are responsive to price signals, then legal procedures significantly delay such responses.

Two important policy aims were the protection of open space and the direction of residential development towards certain locations. In order to protect open space, the supply of residential land at preferable places has been limited consistently through spatial planning over the past decades. The production of social housing was planned and subsidized before the early 1990s. Then the responsibility for the realization of housing supply and the provision of local public goods was shifted towards local governments and market parties. Municipalities had to subsidize social housing and other local public goods, like roads and parks. This was done with the money obtained from sales of land to private sector developers. Furthermore, new residential land has been taxed. This is most likely to make the supply of housing less responsive.

Summarizing, the zoning system implies a segmentation of land markets and essentially turns the supply of residential land into a policy outcome. In this setting it is likely that the price elasticity of housing supply is reduced and inelastic. Besides that, supply responses to prices are likely to be strongly delayed or even disabled. This is quite in line with Glaeser and Gyourko (2003) who found that measures of zoning strictness are found to be highly correlated with high prices.

2.4 Hypotheses

The first hypothesis formulated in this study concerns the difference of the elasticity of the housing supply between the different provinces in the Netherlands. It is recognized that housing is produced and consumed in heterogeneous markets, which reflect local characteristics such as zoning restrictions, availability of developable land, income growth, and demographics. Following the evidence of Saiz (2008) who shows that the regional price elasticity of the housing supply can differ from the national aggregate, the first hypothesis is formulated:

H_1: The different provinces in the Netherlands have different elasticities of housing supply to the house price.

This study looks at the different types of dwellings with regard to housing supply. It is likely that there is different demand for different types of houses, this results in different prices. As stated before, the factor which is most commonly found to influence the development of the housing supply is the housing price. Therefore the second hypothesis is as follows:

H_2: Different categories of dwellings show different elasticities of housing supply to the house price in the twelve provinces in the Netherlands.

The third hypothesis focuses on the difference between the elasticity of the housing supply with regard to the price and the demographic variable. As argued before the supply of residential land in the Netherlands is basically a policy decision instead of a market outcome. This is mainly due to the regulation of land use. The government has planned construction based on the housing need. The housing need estimate may be based more on stated preference data and demographic models than on the demand revealed in prices. For this reason, the third hypothesis is formulated as the following:

H_3: The elasticity of housing supply to the demographic variable is higher than the elasticity to the price in the majority of the twelve provinces in the Netherlands.

3. Data

3.1 Data resources

The data for the variables gross domestic product per capita[5], stock of total dwellings[6], share of the population aged between 25-44 years old, newly issued building permits for new housing and residential construction costs used as part of this studies is retrieved from StatLine, the database of CBS. The data with regard to the house prices for the different types of dwellings is retrieved from the land register (Kadaster) and the data with regard to the real interest rate is extracted from Datastream.

This study uses data on different types of dwellings with regard to the house prices. The different types of dwellings on which house price data is available are broadly divided into two main

[5] The gross domestic product per capita was given for the period 1995 – 2010 by the CBS. After 2010 CBS used a different method to measure the gross domestic product. Because of this there was a new base level in 2010. To get the data for the period 2010:1 – 2012:4 the growth percentage of the next period, obtained by the new method, was added to the value of 2010. The same method has been used to get the data for the other following periods.

[6] The data for the stock of the total dwellings was given for the period 1995 – 2010 by the CBS. From 2010 onwards CBS used a different method to measure the stock of the total dwellings. To obtain the connecting data for the periods after 2010, the net mutation, which was given for these periods, was added to the stock in the previous period. The net mutation was calculated by the sum of the number added to the stock minus the number withdrawn from the stock plus corrections.

categories, namely single-family houses and apartments. The category single-family houses is subdivided in total single-family houses, detached houses, terraced houses, end-of-terrace houses and semi-detached houses. For the apartments there is no subdivision. This study also looks at the total average house price development and the total single-family house price development. The total average house price category exists of all of the different types of single-family houses and the apartments together.

All of these variables have different values per province of the Netherlands, except for the interest rate. This is the same for the entire country, since the same rules with respect to mortgages apply to the different provinces. This is because of the national policy setting of the Netherlands with respect to the mortgage market. The twelve different provinces of the Netherlands are Drenthe, Utrecht, Groningen, Flevoland, Zuid-Holland, Noord-Holland, Noord-Brabant, Friesland, Overijssel, Gelderland, Zeeland and Limburg.

3.2 Descriptive Statistics

The variables and their movement over time will be discussed in this section. Figures 3 to 7 in Section 8 illustrate this.

House prices

First of all there is an upward trend for the development of the house prices of all different categories of dwellings in all of the provinces of the Netherlands. Utrecht has the highest average house price in the Netherlands followed by Noord-Brabant and Noord-Holland, while Groningen has the lowest average house prices. This seems to suggest that there is high demand for houses in Utrecht, Noord-Brabant and Noord-Holland, while there is low demand for houses in Groningen. As visible in Figure 3 the total single-family house price development is mostly in line with these results. Furthermore, in Figure 3 there is a rough division into two groups visible. One group has lower growth in single-family house prices than the other group. The group with the lower growth in prices consists of the provinces Groningen, Friesland, Drenthe, Overijssel, Flevoland, Zeeland and Limburg. For the other categories of single-family houses this division is also visible, although less clear for some categories. In line with the development of the average house price Utrecht, Noord-Holland and Zuid-Holland show high growth in house prices. After these three provinces Noord-Brabant and Gelderland show the highest growth, which implies high housing demand for these provinces. Figures 4 and 5 depict the development of detached and semi-detached house prices. These two types of dwelling categories show the largest differences in prices between the different provinces. As visible in Figure 6, Noord-Holland has the highest growth in prices for apartments, which implies that the demand for apartments is the highest in Noord-Holland. In contrast to the single-family dwellings, Zuid-Holland only has the sixth highest mean value for apartments. This seems to suggest that the demand for apartments in Zuid-Holland is lower than the demand for single-family houses.

Income per capita

Groningen has the highest mean income per capita and the highest maximum value. This is in contrast with the development of the price variables, since Groningen has the lowest average house prices. Utrecht, Noord-Holland and Zuid-Holland have the highest values for the mean income per capita after Groningen, these three provinces are also the provinces that in general have the highest house prices.

Real interest rate

The real interest rate has a downward trend over time, going from 7.7 to 1.73. These values are respectively the maximum and the minimum value. The interest rate is the same for all of the different provinces in the Netherlands.

Dwelling stock

The stock of dwellings is gradually rising over time, therefore it has a low standard deviation. The average stock of dwellings is by far the highest in the province Zuid-Holland, followed by Noord-Holland and Noord-Brabant. These three provinces are the only provinces with an ending stock of dwellings of more than one million. Groningen, Friesland, Drenthe, Flevoland and Zeeland all have an ending stock of dwellings which is below 300.000.

Demographic variable

The demographic variable is decreasing over time. This is because the demographic variable covers the share of the population aged between 25 and 44 of the total population and the Netherlands is an ageing country. Limburg is ageing the fastest, the province started with 32 percent of the total population being aged between 25 and 44 in 1995 and this was only 23 percent at the end of 2012. On an aggregate national level the share of this age group decreased from 32 to 26 percent in the Netherlands.

Newly issued building permits for new housing

Newly issued building permits for new housing is not moving very gradually over time. It therefore has a high standard deviation. The mean is the highest in Noord-Brabant followed by Gelderland and the lowest in Zeeland and Flevoland.

Construction costs

As visible in Figure 7 construction costs is not moving gradually over time. Hence, just like the standard deviation of newly issued building permits for new housing the standard deviation of construction costs is high. This seems reasonable, since it is likely that there exists a relation between construction costs and newly issued building permits. Zuid-Holland has the highest mean and maximum value, while Zeeland has the lowest mean and maximum value.

4. Econometrics

The empirical methodology and the corresponding long-run and short-run results are discussed in this section.

4.1 Econometric model of housing demand and supply

The main research question will be answered using an econometric model of the housing market. The data used in this study is quarterly and covers the period from the first quarter of 1995 to the fourth quarter of 2012 for all of the twelve provinces in the Netherlands. The Engle and Granger two-step estimation procedure is used in this study. The model exists of a supply and demand equation. It first estimates the long-run equilibrium, after which the dynamic regressions are derived to estimate the short-run supply and demand. It is based on work by Rae and van den Noord (2006) and Hüfner and Lundsgaard (2007), who respectively have researched the Irish and Swedish housing market. The same model has also been applied by Caldera and Johansson (2013) in their paper about the price responsiveness of housing supply.

The long-run relationship is estimated for the demand and supply side of the housing market by making use of regressions 1 and 2. To start with this the order of integration of the involved time series is verified by making use of the standard Augmented Dickey Fuller (ADF) test for the presence of unit roots. The optimal lag length was chosen based on the Schwartz Bayesian Information Criterion (SBIC), since this study uses quarterly data and there are 72 observations for each time series.

The long-run demand equation:

$$p_{it} = \beta_0 + \beta_1 y_t + \beta_2 r_t + \beta_3 s_t + \beta_4 d_t + \gamma_t + \mathrm{ECT}_t^p \qquad (1)$$

The dependent variable in the demand equation is the real house price for seven different categories of dwellings (p_{it}). The independent variables in Equation 1 are gross domestic product per capita (y_t), the real interest rate (r_t), the stock of the total dwellings (s_t), a demographic variable (d_t), a set of quarterly dummies (γ_t) and the error term (ECT_t^p). The demographic variable covers the share of the population aged between 25-44 years old, these are the persons who are most likely to buy a house. All the variables are in logs, except the real interest rate. The real long interest rate is included as a measure for opportunity costs of foregone investment in other markets. In addition the set of quarterly dummies is included to control for seasonality.

The long-run supply equation:

$$i_t = \beta_0 + \beta_1 p_{it-1} + \beta_2 cc_{t-1} + \beta_3 d_t + \gamma_t + ECT_t^i \qquad (2)$$

The dependent variable in the supply equation is the number of newly issued building permits for new housing (i_t). The explanatory variables in the supply function are the real prices of seven

different categories of dwellings at time t-1 (p_{it-1}), real residential construction costs at time t-1 (cc_{t-1}), the same demographic variable as in Equation 1 (d_t), a set of quarterly dummies (γ_t) and the error term (ECT_t^i). All the variables are in logs. In addition the set of quarterly dummies is included to control for seasonality. The real prices of different types of dwellings and the construction costs are both included as lagged variables in Equation 2. Since there is typically a lag between the movement in prices and the investment in housing, these lagged variables reflect the nature of the construction industry. The main coefficient of interest is β_1 which is used to estimate the elasticity of housing supply with respect to the real house price of different type of dwellings for each of the twelve provinces of the Netherlands.

Subsequently the existence of a long-run relationship between the real prices of different types of dwellings or the number of newly issued building permits for new housing and the explanatory variables in Equations 1 and 2 is verified. To check if the Equations 1 and 2 can indeed be interpreted as long-run relationships the stationarity of the residuals of these equations is verified. Afterwards the dynamic regressions are derived. This is done by including the error correction terms, i.e. the residual derived from the long-run relationships, lagged one period into the short-run regressions. These error correction terms need to be negative and significant, which will be further elaborated on in this Section after the equations are explained. The short-run regressions are the first differences of the long-run demand and supply equations with an added error correction term.

Short-run demand equation:

$$\Delta p_{it} = \beta_0 + \beta_1 \Delta y_t + \beta_2 \Delta r_t + \beta_3 \Delta s_t + \beta_4 \Delta d_t + \beta_5 ECT_{t-1}^p + \gamma_t + \varepsilon_t \qquad (3)$$

The dependent variable in the short-run demand equation is the real house price for seven different categories of dwellings (p_{it}). The independent variables in Equation 3 are gross domestic product per capita (y_t), the real interest rate (r_t), the stock of total dwellings (s_t), the same demographic variable as in Equation 1 and 2 (d_t), the error correction term (ECT_{t-1}^p), a set of quarterly dummies (γ_t) and the error term (ε_t). As stated above, the error correction term is defined as the residual from Equation 1 lagged one period. All the variables are in logs, except the real interest rate.

Short-run supply equation:

$$\Delta i_t = \beta_0 + \beta_1 \Delta p_{it-1} + \beta_2 \Delta cc_{t-1} + \beta_3 \Delta d_t + \beta_4 ECT_{t-1}^i + \gamma_t + \varepsilon_t \qquad (4)$$

The dependent variable in the supply equation is the number of newly issued building permits for new housing (i_t). The explanatory variables in the supply function are the real prices of seven different types of dwellings (p_{it-1}), real residential construction costs (cc_{t-1}), the same demographic variable as in Equation 1, 2 and 3 (d_t), the error correction term (ECT_{t-1}^i), a set of

quarterly dummies (γ_t) and the error term (ε_t). As stated above the error correction term is defined as the residual from Equation 2 lagged one period. All the variables are in logs.

Equations 1 and 2 respectively represent the long-run equilibrium relationship between the real prices of different types of dwellings and the number of newly issued building permits for new housing and the explanatory variables. Often there can be short-run deviations from this equilibrium. To understand how fast the series revert back to equilibrium, the short-run Equations 3 and 4 are estimated. These short-run deviations can be called errors and the adjustment to equilibrium can be called correction. For this reason the error correction term is incorporated when studying the short-run dynamics. The coefficients β_5 in Equation 3 and β_4 in Equation 4 are the coefficients of the error correction term and measure the quarterly speed of adjustment to the long-term equilibrium. The absolute value of the coefficient equals the percentage of the gap between the short-run deviation and the long-term equilibrium, which will be closed in the following period. These coefficients are expected to be negative and significant. If for example the short-run demand deviation in period t-1 has overshot the long-run demand equilibrium, the value of the error correction term included in Equation 3, for period t, is positive. If this positive error correction term is multiplied by a negative β_5 coefficient, it generates a negative adjustment. This results in a correction back towards the long-run equilibrium. Similarly a short-run deviation in period t-1 that is below equilibrium, will be positively adjusted towards equilibrium in period t by a negative coefficient of the error correction term. As a result of this it is essential to find a significant negative coefficient of the error correction term to establish a stable long-term relationship.

4.2 Long-run estimates

Tables 1 to 7 in Section 7, following from the long-run demand and supply equation, show the elasticities for the different categories of dwellings for the Netherlands and its provinces. Table 12 and Table 16 show the corresponding coefficient of the error correction terms for the demand and supply equation, respectively. Except for two out of 182 values, all coefficients for the error correction terms fulfill the criteria of negative sign and statistical significance necessary to establish a long-term relationship between the dependent and independent variables. As can be seen in Table 12, the relationship between the real average total house prices and the explanatory variables in Groningen and secondly the relationship between the real price of apartments and the explanatory variables in Noord-Holland is insignificant. Hence only these two regressions cannot be interpreted as the long-run equilibrium, all of the other regressions can be.

Long-run housing demand

Since the independent and dependent variables are both in logs the beta coefficients of Equation 1 can be interpreted as the elasticity of the price with respect to the concerned explanatory variable. These elasticities for the long-run demand side are shown in Tables 1 to 4 in Section 7 for different categories of dwellings for the Netherlands and its provinces. The main findings are discussed below.

As observed in Table 1, the relation between demand and income is positive and significant. This is in line with literature. The Netherlands has an elasticity of the price with respect to income per capita close to or above 2. There is little difference between provinces, except for Flevoland. The income elasticity in Flevoland is in general the lowest, which seems to suggest that the income level does not have a large influence on the demand of houses in Flevoland. This might suggest that people in Flevoland, are satisfied to live there and would like to stay there irrespective of changes in income, but demand is not only driven by relocations within the province. There is an ongoing move from people out of the Randstad to Flevoland. On the contrary, Zeeland has in general the highest income elasticity of demand. This may suggest that houses in Zeeland can be considered as a luxury good. A high percentage of the houses might be second homes, which will be sold or bought when income respectively decreases or increases. This view might be supported by the fact that the provinces Noord-Holland, Zeeland and Gelderland have the highest number of second homes and almost a quarter of all caravans are located in Gelderland followed by Zeeland and Noord-Brabant (Dijst, Lanzendorf, Barendregt & Smit, 2005). These provinces are also the provinces, together with Friesland and Overijssel, that have in general a higher income elasticity than the national average. These figures of the study of Dijst et. al (2005) are only based on figures from 1998, but it is not expected that there were large differences during the period 1995 to 2012.There is also little difference in elasticities between the different categories of dwellings. It should, however, be noted that detached houses have the highest elasticity in every province. This may suggest that detached houses may be considered as the most exclusive category of dwellings, which seems reasonable since on average, detached houses have the highest price, as visible in Figure 4.

The relation between demand for houses and the interest rate is insignificant and almost negligible, as can be seen in Table 2. This is in line with other empirical models, which also seem to have difficulty to incorporate the effect of the interest rate. This may indicate that the estimation framework is unable to control for the potential simultaneity bias between interest rates and house prices.

Table 3 shows a mostly insignificant and positive relation between the stock of dwellings and house prices. The positive sign for the Netherlands is counterintuitive. This could be explained by the fact that this control variable is picking up the effect of population on house prices. Due to a growing population the stock of dwellings is growing, irrespective of price changes. Since the total population is not included as a control variable in Equation 1, this might be the cause of the positive sign. Between the provinces there are some differences, but the results of Groningen stand out. Groningen has by far the highest significant elasticity for all of the different categories of dwellings. This could be due to the fact that new houses added to the stock of dwellings in Groningen are high quality houses, which improve the quality of housing stock. This might have a positive effect on price levels. Especially in Groningen, where earthquakes due to natural gas extraction are common since 1986, people might be willing to pay a lot for high quality dwellings.

Moreover terraced houses are the most vulnerable during an earthquake[7]. This is supported by evidence in Table 3, which shows the lowest elasticity for Groningen for terraced and end-of-terraced houses. However, the relationship between the real average total house prices and the stock of dwellings in Groningen cannot be interpreted as a long-term relationship since the error correction term is insignificant.

As Table 4 shows, the relation between the demographic variable and housing demand is significant and positive for the Netherlands and its provinces. This is in line with other studies. The elasticities range from 0.365 to 8.451 between the different provinces, while most of them are between 1 and 3. It should be noted that just like the elasticity of the stock of dwellings, Groningen has the highest elasticity for every type of dwelling. However, the relationship between the real average total house prices and the demographic variable in Groningen cannot be interpreted as a long-term relationship since the error correction term is insignificant. Each dummy variable coefficient in Equation 1 shows the price effect of that quarter relative to the first quarter, the base period. Quarter 3 mostly has the highest effect on the price. The results of these dummies are, however, insignificant and not shown here.

To summarize, the elasticities of the housing prices in the long-run are significant and positive for income, almost negligible and insignificant for the interest rate, insignificant and positive for the stock of dwellings and significant and positive for the demographic variable.

Long-run housing supply

Since the independent and dependent variables are both in logs in Equation 2, the beta coefficients can be interpreted as the elasticity of long-run housing supply with respect to the concerned explanatory variable. These elasticities for the long-run supply side are shown in Tables 5, 6 and 7 in Section 7. The main findings are discussed below.

The main coefficient of interest of this study is the elasticity of housing supply with respect to the real house price, i.e. β_1 in Equation 2. As seen in Table 5, the price elasticity of housing supply is negative for the Netherlands on a national aggregate level. This is not in line with academic literature, since other studies find low but positive elasticities for the Netherlands and other European countries show more positive figures. This deviation might be due to policy in the Netherlands (Vermeulen and Rouwendal, 2007). As mentioned in Section 2.3 the Spatial Planning Act in the Netherlands forms a top-down process going from the national government, who provides rough guidelines, to the provinces and finalized by municipal zoning plans. These plans have to be updated approximately every ten years. This happens during a process that may take again several years. The zoning plans are legally binding and the procedure to make amendments is lengthy. In this system the supply of residential land is a policy outcome instead of a market outcome. Market signals can have an effect, limited to the extent that government institutions are sensitive to them. Furthermore, even if these governmental institutions are responsive to price signals, then legal procedures significantly delay such responses. This view is

[7] https://www.researchgate.net/profile/F_Klijn/publication/307877929_Aardbevingen_Groningen_naar_een_methode_voor_risicogebaseerd_prioriteren_versterkingen/links/582475ae08aeb45b588b762e/Aardbevingen-Groningen-naar-een-methode-voor-risicogebaseerd-prioriteren-versterkingen.pdf

supported by evidence of Glaeser et al. (2008) and Gyourko (2009). They found evidence that in supply-constrained housing markets most of the adjustments appear in the housing price instead of in expanding housing supply. Glaeser and Gyourko (2003) looked at the effects of land-use controls, specifically zoning, on housing supply in the United States. They find that the lack of supply which causes high house prices is indeed due to these land-use controls. Monk and Whitehead (1996) find that the planning system comes with significant costs, such as relatively high increases in prices in economically good times, without being capable to generate higher housing output during a recession. Besides this, stricter regulatory policy is also associated with fewer permits to be issued. In addition Caldera and Johansson (2013) find the time it takes before one obtains a building permit to be of influence as well. The longer it takes, the lower the elasticity tends to be. For the sample of 21 OECD countries they took into consideration in their study, the Netherlands is indeed a country in which it takes longer than on average to obtain a building permit. Furthermore Vermeulen and Rouwendal (2007) argue that two important policy aims over the past decades in the Netherlands were the protection of open space and the direction of residential developments towards certain locations. In order to protect open space, the supply of residential land at preferable places has been limited consistently through spatial planning over the past decades. This might indicate that the scarcity of land in the Netherlands also causes housing supply to be inelastic. Supportive evidence for this relation is found by Saiz (2010), who shows that land available to build on increases the elasticity of the housing supply. In addition Caldera and Johansson (2013) show that the estimated housing supply elasticity is lower in more densely populated countries. They show that the Netherlands is by far the most densely populated country of their sample of 21 OECD countries. Therefore the housing supply might be very inflexible and may have a negative elasticity in The Netherlands. This may be illustrated by the elasticity of Flevoland. Flevoland has the lowest elasticity for almost every type of dwelling. This might be due to the fact that there was a high planned increase in housing supply in Flevoland, since housing supply in Flevoland is very much of planned nature and therefore inflexible. The most illustrative example of this might be the city of Almere. It is for instance already known that 60.000 new dwellings will be added to the stock of dwellings in Almere in the period 2010-2030[8].

There is little difference between the elasticities of the different provinces, except for Drenthe, Utrecht, Zuid-Holland and Noord-Holland. The price elasticity of housing supply in these four provinces is positive and significant. For Utrecht, Zuid-Holland and Noord-Holland this could be due to very high demand, caused by economic growth and urbanization. As mentioned before and visible in Figures 3, 4 and 5, the house prices show in general the highest growth in these three provinces. Furthermore, it might be possible that the supply is more flexible in these provinces due to converting industry buildings and empty offices into dwellings. Especially the regions Amsterdam, Rotterdam, The Hague, Utrecht and Eindhoven are seen as important office regions, where a covenant aimed to decrease the number of empty offices would make such

[8] https://www.almere.nl/fileadmin/files/almere/wonen/Woonvisie_WT2.pdf

transformations possible[9]. In Drenthe the high elasticity might be due to a large municipal reorganization. In 1998 34 municipalities were merged into 12 new municipalities. This merger led to new policies, which might have caused housing supply to be a better market outcome. Between the different categories of dwellings there is no pattern visible in the house price elasticities. It should be noted that the negative price elasticity for apartments for the Netherlands and four provinces might be due to the fact that the majority of apartment complexes are constructed by project developers and almost never by individuals.

As observed in Table 6, the relation between housing supply and construction costs is significant and positive and does not differ much between the provinces and categories of dwellings. The positive relation is unexpected, since it is expected that there will be a decrease in new supply if the costs of new supply rise. A possible explanation for this positive sign might be the fact that the construction costs variable picks up a business cycle effect that is not accounted for by the other variables.

The relation between housing supply and the demographic variable is mostly positive and significant at the one percent level, as visible in Table 7. This is in line with academic literature. The elasticity ranges between 1.448 and 5.589. Drenthe and Friesland have the highest elasticities and Noord-Brabant and Zeeland on the contrary have the lowest elasticities of housing supply with respect to the demographic variable.

Each dummy variable coefficient shows the effect of that quarter on the supply relative to the effect of the first quarter, the base period. Most of the time quarter 4 has the highest positive significant effect on supply, but these results are not shown here.

Summarizing, the price elasticity of housing supply in the long-run is mostly inelastic, except for Drenthe, Utrecht, Noord-Holland and Zuid-Holland. Inflexible housing supply due to policy setting might cause the price elasticity to be inelastic. The exceptions found for four provinces could be caused by more flexibility on a local level due to for instance transformation of buildings with different functions to dwellings. Secondly, the relation between housing supply and construction costs is significant and positive and finally the relation between housing supply and the demographic variable is mostly significant and positive at the one percent level.

4.3 Short-run estimates

Short-run housing demand

Since the independent and dependent variables both enter Equation 3 in logs, the beta coefficients can be interpreted as the elasticity of the price with respect to the concerned explanatory variable. These elasticities for the short-run demand side are shown in Tables 8 to 12 in Section 7 for different categories of dwellings for the Netherlands and its provinces. The main findings are discussed below.

As observed in Table 8, the relation between demand and income is positive and significant. This is in line with literature. For the Netherlands on an aggregate national level the income elasticity

[9] https://www.rijksoverheid.nl/onderwerpen/leegstand-kantoren/documenten/convenanten/2012/06/27/convenant-aanpak-leegstand-kantoren

on the short-run is a little above one for all of the different categories of dwellings. There is little difference between provinces and the different categories of dwellings, except for the apartment's category. That type of dwelling shows negative elasticities in Drenthe, Friesland and Zeeland. This may indicate that apartments are seen as inferior goods in these provinces. Inferior goods are defined as goods that are affordable and adequately fulfil their purpose, but as more costly substitutes, that are preferred, become available the use of the inferior good will be reduced. All of the estimated elasticities are lower in the short-run than in the long-run, this might be due to the fact that people tend to make decisions that they immediately benefit from in the short-run.

Similarly as in the long-run, the relation between demand for houses and the interest rate is insignificant and almost negligible in the short-run, as can be seen in Table 9. This is in line with other empirical models, which also seem to have difficulty to incorporate the effect of the interest rate. This may indicate that the estimation framework is unable to control for the potential simultaneity bias between interest rates and house prices.

Table 10 shows a mostly insignificant and negative relation between the stock of dwellings and house prices. The negative sign is expected. This is in contrast to the long-run, which shows a positive elasticity when significant. The absolute values of the short-run elasticities tend to be larger than in the long-run and may be due to the housing market dynamics on the short-run. As illustrated in Figure 2, the housing supply adjusts slowly, which can cause heavy price movements on the short-run.

The relation between the demand of housing and the demographic variable is partially significant and positive. Academic literature agrees upon a positive relationship, which the Netherlands on a national aggregate level exhibits. As observed in Table 11, most of the provinces show the same positive relation, except for Flevoland. This could be due to the fact that the demographic variable covers the share of 25-44 year old people in the total population instead of the total population. Especially for Flevoland, the share of 25-44 year old people in the total population might be less relevant since there is an ongoing growth of the total population, stimulated by the growth of Almere. Therefore the total population might have been of more relevance in Flevoland. Similarly as the elasticities of the stock of dwellings, the short-run elasticities of the demographic variable tend to be larger than in the long-run. This may be due to the housing market dynamics on the short-run. As illustrated in Figure 2, the housing supply adjusts slowly, which can cause heavy price movements on the short-run.

Further, each dummy variable coefficient in Equation 3 shows the price effect of that quarter relative to the first quarter. Most of the time quarter 3 has the highest effect on the price. However, the results of these dummies are frequently insignificant and there is no clear pattern visible when the results of the different provinces are compared. These results are not shown.

Table 12 shows the coefficients of the error correction term, the β_5 coefficients estimated in Equation 3, which measures the quarterly speed of adjustment to the long-term equilibrium. As mentioned above, all of the error correction terms are negative and significant except for the error correction term in Groningen related to the average total house prices and secondly the

error correction term in Noord-Holland related to the price of apartments, as is visible in Table 12. The coefficient of the error correction terms range between -0.083 and -0.720, suggesting that there are large differences across the provinces and the different categories of dwellings in the implied speed of price adjustment. These estimates imply that between a little above 30% and 100% of the differences between actual and equilibrium price is closed within a year, depending on the province. Prices adjust fast to shocks in Limburg, which has in most of the categories the most negative error correction term, whereas the reaction of prices is lower in Groningen. However, there is no clear pattern visible in the error correction term.

To summarize, the elasticities of the housing prices in the short-run are positive and significant for income. Secondly, the interest rate elasticity of the house price is almost negligible and insignificant. Thirdly, the elasticity of the stock of dwellings is mostly insignificant and negative. Finally, the demographic elasticity of the house price is partially significant and positive.

Short-run housing supply

Since the independent and dependent variables are both in logs in Equation 4, the beta coefficients can be interpreted as the elasticity of short-run housing supply with respect to the concerned explanatory variable. These elasticities for the short-run supply side are shown in Tables 13 to 16 in Section 7. The main findings are discussed below.

The main coefficient of interest of this study is the elasticity of housing supply with respect to the real house price, i.e. β_1 in Equation 4. As seen in Table 13 the price elasticity of housing supply is positive and mostly insignificant for the Netherlands. This is the expected positive relationship, Caldera and Johansson (2013) show similar evidence. However, other studies find almost fully inelastic elasticities for the Netherlands on the short-run. A more inelastic price elasticity of housing supply on the short-run seems to be more reasonable since housing supply tends to be inflexible in the short-run. The results found in Table 13 may be due to the fact that this study takes data from a relatively short time span into account. Zeeland and Flevoland are the two provinces that, on average, have the lowest price elasticity. This might be due to the fact that housing supply in Flevoland is of planned nature and therefore inflexible and that houses in Zeeland might be substituted by houses in Belgium. Furthermore, it is hard to see a pattern in the price elasticity of housing supply in the short-run and the fact that the results are mostly insignificant seems to indicate that the price effect on housing supply is irrelevant in the short-run.

The relation between construction costs and housing supply is mostly insignificant and inelastic. As Table 14 shows, elasticities are ranging from -0.219 to 0.155. For the Netherlands on a national aggregate the elasticities are around 0. This is not in line with literature, since it is expected that there is a decrease in new supply when the costs of new supply rise. This suggests that changes in construction costs do not influence changes in housing supply in the short-run, which may be explained by the fact that changes in construction costs are not large in the short-run. Most of the provinces show similar evidence, however it should be noted that Friesland shows the expected significantly negative relationship for every dwelling category.

The relation between the demographic variable and housing supply is insignificant and negative

for the Netherlands on a national aggregate level. This relation is unexpected. Between the different provinces and categories of dwellings the differences are big. The elasticity is insignificant and ranges from -17.126 to 10.814, as can be seen in Table 15. The large variance and insignificance of the elasticities may suggest that the demographic variable does not typically influence housing supply in the short-run. This may be due to the fact that demographic changes are limited on the short-run.

Each dummy variable coefficient in Equation 4 shows the effect of that quarter on the short-run supply relative to the effect of the first quarter, the base period. These results are not shown here and the results of these dummies show significance, but there is no clear pattern visible when the results of the different provinces are compared.

Table 16 shows the coefficients of the error correction term, the β_4 coefficients estimated in Equation 4, which measures the quarterly speed of adjustment to the long-term equilibrium. As mentioned above, all of the error correction terms are negative and significant. The error correction terms range between -0.410 and -0.826, suggesting that there are large differences across the provinces and the different categories of dwellings in the implied speed of housing supply adjustment. These estimates imply that 100% of the differences between actual and equilibrium supply is closed within a year. Supply tends to adjust fast to shocks in Zuid-Holland, which has in most of the categories the most negative error correction term, whereas the reaction of supply is the lowest in Friesland. There is no clear pattern visible between the different categories of dwellings and the error correction term.

Summarizing, price elasticities of housing supply are mostly insignificant and positive in the short-run. This is the expected sign. However, a more inelastic price elasticity of housing supply in the short-run seems to be more reasonable since housing supply tends to be inflexible in the short-run. The fact that the results are mostly insignificant seems to indicate that the price effect on housing supply is irrelevant in the short-run. The results found in Table 13 may be due to the fact that this study takes data from a relatively short time span into account. In addition, the construction costs elasticity and the demographic elasticity are mostly insignificant. Hence, changes in construction costs and population do not typically influence changes in housing supply in the short-run.

5. Discussion

The results found in this study are interesting. In this chapter the limitations of this study are discussed, these limitations also offer interesting opportunities for future research which are elaborated on in the next Section.

First of all, this study into housing supply is limited by the fact that the time span ranges from the first quarter of 1995 to the fourth quarter of 2012. Due to the unavailability of price data covering the years after 2012 it was impossible to take the years from 2012 to 2017 into account. Another limitation is the level on which the data could be obtained. This thesis used data on provincial level, where it probably would show different results if data on municipality level or even a city level would have been used.

Furthermore, this thesis does not elaborate on specific individual outliers, since this was out of the scope of this thesis. It could, however, be interesting to see what caused these specific outliers.

This study also provides possible explanations for some of the estimated relationships found in this study. For example the suggested policy effect on price responsiveness of housing supply may not be the correct reason why the elasticities are very low in the Netherlands. Besides that, the effect of converting industry buildings and empty offices into dwellings and the municipal reorganization in Drenthe to account for the high elasticity in Utrecht, Noord-Holland, Zuid-Holland and Drenthe might not be the right reason. The suggestion that houses in Zeeland may be considered as second homes or may be substituted by houses in Belgium may be argued as well. The short-run estimates of housing supply are mostly insignificant and hard to explain. This might be explained by poor quality of data or the relatively short time span of which data is used in this study. This might also be an explanation for the other relationships, which do not show the expected sign or deviate from the general view. Besides this, it could be a limitation that this thesis did not check other demographic variables than the one used in this thesis since the Netherlands is an ageing country. Especially for Flevoland, the share of 25-44 year old people in the total population might be less relevant since there is an ongoing growth of the total population, stimulated by the growth of Almere. In addition it is suggested that the stock of dwellings might have picked up the effect of population on house prices. Therefore the total population might have been of more relevance, especially in Flevoland. Finally, it seems to be possible to improve the econometric model since it seems to be unable to control for the potential simultaneity bias between interest rates and house prices, as this relation is insignificant and almost negligible on the short-run and the long-run.

6. Conclusion

In this thesis the housing supply responsiveness in the Netherlands was studied for all of the twelve different provinces of the Netherlands for seven different categories of dwellings in both the long- and the short-run.

There is strong evidence that there are large differences between the different provinces and categories of dwellings for all of the explanatory variables. Regarding the elasticities of housing supply with respect to the house price it can be concluded that the different provinces all have different elasticities of housing supply with respect to the price. The level of significance varies as well between the different provinces. This confirms the first hypothesis of this thesis.

The price elasticity of housing supply on the long-run is negative for the Netherlands. This is not in line with academic literature, since other studies only find low but positive elasticities for the Netherlands and other European countries show more positive figures. This deviation might be due to policy and the high population density in the Netherlands. Due to the spatial planning system in the Netherlands the supply of residential land seems to be a policy outcome instead of a market outcome. Therefore the housing supply might be very inflexible and inelastic. These low elasticities might have negative consequences since it is known that bubbles on the housing price market are more common, larger and last longer in areas where supply is inelastic. Besides that, the volatility of house prices is higher in more inelastic markets, where supply is constrained by regulations (Glaeser et al. 2008). Furthermore, an unresponsive housing supply can increase the sensitivity of house prices to demand shocks and therefore influence private consumption patterns and residential investment (Grimes & Aitken, 2006).
There is little difference between the price elasticities of the different provinces, except for Drenthe, Utrecht, Zuid-Holland and Noord-Holland. The price elasticity of housing supply in these four provinces is significant and positive. For Utrecht, Zuid-Holland and Noord-Holland this could be due to high demand, caused by economic growth and urbanization. Furthermore, it might be possible that the supply is more flexible in these provinces.

In the short-run the price elasticity of housing supply is mostly positive and insignificant for the Netherlands. This is the expected positive relationship, Caldera and Johansson (2013) shows similar evidence. However, other studies find almost fully inelastic elasticities for the Netherlands in the short-run. A more inelastic price elasticity of housing supply in the short-run seems to be more reasonable since housing supply tends to be inflexible in the short-run. The results found in this study may be due to the fact that this study takes data from a relatively short time span into account. Furthermore, it is hard to see a pattern in the price elasticity of housing supply on the short-run. Besides this, the fact that the results are mostly insignificant seems to indicate that the price effect on housing supply might be irrelevant in the short-run.

The second hypothesis is also confirmed as it expressed the expectation that different categories of dwellings show different elasticities of housing supply to the house price in the twelve

provinces in the Netherlands. Since every type of dwelling shows a different elasticity, this claim is supported by strong evidence.

Since the elasticity of housing supply with respect to the demographic variable is higher than the elasticity of housing supply with respect to the price in the long-run, the third hypothesis is confirmed for the long-run. This might be due to the fact that the supply of residential land in the Netherlands is basically a policy decision instead of a market outcome. This is caused by the regulation of land use. The government has planned construction based on the housing need. The housing need estimates may be based more on stated preference data and demographic models than on the demand revealed in prices. In the short-run the third hypothesis cannot be confirmed since the demographic variable is hardly found to be significant for provinces and categories of dwellings. Hence changes in the population do not typically influence changes in housing supply in the short-run, which may be explained by the fact that especially in the short-run changes in the population are not large.

The research question of this thesis is: *What is the effect of house prices on housing supply in the Netherlands?* Price elasticity of housing supply in the long-run is mostly inelastic, except for Drenthe, Utrecht, Noord-Holland and Zuid-Holland. Inflexible housing supply due to policy setting might cause the price elasticity to be inelastic. The exceptions found for four provinces could be caused by more flexibility on a local level due to for instance transformation of buildings with different functions to dwellings. In addition it is hard to see a pattern in the price elasticity of housing supply in the short-run. The estimates are mainly insignificant, which might indicate that housing supply is not flexible in the short-run and the price effect might be irrelevant. Further, these results could be of practical use to policymakers when setting new policy.

Suggestions for further research

Following from the limitations of this study, further research could particularly focus on studying the price responsiveness of housing supply on a more local level. This study showed that the results on a provincial level show different estimates than on a national level. Therefore, it can be hypothesized that a more local level than a provincial level will show different estimates. Estimates of local market supply elasticities could be especially useful for future policy setting. It would be interesting to study the housing market in more recent years, since the prices on the housing market in the Netherlands are rising extremely fast in recent years.

Further research is also possible with regard to the estimates of the elasticities and their significance. Starting with the results of the demand equations, the interest rate elasticities are both in the long- and short-run almost negligible and in almost every case insignificant. It seems to be that the model used in this study has difficulty to incorporate the effect of the interest rate. Further research could aim to develop a model which is able to incorporate the effect of the interest rate. The elasticity of the stock of dwellings to the price is significant and positive in the long-run. While a negative sign is expected, the positive sign of the elasticity is counterintuitive. As suggested before this might be due to the fact that the stock of dwellings variable is picking

up the effect of population on house prices. It might be interesting to use for example a variable which measures the number of dwellings per 1000 inhabitants. In the short-run however, the elasticity of the stock of dwellings is insignificant and negative. The negative sign is expected here. This in contrast to the long-run, which showed a mostly positive elasticity. Further research may verify whether this relationship is indeed positive in the long-run or negative as expected. Furthermore, the relationship in the short-run seems to be as expected, but further research should be done to confirm this view.

With regard to the estimates of the supply equations, further research might be useful as well. The price elasticity of housing supply in the long-run is significant and positive, while it is hard to see a pattern in the short-run. It might be interesting to find out more about the movement in the short-run. The construction costs elasticity in both the long- and short-run could also be an interesting field for further research. In the long-run eight of the twelve provinces have a significant and positive construction costs elasticity of housing supply. The positive relation is unexpected, since it is expected that there will be a decrease in new supply if the costs of new supply rise. In the short-run construction costs are hardly found to be significant. Further research might show different or significant results. The demographic variable does not give significant estimates in the short-run. Further research might find significant results in the short-run, which makes it possible to estimate the relationship between the demographic variable and housing supply in the short-run. Finally, it would be interesting to run the regression with relative prices compared to the national average, instead of absolute price levels. This might show different results, which could make the interpretation of the differences between the provinces better.

7. Tables

Long-run housing demand

Table 1

This table shows the elasticities of housing demand with respect to the real income per capita for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	2.208***	2.298***	2.607***	2.117***	2.258***	2.295***	1.891***
Drenthe	2.190***	2.219***	2.258***	1.912***	2.060***	2.148***	2.169***
Utrecht	1.911***	2.000***	2.742***	1.570***	1.822***	2.420***	1.670***
Groningen	2.095***	2.099***	2.389***	1.837***	1.885***	2.048***	2.156***
Flevoland	1.031***	1.014***	1.984***	0.995***	0.946***	1.123***	1.448***
Zuid-Holland	1.832***	1.917***	2.118***	1.824***	1.953***	2.108***	1.785***
Noord-Holland	2.228***	2.348***	2.449***	2.257***	2.414***	2.368***	1.832***
Noord-Brabant	2.732***	2.754***	2.844***	2.566***	2.608***	2.780***	2.461***
Friesland	2.375***	2.521***	2.617***	2.319***	2.613***	2.283***	1.369***
Overijssel	2.389***	2.471***	2.558***	2.521***	2.409***	2.317***	2.010***
Gelderland	2.290***	2.379***	2.697***	2.301***	2.304***	2.379***	2.380***
Zeeland	2.874***	2.878***	2.970***	2.758***	2.880***	2.589***	2.737***
Limburg	1.976***	2.085***	2.387***	2.037***	1.705***	1.856***	1.911***

*** p<0.01, ** p<0.05, * p<0.1

Table 2

This table shows the elasticities of housing demand with respect to the real interest rate for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	0.001	0.002	0.001	0.005	0.003	0.004	0.002
Drenthe	-0.007	-0.008	-0.010	-0.004	-0.007	-0.007	-0.003
Utrecht	0.011*	0.013*	0.012	0.015***	0.015**	0.011	0.015***
Groningen	0.005	0.002	0.003	0.000	-0.001	0.011	0.020
Flevoland	0.018**	0.019**	0.025*	0.015**	0.014*	0.027***	-0.018
Zuid-Holland	-0.005	-0.003	-0.002	-0.001	-0.005	-0.002	-0.003
Noord-Holland	-0.001	0.003	-0.000	0.006	0.006	0.001	-0.005
Noord-Brabant	0.001	0.004	0.008	0.006	0.007	0.008	-0.001
Friesland	0.013*	0.014**	0.009	0.024***	0.021***	0.013*	0.009
Overijssel	-0.009*	-0.009*	-0.003	-0.010**	-0.010*	-0.005	-0.007
Gelderland	-0.003	-0.003	-0.002	0.001	-0.000	-0.001	-0.002
Zeeland	-0.010	-0.012	-0.017**	-0.005	-0.013	-0.010	-0.012
Limburg	0.002	0.003	0.007	0.004	0.008**	0.001	0.001

*** p<0.01, ** p<0.05, * p<0.1

Table 3

This table shows the elasticities of housing demand with respect to the stock of dwellings for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	0.632	0.497	0.979	0.999	0.267	1.355	3.174
Drenthe	1.992*	2.188	4.290***	2.259	1.957	2.095*	1.064
Utrecht	1.032	0.984	-0.205	2.630***	1.524	0.012	2.726**
Groningen	9.994***	10.463***	13.904***	7.111**	6.631**	12.352***	10.284***
Flevoland	1.894***	1.837***	0.423	1.940***	2.183***	2.518***	1.560*
Zuid-Holland	0.928	0.919	2.993*	1.335	0.282	1.464	2.571
Noord-Holland	0.649	-0.037	2.147	0.068	-0.996	1.227	4.824
Noord-Brabant	-1.300	-0.961	-0.334	-0.280	0.046	-0.370	0.743
Friesland	2.857	2.709	4.243	2.254	0.726	4.074	3.715
Overijssel	-0.796	-0.798	0.969	-1.335	-0.877	0.212	1.345
Gelderland	0.932	0.670	1.019	0.740	0.482	1.479	1.593
Zeeland	-0.286	-0.157	2.353	-0.434	-2.037	2.541	-1.971
Limburg	-0.472	-0.376	0.867	-0.498	2.165	1.541	-0.790

*** p<0.01, ** p<0.05, * p<0.1

Table 4

This table shows the elasticities of housing demand with respect to the demographic variable for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	2.021***	2.152***	2.989***	1.976***	2.009**	2.573***	2.321***
Drenthe	1.475***	1.621***	2.523***	1.190***	1.378***	1.421***	0.759*
Utrecht	1.503**	1.382**	1.842**	1.908***	1.633***	1.419*	2.578***
Groningen	6.100***	6.335***	8.451***	4.200**	4.460***	6.604***	5.757***
Flevoland	1.921***	1.836***	0.365	2.070***	2.499***	2.614***	2.143***
Zuid-Holland	1.185	1.470*	2.907***	1.533*	1.350	2.042**	1.797**
Noord-Holland	2.005**	1.724**	3.382**	1.605***	1.293*	2.307**	3.266***
Noord-Brabant	1.995**	2.191***	2.347***	2.037**	2.415***	2.384***	2.487***
Friesland	2.818***	3.087***	4.214***	2.262***	2.260***	3.415***	0.946
Overijssel	2.158***	2.382***	3.817***	2.068***	2.254***	2.680***	2.241**
Gelderland	2.414***	2.385***	3.165***	2.148***	2.167***	2.728***	2.735***
Zeeland	3.603***	3.785***	5.298***	3.311***	3.122***	4.446***	2.213***
Limburg	1.159***	1.371***	2.062***	1.207***	1.581***	1.699***	0.531

*** p<0.01, ** p<0.05, * p<0.1

Long-run housing supply

Table 5

This table shows the elasticities of housing supply with respect to the real house price for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-0.059	-0.057	-0.040	-0.075	-0.054	-0.052	-0.076
Drenthe	0.651***	0.616**	0.510**	0.685**	0.687***	0.607**	0.647***
Utrecht	0.684***	0.659***	0.516***	0.706***	0.675***	0.564***	0.679***
Groningen	-0.018	-0.038	-0.027	-0.051	0.049	-0.063	0.032
Flevoland	-0.210	-0.214	-0.110	-0.217	-0.250	-0.133	-0.174
Zuid-Holland	0.400***	0.385***	0.325***	0.392***	0.410***	0.312***	0.364***
Noord-Holland	0.389***	0.409***	0.318***	0.424***	0.438***	0.367***	0.288***
Noord-Brabant	-0.064	-0.062	-0.049	-0.068	-0.069	-0.057	-0.068
Friesland	0.120	0.115	0.086	0.199	0.169	0.119	0.120
Overijssel	-0.139	-0.135	-0.104	-0.147	-0.150	-0.138	-0.178
Gelderland	0.017	0.014	0.021	0.012	0.017	0.005	0.000
Zeeland	-0.169	-0.187	-0.219	-0.146	-0.152	-0.174	-0.111
Limburg	0.314	0.306	0.259	0.284	0.309	0.249	0.272

*** p<0.01, ** p<0.05, * p<0.1

Table 6

This table shows the elasticities of housing supply with respect to the real construction costs for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	0.494***	0.494***	0.490***	0.501***	0.493***	0.493***	0.500***
Drenthe	0.039	0.044	0.054	0.044	0.040	0.048	0.060
Utrecht	0.043	0.045	0.050	0.042	0.047	0.054	0.035
Groningen	0.223**	0.227**	0.226**	0.228**	0.212**	0.231**	0.215**
Flevoland	0.095	0.096	0.089	0.095	0.101	0.091	0.082
Zuid-Holland	0.252***	0.251***	0.251***	0.252***	0.247***	0.259***	0.260***
Noord-Holland	0.222**	0.209**	0.236***	0.203**	0.194**	0.213**	0.255***
Noord-Brabant	0.395***	0.394***	0.392***	0.396***	0.397***	0.395***	0.392***
Friesland	0.068	0.067	0.076	0.042	0.052	0.067	0.083
Overijssel	0.293***	0.293***	0.287***	0.299***	0.297***	0.294***	0.308***
Gelderland	0.348***	0.349***	0.346***	0.349***	0.348***	0.351***	0.353***
Zeeland	0.196***	0.197***	0.197***	0.197***	0.199***	0.199***	0.190***
Limburg	0.243***	0.242***	0.242***	0.243***	0.247***	0.254***	0.251***

*** p<0.01, ** p<0.05, * p<0.1

Table 7

This table shows the elasticities of housing demand with respect to the demographic variable for different categories of dwellings for the Netherlands and its provinces in the long-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	2.466***	2.474***	2.522***	2.415***	2.490***	2.487***	2.369***
Drenthe	5.497***	5.393***	5.157***	5.556***	5.513***	5.378***	5.589***
Utrecht	3.589***	3.675***	3.162***	3.889***	3.632***	3.299***	3.541***
Groningen	4.045***	3.957***	4.004***	3.895**	4.327***	3.853***	4.272***
Flevoland	0.511	0.507	0.697	0.514	0.442	0.701	0.552
Zuid-Holland	3.010***	2.915***	2.775***	2.911***	2.955***	2.686***	2.946***
Noord-Holland	3.602***	3.696***	3.415***	3.710***	3.751***	3.646***	3.415***
Noord-Brabant	2.052***	2.058***	2.078***	2.031***	2.036***	2.065***	2.027***
Friesland	4.850***	4.830***	4.708***	5.176***	5.035***	4.833***	4.858***
Overijssel	2.740***	2.755***	2.867***	2.701***	2.708***	2.748***	2.504***
Gelderland	2.406***	2.400***	2.416***	2.396***	2.406***	2.380***	2.368***
Zeeland	1.508*	1.448*	1.292	1.631*	1.639**	1.526**	1.734*
Limburg	2.285***	2.266***	2.219***	2.232***	2.251***	2.141***	2.319***

*** p<0.01, ** p<0.05, * p<0.1

Short-run housing demand

Table 8

This table shows the elasticities of housing demand with respect to the real income per capita for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	1.298***	1.361***	1.602***	1.130***	1.190***	1.253**	1.097**
Drenthe	1.647***	1.886***	1.780***	1.185***	1.699**	2.122***	-0.046
Utrecht	1.345**	1.469**	0.500	1.059**	1.410*	2.165**	1.056**
Groningen	0.220	0.230	0.374**	0.106	0.341*	0.657**	0.478**
Flevoland	0.547*	0.535*	2.449**	0.437*	0.481	0.403	1.497*
Zuid-Holland	1.114***	1.250***	0.739	1.323***	0.956**	0.600	1.036***
Noord-Holland	1.410***	1.313**	1.878	1.122*	1.006	0.662	1.129
Noord-Brabant	0.699	0.690	0.509	0.703*	0.573	0.488	0.096
Friesland	0.314	0.527	0.519	0.166	0.919*	0.442	-3.354**
Overijssel	0.907**	1.014***	1.023*	1.197***	1.017**	0.897***	0.667
Gelderland	0.997***	0.955**	1.439***	1.005**	0.968**	0.889**	0.982**
Zeeland	0.759*	0.838*	1.109	0.384	0.598	0.790*	-0.134
Limburg	1.083**	1.188***	1.505**	1.311**	0.723	1.090**	0.548

*** p<0.01, ** p<0.05, * p<0.1

Table 9

This table shows the elasticities of housing demand with respect to the real interest rate for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	0.001	0.002	-0.003	0.003	0.004	0.006**	0.002
Drenthe	0.001	-0.001	-0.001	-0.000	-0.014**	0.004	0.027*
Utrecht	0.004	0.001	-0.005	0.007	0.004	0.002	0.004
Groningen	0.002	0.002	0.003	0.004	0.007	0.011	0.017**
Flevoland	0.001	0.007	0.015	0.003	0.008	0.025**	-0.064***
Zuid-Holland	0.000	0.002	0.010	0.001	0.002	0.003	0.004
Noord-Holland	-0.000	-0.003	-0.021	-0.002	0.003	0.009	0.006
Noord-Brabant	0.004	0.006*	0.008	0.004**	0.005	0.008*	0.002
Friesland	0.005	0.008*	0.001	0.013*	0.011**	0.001	-0.015
Overijssel	0.003	0.005	0.004	0.000	0.004	0.009**	0.005
Gelderland	0.001	-0.000	-0.007	0.002	0.005	-0.001	-0.002
Zeeland	0.000	-0.002	0.007	-0.005	-0.019**	-0.005	0.027*
Limburg	0.001	0.003	0.006	0.002	0.013**	0.002	-0.003

*** p<0.01, ** p<0.05, * p<0.1

Table 10

This table shows the elasticities of housing demand with respect to the stock of dwellings for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-8.833*	-8.909*	-7.371	-8.109**	-10.628**	-6.906	-3.940
Drenthe	-0.949	-0.592	1.580*	0.790*	-0.807	-2.521	-0.233
Utrecht	1.974	1.719	6.040	1.161	1.432	0.396	2.869
Groningen	-1.984	-3.175	-8.890**	0.450	-13.153**	1.626	-7.770**
Flevoland	1.004	1.436	-0.881	1.724	2.676**	4.413**	2.541
Zuid-Holland	-2.804	-0.971	0.755	-0.578	0.798	-4.632	-2.118
Noord-Holland	1.453	2.828	8.797	-0.070	-2.171	5.616	-3.207
Noord-Brabant	-3.990	-3.903	0.439	-6.507**	-6.713*	-1.397	-0.465
Friesland	-11.033**	-10.186**	-12.369**	-7.121*	-9.378**	-7.554	-9.575
Overijssel	-3.841	-3.322	-4.533	-6.950**	-7.987*	-3.218	-8.419
Gelderland	-1.911	-3.171	-2.608	-3.465	-5.005	-2.986	-0.765
Zeeland	0.459	-0.615	0.630	-0.434	2.332	3.765	7.612
Limburg	-7.238*	-6.229	-2.994	-6.590*	-6.133	-8.211**	-13.312*

*** p<0.01, ** p<0.05, * p<0.1

Table 11

This table shows the elasticities of housing demand with respect to the demographic variable for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	5.511***	5.578***	5.818**	5.322***	6.113***	6.175***	4.740***
Drenthe	1.003	0.424	1.170	0.675	0.829	0.356	3.364
Utrecht	1.027	0.748	5.427	2083	0.126	-0.257	2.077
Groningen	2.219	1.969	4.744**	-0.469	2.674	0.204	4.616**
Flevoland	-1.373	-1.986	-6.948	-1.200	-1.906	-1.786	-4.899
Zuid-Holland	3.532*	2.972	5.808	2.363	3.103	7.543	4.464*
Noord-Holland	3.256	2.964	0.649	3.292	4.194	6.629	5.585*
Noord-Brabant	6.057***	6.533***	5.020	7.195***	7.361***	6.839**	5.715
Friesland	7.510***	7.177***	9.054***	6.332***	6.055***	7.423**	13.518
Overijssel	5.592***	5.381***	8.313***	5.265**	6.783**	6.546***	8.938**
Gelderland	4.591***	5.017***	4.597***	4.506***	5.058***	5.233***	4.801***
Zeeland	2.752	3.073	4.186	2.444	1.068	3.491	-3.020
Limburg	4.567**	4.678**	3.666	4.656*	6.407**	5.725***	5.762

*** p<0.01, ** p<0.05, * p<0.1

Table 12

This table shows the error correction terms for the short-run demand equations of different categories of dwellings for the Netherlands and its provinces.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-0.302***	-0.280***	-0.336***	-0.238***	-0.307***	-0.327***	-0.232***
Drenthe	-0.232***	-0.235***	-0.380***	-0.142**	-0.289***	-0.519***	-0.629***
Utrecht	-0.387***	-0.391***	-0.696***	-0.478***	-0.452***	-0.546***	-0.422***
Groningen	-0.083	-0.112*	-0.186**	-0.163**	-0.230***	-0.201***	-0.164***
Flevoland	-0.227**	-0.225**	-0.561***	-0.196***	-0.239***	-0.501***	-0.650***
Zuid-Holland	-0.224***	-0.162**	-0.680***	-0.147***	-0.264***	-0.520***	-0.155***
Noord-Holland	-0.164**	-0.220**	-0.368***	-0.310***	-0.310***	-0.443***	-0.131
Noord-Brabant	-0.230***	-0.225***	-0.334***	-0.170***	-0.253***	-0.259***	-0.283***
Friesland	-0.281***	-0.285***	-0.435***	-0.206***	-0.211***	-0.285***	-0.669***
Overijssel	-0.251***	-0.242***	-0.397***	-0.236***	-0.309***	-0.316***	-0.381***
Gelderland	-0.243***	-0.264***	-0.318***	-0.180***	-0.294***	-0.251***	-0.203***
Zeeland	-0.163**	-0.178**	-0.398***	-0.116*	-0.261**	-0.249**	-0.478***
Limburg	-0.547***	-0.469***	-0.488***	-0.416***	-0.543***	-0.589***	-0.723***

*** p<0.01, ** p<0.05, * p<0.1

Short-run housing supply

Table 13

This table shows the elasticities of housing supply with respect to the real house price for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	0.777	0.630	0.415	0.874	0.695	0.640	1.491**
Drenthe	1.001	0.520	-0.003	0.535	1.279*	-0.425	0.415
Utrecht	1.503**	1.131*	0.224	2.107***	0.709	-0.005	2.237**
Groningen	0.379	0.060	0.546	-0.638	0.837	-0.040	0.918*
Flevoland	-0.199	0.064	-0.327	0.876	-0.296	-0.600	-0.273
Zuid-Holland	0.805	0.752	0.307	0.680	0.742	-0.081	1.524**
Noord-Holland	0.951	0.866	0.536**	0.361	0.851	0.701**	0.533
Noord-Brabant	0.154	0.022	0.081	0.925	0.122	-0.152	0.652
Friesland	0.690	0.489	0.633	1.799***	-0.112	0.367	0.043
Overijssel	1.816	1.378	0.857	0.969	1.201*	0.196	0.596
Gelderland	1.536***	1.367***	0.607	1.179	1.474***	1.383***	0.325
Zeeland	-0.473	-0.346	-0.764**	0.618	0.476	-0.219	-0.196
Limburg	1.751***	1.961**	1.573**	1.409**	0.923	1.593*	0.848

*** p<0.01, ** p<0.05, * p<0.1

Table 14

This table shows the elasticities of housing supply with respect to the real construction costs for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-0.002	-0.004	-0.006	-0.011	0.005	0.005	0.000
Drenthe	-0.133	-0.135	-0.136	-0.137	-0.122	-0.137	-0.121
Utrecht	-0.091	-0.084	-0.075	-0.094	-0.081	-0.080	-0.114*
Groningen	0.039	0.046	0.034	0.043	0.022	0.051	0.025
Flevoland	-0.045	-0.045	-0.048	-0.032	-0.037	-0.059	-0.058
Zuid-Holland	-0.060	-0.061	-0.063	-0.055	-0.041	-0.050	-0.057
Noord-Holland	0.066	0.059	0.092	0.043	0.026	0.038	0.059
Noord-Brabant	0.136	0.132	0.131	0.135	0.133	0.128	0.155
Friesland	-0.195***	-0.195***	-0.184***	-0.219***	-0.198***	-0.189***	-0.195***
Overijssel	-0.005	0.004	0.009	0.008	0.014	0.026	0.005
Gelderland	0.074	0.059	0.056	0.047	0.031	0.071	0.058
Zeeland	0.014	0.017	0.002	0.017	0.006	0.024	0.009
Limburg	0.022	0.019	-0.001	0.036	0.046	0.028	0.025

*** p<0.01, ** p<0.05, * p<0.1

Table 15

This table shows the elasticities of housing supply with respect to the demographic variable for different categories of dwellings for the Netherlands and its provinces in the short-run.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-3.962	-3.111	-2.233	-4.368	-2.983	-3.639	-8.990
Drenthe	6.362	7.534	9.467	7.243	4.811	10.814	7.993
Utrecht	-5.068	-3.090	1.658	-7.493	-0.051	2.814	-10.273
Groningen	-6.465	-6.537	-8.925	-5.853	-4.655	-7.371	-6.421
Flevoland	2.919	2.781	6.305	-0.083	0.719	7.561	3.880
Zuid-Holland	-7.094	-7.256	-4.267	-6.306	-5.679	-2.656	-12.525
Noord-Holland	-5.947	-4.267	-4.479	-0.644	-2.850	-4.245	-7.128
Noord-Brabant	-1.416	-0.436	-0.358	-6.887	-1.559	1.169	-5.172
Friesland	6.006	6.987	4.809	2.401	10.911	7.258	8.703
Overijssel	-13.844	-11.105	-9.434	-8.089	-9.914	-4.429	-9.379
Gelderland	-11.497*	-10.667	-5.869	-9.032	-10.613*	-11.136	-4.174
Zeeland	8.317	7.038	6.936	4.314	4.655	6.478	8.902
Limburg	-14.755	-15.616	-15.867	-15.486	-13.177	-17.126	-13.541

*** p<0.01, ** p<0.05, * p<0.1

Table 16

This table shows the error correction terms for the short-run supply equations of different categories of dwellings for the Netherlands and its provinces.

	P Total Houses	P Total Single Family Houses	P Detached Houses	P Terraced Houses	P end-of-terrace House	P Semi Detached House	P Apartment
The Netherlands	-0.450***	-0.449***	-0.449***	-0.451***	-0.447***	-0.458***	-0.469***
Drenthe	-0.733***	-0.727***	-0.718***	-0.721***	-0.730***	-0.719***	-0.742***
Utrecht	-0.674***	-0.677***	-0.692***	-0.663***	-0.673***	-0.663***	-0.651***
Groningen	-0.624***	-0.626***	-0.629***	-0.605***	-0.603***	-0.632***	-0.598***
Flevoland	-0.671***	-0.672***	-0.657***	-0.683***	-0.680***	-0.658***	-0.660***
Zuid-Holland	-0.510***	-0.515***	-0.510***	-0.513***	-0.524***	-0.498***	-0.500***
Noord-Holland	-0.815***	-0.821***	-0.826***	-0.812***	-0.803***	-0.787***	-0.802***
Noord-Brabant	-0.699***	-0.695***	-0.694***	-0.714***	-0.700***	-0.687***	-0.702***
Friesland	-0.432***	-0.430***	-0.434***	-0.410***	-0.431***	-0.432***	-0.426***
Overijssel	-0.676***	-0.691***	-0.686***	-0.711***	-0.707***	-0.715***	-0.705***
Gelderland	-0.531***	-0.531***	-0.528***	-0.533***	-0.516***	-0.522***	-0.503***
Zeeland	-0.696***	-0.703***	-0.659***	-0.692***	-0.695***	-0.700***	-0.693***
Limburg	-0.708***	-0.696***	-0.661***	-0.739***	-0.759***	-0.748***	-0.727***

*** p<0.01, ** p<0.05, * p<0.1

8. Figures

Figures 3 and 4 respectively depict the development of total single-family house prices and detached house prices in the Netherlands and its provinces during the period 1995 to 2012.

Figure 3: Total Single-family house prices

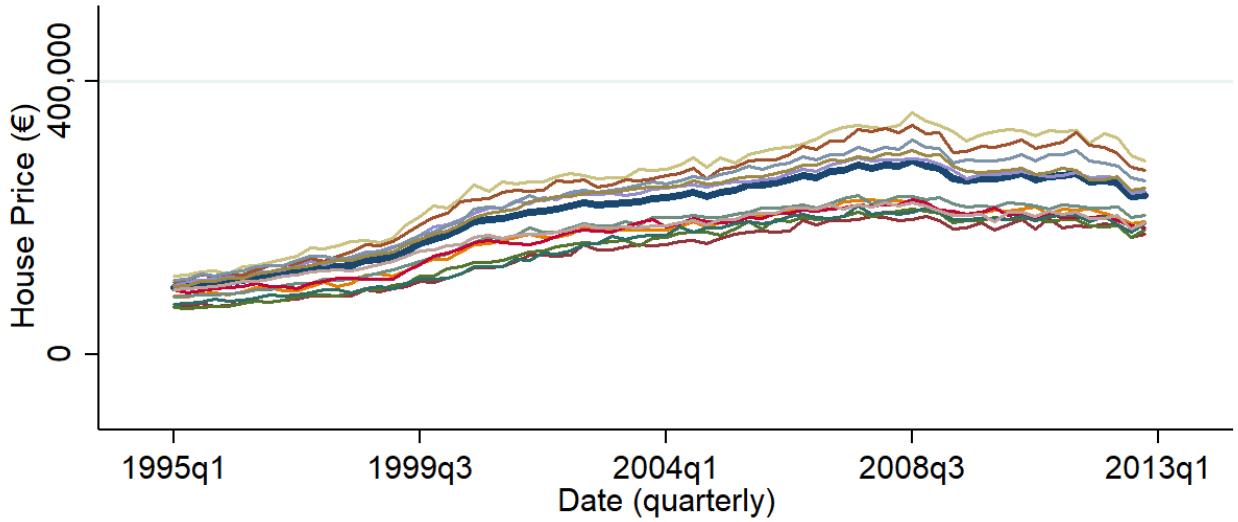
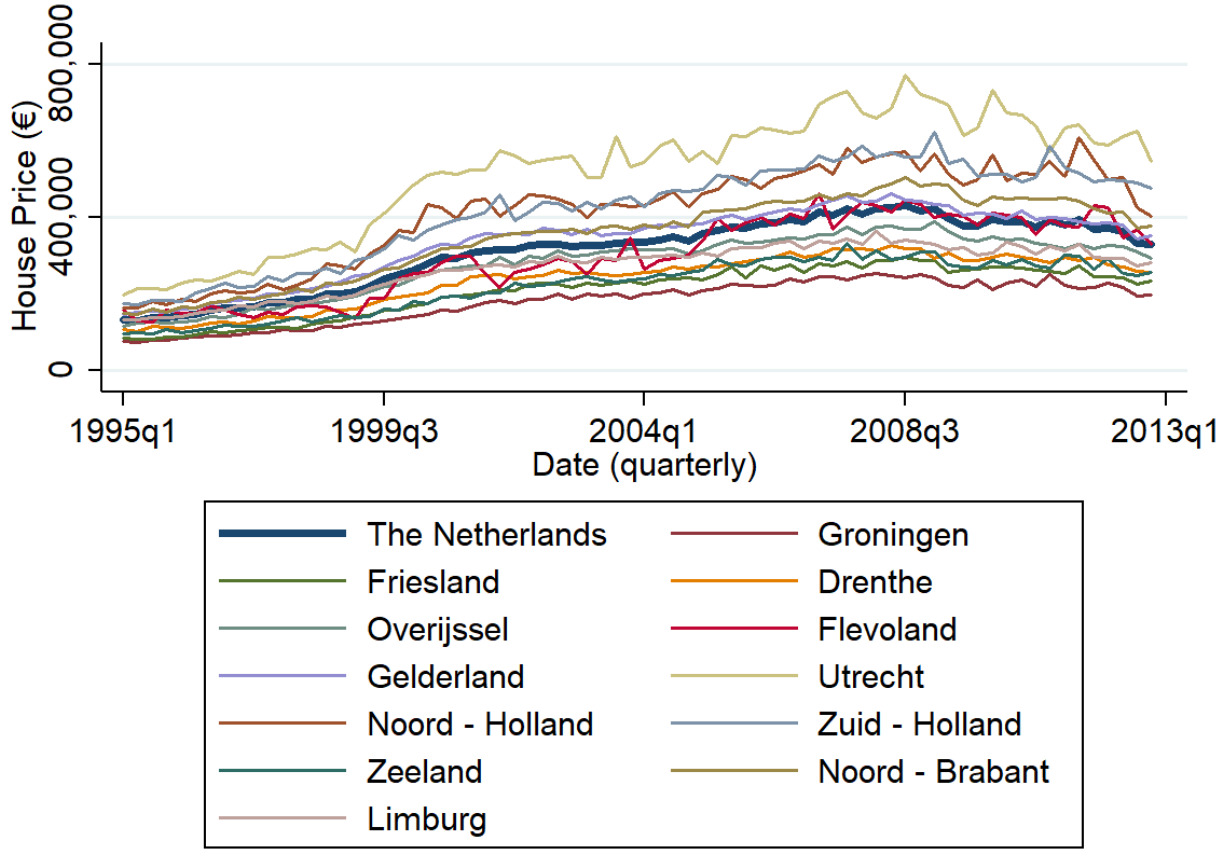


Figure 4: Detached house prices



Figures 5 and 6 respectively depict the development of semi detached house prices and the price of apartments in the Netherlands and its provinces during the period 1995 to 2012.

Figure 5: Semi detached house prices

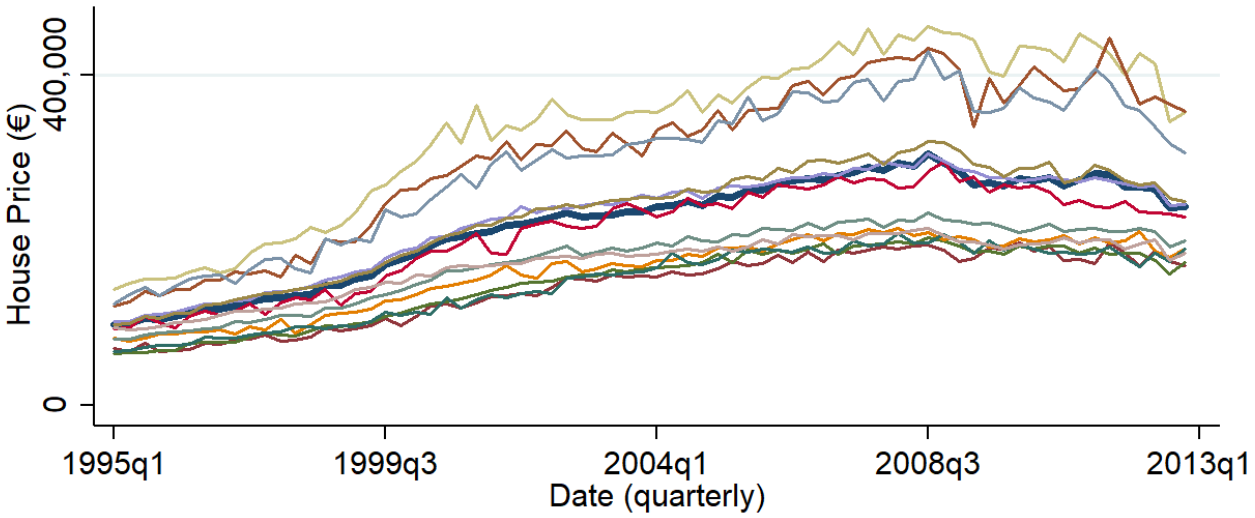


Figure 6: Apartments

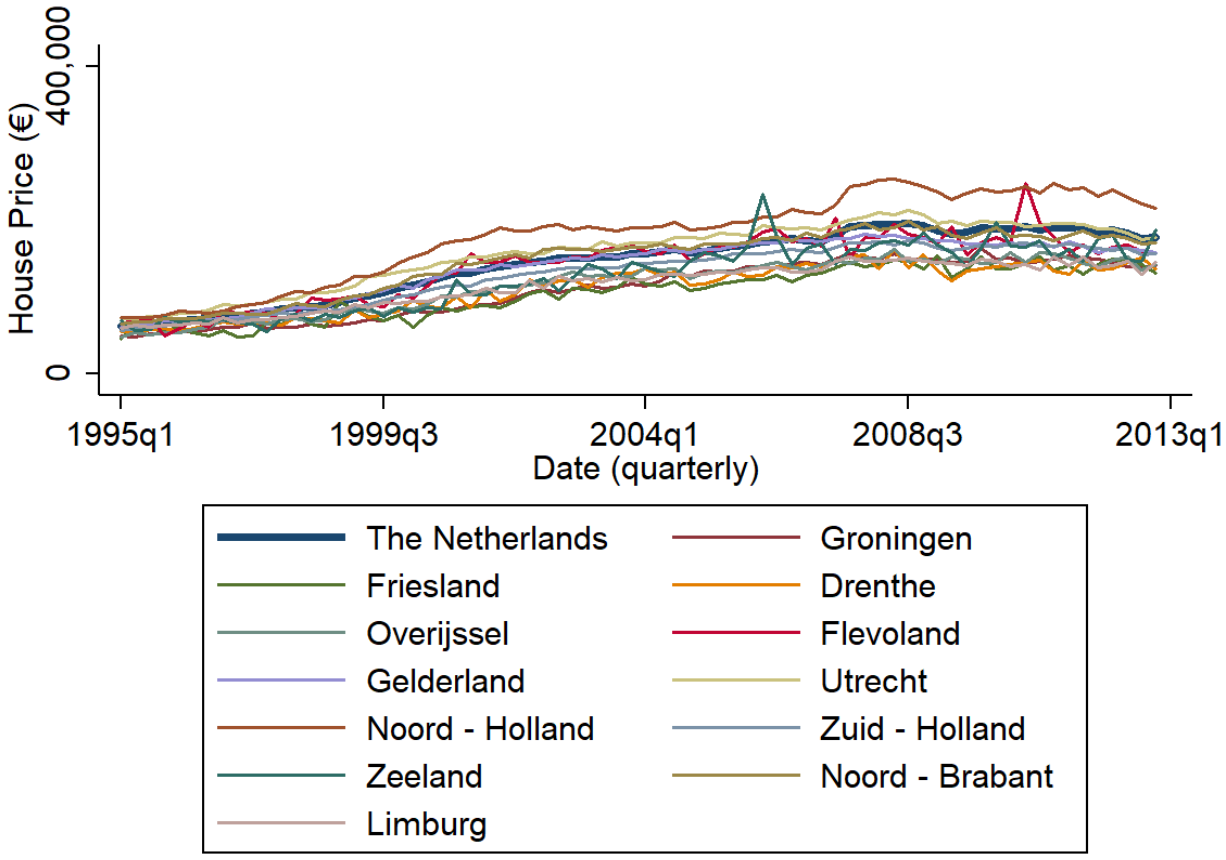
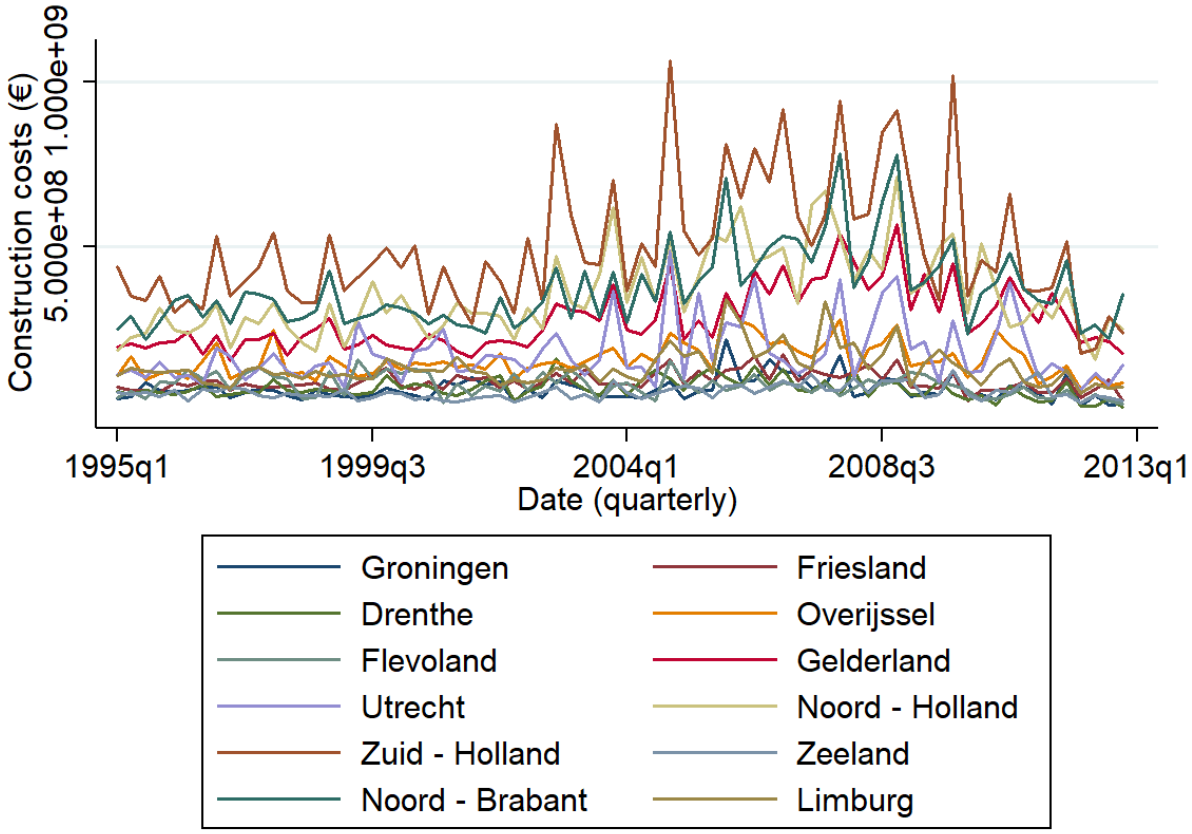


Figure 7

Development of the construction costs in the provinces of the Netherlands during the period 1995 to 2012. Since the amount of the construction costs in the Netherlands is the total of all of the provinces it is not included in this figure.



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