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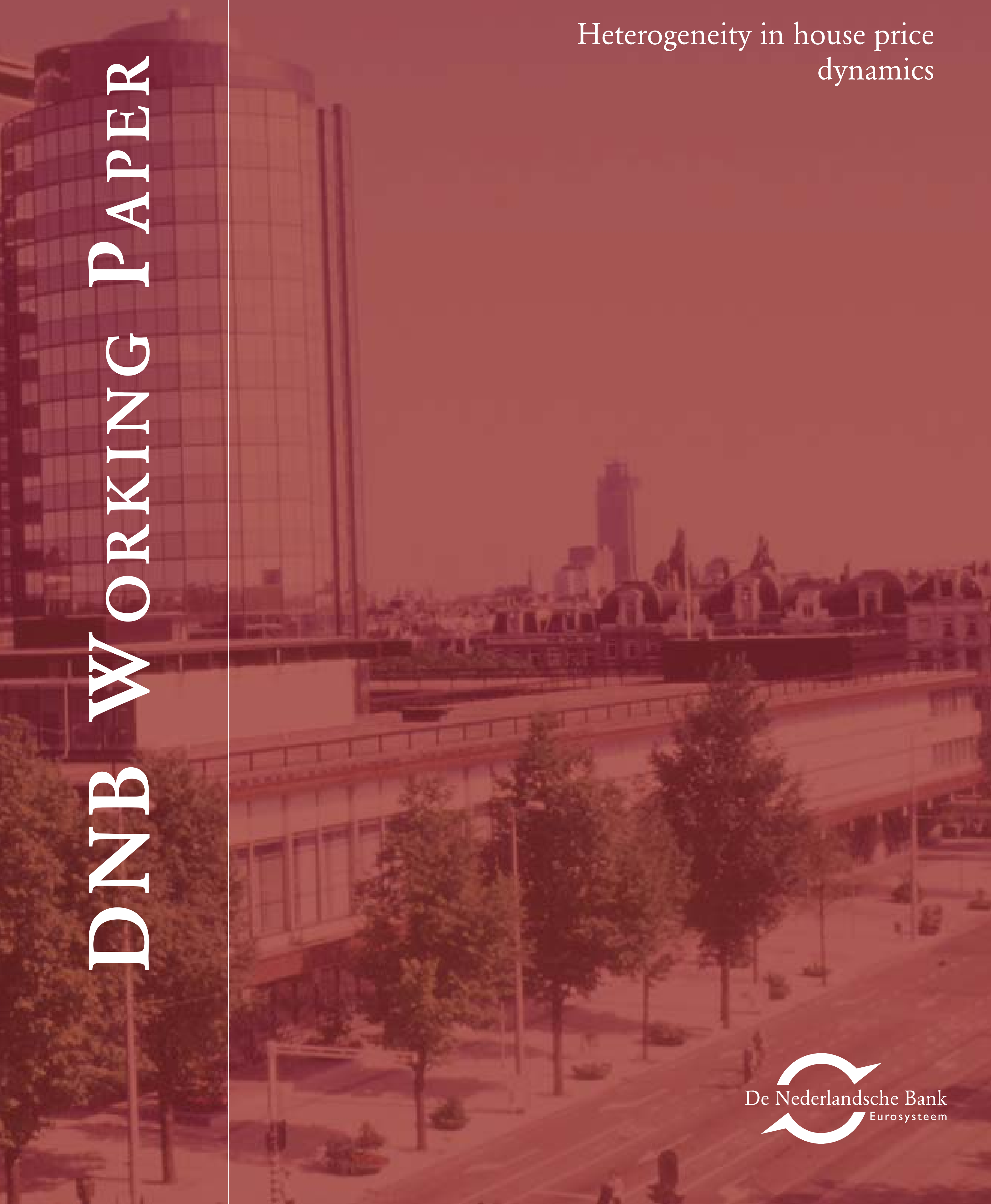

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Heterogeneity in house price dynamics

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Abstract

To what extent do house price dynamics differ across market segments? And what determines this heterogeneity? We address these questions by analysing a data set of individual houses and mortgages, based on a survey of about 2,000 Dutch households over the period 2003–2011. We estimate a dynamic panel data model of house price dynamics by means of the Arellano-Bond estimator. Three main empirical results emerge. First, we generally find that house price dynamics imply a convergence towards their long-run equilibrium value, as indicated by a negative serial correlation coefficient and a positive estimated mean reversion coefficient. Second, there is evidence that the housing market in the Netherlands is inefficient. Third, there is important heterogeneity across different market segments. We document that the speed of convergence of house price dynamics and the efficiency of housing markets depends on the geographical location and degree of urbanization, the type and year of construction of a house, the type of mortgage financing and households' sentiment about the medium-term outlook for income.

Key words: Housing market dynamics, house prices, heterogeneity, survey data, panel analysis.

JEL Codes : D14, G12, R32.

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1. Introduction

There is a rich literature on the housing market and its role in the economy (Mishkin, 2007), which in recent years has focused on the role of the housing market in the Great Crisis (see e.g. Mian and Sufi, 2009, 2010). This research has highlighted the importance of understanding the dynamics of house prices, and of the drivers of booms and busts in the housing market (e.g. Agnello and Schulknecht, 2009). One important insight of the literature is that these dynamics and their drivers can vary significantly across local markets (Capozza et al., 2004).

In this paper we take a more systematic look at heterogeneity in house price dynamics. We investigate differences across segments of the housing market defined by location, degree of urbanization, age and type of housing, the type of mortgage finance and measures of house owners' sentiment. One important novelty of our study is that we gauge the heterogeneity of house price dynamics using a large panel of households.

In our empirical analysis, we use a data set on housing and mortgages in the Netherlands. Over the past decades, the Dutch housing market has experienced phenomena that were quite common for industrial countries – a rapid increase in housing wealth and household debt, accompanied by a strong growth of mortgage markets which in part reflected financial innovation, and a corresponding rising share of housing loans in bank assets. House prices in the Netherlands experienced pronounced swings similar to those observed in other countries, first rallying sharply and then peaking around the time of the global financial crisis. We therefore believe that the Dutch case can shed light on house price dynamics more generally.

Our data set is based on the DNB Household Survey (DHS), an annual survey of about 2,000 households in the Netherlands that started in 1993. The characteristics of households in the DHS panel are overall fairly close to those of the Dutch population, although we find some differences in terms of education, geographical concentration, and wealth and income. One important advantage of our data set is that it contains information on the official value of a house determined by the municipality in which it is located. In the Netherlands, this value is used to calculate an imputed home ownership value and a residential property tax.

We use a dynamic panel data model by means of the Arellano-Bond panel data estimator to explain the dynamics of individual house prices and to investigate heterogeneity across different segments of the housing market in the Netherlands.

We find three key results. First, house prices generally converge towards their long-run equilibrium value, although this convergence is not very rapid. Second, there is evidence that the housing market in the Netherlands is inefficient. These results are in line with the extensive evidence provided for the United States, based on different types of data and different empirical approaches. Third, we find important heterogeneity in house price dynamics along different dimensions, some of which have not yet been documented in the literature. We show that the speed of convergence of house price dynamics depends on the geographical region, the degree of urbanization, the type of house and its year of construction, and the type of mortgage financing. In particular, we find that convergence tends to be faster for prices of houses located in the largest cities/highly urbanized areas. By contrast, convergence tends to be slower for prices of flats/apartments and houses financed with interest-only mortgages. We also find evidence that households' sentiment about the medium-term outlook of income matters for house price dynamics.

The rest of the paper is organized as follows. The next section surveys the literature on the drivers of house price dynamics. Section 3 documents the characteristics of our panel data set and describes our measure of house prices. Section 4 presents our empirical model and the results. Section 5 concludes.

2. Literature review

A rich literature has investigated the dynamic properties of the housing market and documented that it is generally not efficient and characterized by serial correlation and mean reversion. Large swings in house prices are typically followed by reversals to the (unobserved) fundamental price level.[1]

The empirical work has generally relied on two types of data. A first set of studies uses cross-sectional data or panel data on regions or metropolitan areas within a country – typically the United States – in an effort to investigate housing dynamics and how they differ across market segments. Important contributions to this literature strand include Case and Shiller (1989), Abraham and Hendershott (1993, 1996), Meese and Wallace (1994), Capozza and Seguin (1996), Malpezzi (1999), Kalra et al. (2000), Meen (2002), Capozza et al. (2002), Capozza et al. (2004), Zandi and Chen (2006), and Gao et al. (2009).

A second type of studies uses cross-country data, in an attempt to study the role of macroeconomic drivers along with financial and institutional factors. Tsatsaronis and Zhu (2004) provide an overview of this type of analysis.

One important finding of this literature is that there is significant heterogeneity in house price dynamics across different market segments. The geographical location of houses is typically

[1] For an in-depth review of earlier studies, see Cho (1996).

highlighted as a proximate source of heterogeneity (e.g. Meese and Wallace, 1994; Abraham and Hendershott, 1996; Himmelberg et al., 2005; Zandi and Chen, 2006).

A recent study by Gao et al. (2009) provides a systematic analysis of geographical heterogeneity in US housing markets. Gao et al (2009) use two large panel datasets of house prices from US metropolitan areas – the OFEO and S&P/Case-Shiller house price indices – to cluster market segments depending on their dynamic properties. They first classify housing market segments into "cyclical" (i.e. highly volatile) and non-cyclical (with low volatility) depending on the standard deviation between actual and fundamental house prices over time. They then estimate an asymmetric autoregressive mean reverting model, and find that cyclical markets tend to experience larger house price cycles. They also find that evidence of higher autocorrelation of housing prices during upswings compared to downswings.

In turn, geographical differences in housing dynamics can be explained by seven main factors: income, psychological factors, demographical factors, construction costs, market regulation, mortgage markets and asymmetric information.

Income is found to be a key factor determining whether housing market segments exhibit oscillatory or damped, and convergent or divergent price dynamics (Capozza et al., 2004).[2] Serial correlation is higher in metropolitan areas with higher real income (Capozza, 2002). However, as stressed by Case and Shiller (2004), psychological factors may dominate income growth as a driver of house price dynamics and underpin speculative bubbles in geographical segments of the housing market.

There is evidence from both regional data for the United States and cross-country regressions analysis that demographical factors play a significant role (Takáts, 2010). Capozza et al. (2002), for example, document that serial correlation of house prices is higher in metropolitan areas in the United States with higher population growth.

House price dynamics have been found to be influenced significantly by geographical differences in construction costs. In the United States, higher real construction appear to be associated with higher serial correlation of house prices and lower mean reversion (Capozza et al., 2002). As a result, high real construction cost areas – typically large metropolitan areas and fast growing cities – can witness substantial overshooting of house prices.

Several studies have highlighted that differences in the degree of market regulation may also underpin heterogenous market dynamics. In the United States, the mean reversion of metropolitan

[2] Consistent with this finding, there is evidence that the different willingness to pay for various locations depends on the number of high-income households who desire to live in those locations (Gyourko et al., 2006) or the cross-sectional dispersion of wages combined with limited land supply (Van Nieuwerburg and Weill, 2007).

house prices is found to be larger for low-to-moderately regulated markets than for the stringently regulated markets (Malpezzi, 1999). Green et al. (2005) document that differences in supply elasticities – which underpin housing dynamics – are driven by differences in the urban form and in the urban-land use regulation.

The role of mortgage markets and more in general financial factors are documented in a number of studies, most of which rely either on domestic macro time series (Estrella, 2002; McCarthy and Peach, 2002; Peek and Wilcox, 2006) or on cross-counry data (Muellbauer and Murphy, 1997; Herring and Wachter, 1999; Hilbers et al., 2001; Swank et al., 2002; Iacoviello and Minetti, 2003; Berger-Thomson and Ellis, 2004; Davis and Zhu, 2004; Hofman, 2004; Tsatsaronis and Zhu, 2004; Egert and Mihaljek, 2007; Warnock and Warnock, 2008; Calza et al., 2009). This line of research suggests that house price dynamics depend importantly on the flexibility and depth of domestic mortgage markets, as well as the tax treatment of homeowners (and in particular the extent to which mortgage payments are tax deductible).

In turn, there is research that relates the influence of mortgage financing on house prices to differences in the degree of informational asymmetries. Using data on 10,000 individual commercial property transactions in the United States, Garmaise and Moskowitz (2004) show that limited participation, selective offering and market segmentation are more important than the use of appropriate forms of financing. Warnock and Warnock (2008) document how the strength of legal rights for borrowers and lenders, through collateral and bankruptcy laws, and the depth of credit information systems underpins the role of housing finance.

Finally, from an international perspective, recent research highlighted the role of policy – and in particular monetary policy and macroprudential policy – on the behaviour of house prices (Kuttner and Shim, 2012).

3. The data

The existing literature typically relies on data on either regional/metropolitan housing markets or on data aggregated at the country level. An important novelty of our paper is that we use data on a large cross-section of individual houses and households that are available for a number of consecutive years. These data enable us to shed new light on the heterogeneity of the housing market, its sources, and how it affects the dynamics of house prices.

3.1. The DNB Household Survey

Our data source is the DNB Household Survey (DHS), formerly known as the CentER Savings Survey. The DHS is an annual survey of households in the Netherlands that started in 1993 and is run at Tilburg University by CentERdata.[3] The DHS consists of a sample intended to be representative of the Dutch population; it covers some 2,000 households in each wave, including refreshment samples compensating for panel attrition.[4] Our dataset covers the period 2003–2011, and has 1,891 different households and 6,743 point observations. Table 1 presents statistical information on the characteristics of the survey respondents.

Table 1 about here

The DHS comprises six questionnaires, which relate to work and pensions, accommodation and mortgages, income and health, assets and liabilities, and economic and psychological concepts. The dataset thus provides information on both economic and psychological aspects of financial behaviour. The questionnaires are self-administered: respondents receive them by modem, fill in the answers on their home computers, and return them at a time that is convenient for them. For a detailed description of the CentERpanel and the DHS see Teppa and Vis (2012).

In this paper we mainly focus on the accommodation and mortgages questionnaire. The database used for our analysis consists of home owners, for whom we have information about the value of a house that is determined by the municipality in which it is located (the so-called WOZ-value, in Dutch "waardering onroerende zaken"). In the Netherlands, this WOZ-value is used to calculate an imputed home ownership value and a residential property tax.[5]

The mortgage market in the Netherlands is known to be very developed (Andre', 2010). Annex 1 provides a brief overview of the main types of mortgage contracts, with the same wording as in the DHS questionnaire. 78 percent of households in our sample reported to have contracted at least one mortgage for house purchase purposes.[6]

The DHS contains information that allows to test for the role of five sources of heterogeneity in house market dynamics whose importance has been highlighted in the literature: geographical location and degree of urbanization, income, psychological factors, demographical factors and

[3] In principle all household members aged 16 years and older are allowed to participate. In case of attrition, CentERdata recruits new participants to maintain the panel size, as well as to keep the panel representative with regard to a number of relevant background characteristics such as age, gender, income, education, and region of residence. More information on CentERdata, the CentERpanel and the DHS is available at http://www.uvt.nl/centerdata/dhs.

[4] In addition, for the period 1993–1997, data were also collected separately for a sample (HIP) of some 900 households that was representative of the top 10 percent of the income distribution.

[5] Since data on this variable are available only from 2003 on, we have to discard between 1993 and 2002.

[6] The number of households for which information on the mortgage for the main residence is available is reduced to 1,370, for a total of 4,946 valid household/year observations.

type of mortgage financing. In addition, we can verify whether house price dynamics depend also on other house-specific characteristics, such as the year of construction or the type of house. Table 1 reports summary statistics on house characteristics (geographical region, year of construction), household specific characteristics, (income, wealth, psychological factors, age), and individual respondents' financial arrangement (types of mortgages).

3.2. Measuring house prices

In the DHS, information on our main variable of interest, the house price *p* of household *i* at time *t*, can be gained – for respondents that live in a house they own – from answers to three questions. Our preferred source of information are the answers to a question on the value of a property for tax purposes (the so-called WOZ), which is determined by the municipality based on the value of property with similar characteristics located in the same neighbourhood. This question reads as follows: *"In order to calculate for example the deemed home ownership value (eigenwoningforfait) and the immovable property tax (OZB) the government uses the WOZ-value of your house (the official value of your house determined by the municipality). What is the determined WOZ-value for your house?"*.

Note that that while the WOZ is an official value, the information provided by the answers to the question above is a self-reported value, implying a potential bias. One way to gauge the size of this potential bias is to compare the average of our DHS variable with the average purchase price of owner-occupied dwellings in the Netherlands published by the official national statistical office in the Netherlands (Centraal Bureau voor de Statistiek, CBS or Statistics Netherlands). Statistical tests and graphical evidence (Figures 1 and 2) show that the dynamics of the two series is very similar.[7]

Figure 1 and Figure 2 about here

An alternative – and more direct – source of information on house prices is a question that asks directly for the actual price that was paid for the purchase of that house. While answers to this question have the advantage of providing information on actual transaction prices, a large majority of households in our data set does not change residence during the sample period. Moreover, when a house was purchase prior to the start of our sample period, the DHS does not

[7] The hypothesis that the two variables are independent is strongly rejected by a Pearson's chi-squared test, and the correlation between the two variables is highly significant. In addition, the mean value of annual house price changes of the two series is of a rather similar order of magnitude. The correlation coefficient of the two series in changes is also strongly significant.

provide information on the timing of the transaction. We therefore decided not to use this variable in our empirical analysis.

A third data source consists of answers to the following question: *"About how much do you expect to get for your residence (not including the business part) if you sold it today (empty and not let)?"*. Although data on subjective assessments of the current home value are available for a longer period compared to those on the WOZ value, we opted against using this source of information. The main reason is that answers to this question are clearly subjective and may potentially suffer from a persistent bias.[8]

4. Empirical model and main results

4.1. The model

To explain house price dynamics, we use an empirical model consisting of two equations. The first describes the evolution of the long-term, fundamental value for house prices $P_{it}*$ owned by household *i* at time *t*:

$$P_{it}* = X'_{it}\,\delta + c_i + v_{it} \qquad (1)$$

where X_{it} are time-varying house or household characteristics (such as household income or the mortgage rate), c_i is a set of time-invariant house or household specific regressors, and v_{it} is a white noise unobserved residual.[9]

The second equation describes the short-term dynamics of house prices P_{it} for household *i* at time *t*, and is specified in first differences:

$$\Delta P_{it} = \alpha \Delta P_{it-1} + \beta(P_{it-1}* - P_{it-1}) + \gamma \Delta P_{it}* + u_{it} \qquad (2)$$

where the parameter α captures the degree of serial correlation, β the extent of mean reversion to the fundamental value, and γ the contemporaneous adjustment to fundamentals. u_{it} is a white noise unobserved residual.

This type of model has been used in a number of studies on the dynamics of the housing market (e.g. Capozza et al., 2002; Gao et al., 2009). These studies generally focus on the United States and rely either on time series data, or on panel data with relatively few cross-sectional observations and a relatively long time series. House prices are captured by quarterly data on US

[8] In the literature, estimates of the bias of subjective house prices suggest that it can be significant and difficult to pin down (Capozza et al., 2002; Glindro et al., 2008; Gonzalez-Navarro and Quintana-Domeque, 2009; Bucchianeri and Miron-Schatz, 2011).

[9] We control for the level of unemployment to capture the role of macroeconomic dynamics.

house price indices such as the S&P/Case-Shiller index or the actual repeat-transactions house price index. These papers typically follow a two-step estimation strategy. In the first step, an equation for the fundamental house price – such as equation (1) – is estimated. In the second step, the dynamic equation (2) is estimated separately, where P_{it}* is the fitted fundamental price from the first step.

This two-step procedure is appropriate in a time series context where a cointegration framework is used to distinguish long-term relationships from short-term dynamics. In principle, it is also appropriate for panel data but only when the time series dimension is large.

In our data set however, the time dimension is too small for asymptotic properties to apply in a cointegration-type set up which includes a long-term relationship. To estimate the model consistently, we therefore adopt a different strategy based on estimating in one step a single reduced-form equation that combines equations (1) and (2). In particular, we rewrite equation (2) in levels:

$$P_{it} - P_{it-1} = \alpha P_{it-1} - \alpha P_{it-2} + \beta P_{it-1}* - \beta P_{it-1} + \gamma P_{it}* + \gamma P_{it-1}* + u_{it}$$

$$P_{it} = (1+\alpha-\beta)P_{it-1} + \gamma P_{it}* + (\beta-\gamma)P_{it-1}* - \alpha P_{it-2} + u_{it} \qquad (3)$$

By substituting equation (1) into (3), we get:

$$P_{it} = (1+\alpha-\beta)P_{it-1} + X_{it}'\delta\gamma + X_{it-1}'\delta(\beta-\gamma) - \alpha P_{it-2} + [\beta c_i + \beta v_{it-1} + \gamma \Delta v_{it}] + u_{it}$$

$$P_{it} = (1+\alpha-\beta)P_{it-1} - \alpha P_{it-2} + \Delta X_{it}'\delta\gamma + X_{it-1}'\delta\beta + \beta c_i + \beta v_{it-1} + \gamma \Delta v_{it} + u_{it}$$

$$P_{it} = \theta_1 P_{it-1} + \theta_2 P_{it-2} + \theta_3 \Delta X_{it}' + \theta_4 X_{it-1}' + \varepsilon_{it} \qquad (4)$$

where $\theta_1 = (1+\alpha-\beta)$; $\theta_2 = -\alpha$; $\theta_3 = \delta\gamma$; $\theta_4 = \delta\beta$

Equation (4) can be estimated consistently by means of the Arellano-Bond panel data estimator (Arellano and Bond, 1991). All regressors enter in first differences and in first lags.

Table 2 reports the results from estimating equation (4). In addition to the estimates of α, β and γ – the main parameters of interest – Table 2 also reports F-statistics for the test of equal coefficients and the Hansen-test statistics of overidentifying restrictions.

The first row shows estimates of the baseline specification with the full number of observations. In order to verify the presence of relevant heterogeneity across different house market segments, we also run the baseline regression with data disaggregated along several dimensions: the degree of urbanization, the geographic region, the type of house, the type of mortgage, and the year of construction. In the terminology of Gao et al. (2009), estimates of α, β and γ for these market segments allow us to group them into "cyclical (or volatile)" and "non-cyclical (or tame)".

Table 2 about here

4.2. Results

We highlight two important results on the dynamics of the Dutch housing market.[10] First, our estimates for α, β and γ show that at an aggregate level, house prices in the Netherlands converge towards their long-term equilibrium value.[11] In terms of speed of convergence, the Dutch housing market could be characterised as an intermediate case between "non-cyclical" and "cyclical" in the terminology of Gao et al. (2009). We find that α – which measures the degree of serial correlation – is negative but fairly low. This indicates that at time *t*, house prices change in the opposite direction with respect to their change at time *t-1*, albeit very slowly. It can be interpreted as suggesting that on average, households do not value their house in a persistently adaptive way.

The parameter β – which measures the degree of mean reversion to the fundamental value – is estimated to be positive and fairly high (0.60), implying that a misalignment between fundamental house prices and actual house prices induces a change in the same direction of actual house prices in the following period. In other words, if in the previous period house prices are below their fundamental value (i.e. $P_{it-1}* - P_{it-1} > 0$), prices will adjust upward in the current period. Conversely, if in the previous period house prices are above their fundamental value (i.e. $P_{it-1}* - P_{it-1} < 0$), they will adjust downward in the current period.

The estimate of the parameter γ – which measures the contemporaneous adjustment of house prices to fundamentals – is fairly low (0.20), indicating that the housing market in the Netherlands is rather inefficient. This finding can be explained by high transaction costs and the inelastic supply of housing (Swank et al., 2002; IMF, 2010).

[10] Our results also show that among the parameters of interest (α, β and γ), β is always strongly statistically significant (at the 1% level) and γ is in most cases significant (at least at the 5% level).
[11] This is consistent with evidence from other studies (see IMF, 2010).

A second key observation is that while the dynamics of the Dutch housing market exhibit common features across market segments, there are important heterogeneities. The different housing market segments are all similar in that they are characterised by a negative parameter α, a positive parameter β and – in most cases – a fairly low parameter γ. At the same time, the estimated coefficients for α, β and γ change – at times markedly – when we disaggregate our data along different dimensions. In particular, we find evidence of substantial heterogeneity in the dynamics properties of house prices across different geographical location or degree of urbanization, type of house, type of mortgage financing and household sentiment about the medium-term future. By contrast, we do not find evidence of significant differences in house price dynamics across households of different income or age classes.[12]

More in detail, house prices in *highly urbanized areas* tend exhibit significantly higher parameters mean reversion (β) and a higher parameter measuring market efficiency (γ) compared to areas that with a moderate or limited degree of urbanization. By contrast, we do not detect major differences in the parameter of serial correlation (α). In terms of *geographic region*, we also find visible differences in mean reversion or market efficiency across the main areas of the Netherlands.

In addition to market segmentation in terms of location, our results also provide evidence on heterogeneity in price dynamics of across different *types of housing*, where we observe a wide range of estimates of the degree of mean reversion and the parameter measuring market efficiency. The same is true for when we distinguish houses by *year of construction*.

Results also differ markedly across *types of mortgage*. Annuity or traditional mortgages tend to have a much higher parameter of mean reversion compared to the interest-only type of mortgage. Both market segments appear to be characterised by low serial correlation and low efficiency. This suggests that interest-only mortgages, a financial innovation that became popular in the first decade of this century, are associated with more volatile house price dynamics.

5. Conclusions

This paper investigates the heterogeneity of house price dynamics across different segments of the housing market. It relies on a large panel data set of Dutch households that covers the period 2003–2011, which we build based on survey data on housing and mortgages from the DNB Household Survey for the period.

Given that we have many cross-section observations but only a limited amount of time series observations, in contrast to most of the existing studies of housing market dynamics we do not use

[12] The latter results are not reported for reasons of space but available upon request from the authors.

a time-series framework (typically involving cointegrating relationships). Instead, we apply the Arellano-Bond panel data estimator to a reduced-form equation that captures the dynamics of house prices in terms of both micro- and macroeconomic factors.

In sum, we generally find a negative serial correlation coefficient (α) and a positive estimated mean reversion coefficient (β), implying that house price dynamics lead to a convergence towards their long-run equilibrium value. This is true for the whole sample, as well as for different market segments we investigate. At the same time, the empirical evidence also highlights an important heterogeneity across different market segments defined by geographical location/degree of urbanization, type of housing, type of mortgage financing and household sentiment, indicating that, that although generally converging to the fundamental value, the speed of convergence of house prices varies across market segments. This heterogeneity is particularly pronounced for the mean reversion coefficient (β) and the degree of market efficiency (γ). By contrast, house price dynamics appear not to differ significantly across households of different income or age classes.

In particular, we find that segments that are less volatile are those with the highest degree of urbanization. We also find that houses with more stable house price dynamics are associated with households that are more pessimistic about the medium-term future. In addition, we find that funding conditions display some heterogeneity. Individuals with interest only mortgages tend to have a lower persistence coefficient.

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Table 1: Descriptive statistics of the survey respondents

Characteristic	Mean value	Std.dev.	N.Obs.
Male indicator	0.82	0.38	7,314
Year of birth			
Before 1930 (reference group)	0.04	0.20	7,314
Between 1930 and 1939	0.19	0.39	7,314
Between 1940 and 1949	0.21	0.40	7,314
Between 1950 and 1959	0.24	0.43	7,314
Between 1960 and 1969	0.19	0.39	7,314
After 1969	0.13	0.34	7,314
Level of education			
Low education (ref. group)	0.23	0.42	7,230
Middle education	0.29	0.45	7,230
High education	0.48	0.50	7,230
Geographical region			
Three largest cities (ref.group)	0.13	0.34	7,300
Rest West	0.29	0.45	7,300
North	0.12	0.32	7,300
East	0.21	0.40	7,300
South	0.26	0.44	7,300
Household income classes			
Less than 15,000 euros (reference group)	0.03	0.18	6,125
Between 15,000 and 22,000	0.17	0.38	6,125
Between 23,000 and 40,000	0.53	0.50	6,125
More than 40,000	0.27	0.44	6,125
Mortgage type			
Annuity (reference group)	0.11	0.31	5,290
Traditional life-insurance	0.07	0.26	5,290
Improved tradit. life-insurance	0.24	0.43	5,290
Linear mortgage	0.02	0.14	5,290
Endowment mortgage	0.01	0.11	5,290
Investment mortgage	0.11	0.32	5,290
Interest only mortgage	0.44	0.50	5,290
Type of house			
Detached	0.19	0.39	7,285
Corner	0.13	0.34	7,285
Semidetached	0.19	0.39	7,285
Terraced	0.30	0.46	7,285
Flat	0.15	0.35	7,285
Expectations on economic situation			
Much worse/worse than now	0.23	0.42	5,323
About the same as now	0.55	0.50	5,323
Better/much better than now	0.22	0.41	5,323
Year	2007	2.50	7,314

Note: statistics based on the DNB Household Survey (see Teppa and Vis, 2012

Table 2: Determinants of house prices – reduced form parameter estimates

Specification	α (Std.Err.)	β (Std.Err.)	γ (Std.Err.)	F-test	Hansen-test	N.Obs. (N.hhs.)
Baseline	-0.14 ***	0.60 ***	0.20 **	0.06	0.13	1166
	(0.04)	(0.06)	(0.07)			(419)
By degree of urbanization						
Very strong	-0.05	0.75 ***	0.35 ***	0.75	0.37	149
	(0.06)	(0.13)	(0.11)			(54)
Strong	-0.23 *	1.06 ***	0.46 **	0.88	0.00	277
	(0.13)	(0.13)	(0.16)			(107)
Moderate	-0.13 ***	0.59 ***	0.15 *	0.90	0.18	260
	(0.04)	(0.11)	(0.09)			(90)
Limited	-0.07	0.61 ***	0.15	0.98	0.43	259
	(0.05)	(0.11)	(0.11)			(94)
Very limited	-0.13 ***	0.66 ***	0.34 ***	0.20	0.58	187
	(0.03)	(0.07)	(0.09)			(63)
By geographic region						
Three largest cities	-0.03	0.85 ***	0.42 ***	0.12	0.26	145
	(0.03)	(0.05)	(0.05)			(55)
Rest West	-0.02	0.81 ***	0.08	0.98	0.78	319
	(0.03)	(0.07)	(0.12)			(117)
North	-0.16 ***	0.40 ***	0.25 **	0.80	0.78	135
	(0.04)	(0.04)	(0.10)			(43)
South	-0.26 ***	0.82 ***	0.55 ***	0.74	0.00	309
	(0.08)	(0.14)	(0.11)			(115)
By type of house						
Detached independent	-0.13 ***	0.45 ***	0.29 ***	0.75	0.16	239
	(0.03)	(0.08)	(0.07)			(81)
Corner independent	-0.05	0.62 ***	0.46 ***	0.14	0.32	145
	(0.04)	(0.07)	(0.09)			(56)
Two-under-one-roof house	-0.02	0.77 ***	-0.04	0.87	0.24	219
	(0.07)	(0.11)	(0.21)			(75)
In-between house	-0.01	0.90 ***	0.30 ***	0.44	0.50	317
	(0.05)	(0.09)	(0.09)			(122)
Flat/apartment	-0.06 *	0.82 ***	0.33 ***	0.25	0.55	164
	(0.03)	(0.07)	(0.09)			(64)
By type of mortgage						
Annuity or traditional	-0.06	1.09 ***	0.32	0.68	0.60	74
	(0.09)	(0.20)	(0.20)			(32)
Interest only	-0.08	0.64 ***	0.10	0.62	0.33	453
	(0.09)	(0.10)	(0.12)			(180)
By year of construction						
Before 1945	0.00	0.59 ***	0.24 **	0.28	0.82	191
	(0.03)	(0.09)	(0.05)			(81)
Between 1960 and 1965	0.48 **	1.77 ***	1.05 ***	0.22	0.18	74
	(0.18)	(0.34)	(0.30)			(23)
Between 1975 and 1980	-0.18 **	0.57 ***	0.31 **	0.86	0.03	137
	(0.07)	(0.12)	(0.12)			(45)
Between 1985 and 1990	-0.20 ***	0.50 ***	0.46 ***	0.96	0.07	143
	(0.04)	(0.10)	(0.10)			(49)
By expectation on economic situation						
(Much) worse than now	-0.05	0.82 ***	0.76 ***	0.96	0.11	81
	(0.06)	(0.16)	(0.19)			(40)

Notes:
- Estimates from a dynamic model with annual panel data using the Arellano-Bond estimator. The sample period is 2003–2011. The data are taken from the DNB Household Survey. *, ** and *** indicate statistical significance at the 10%, 5% and 1%, respectively.
- Degree of urbanization: Very strong: 2000 addresses per km2; Strong: 1500 to 2000 addresses per km2 or more; Moderate: 1000 to 1500 addresses per km2; Limited: 500 to 1000; very limited: less than 500 addresses per km2

Annex 1: Mortgage types in the Netherlands

Annuity mortgage: the total amount of periodic payments on interest and repayment remains the same (at least) during the period for which the interest rate was fixed. During the first part of this period, the amount due consists of a relatively large part of interest and a relatively small part of repayment. In later years, it is the other way around.

Traditional life-insurance mortgage: it consists of a loan and a life-insurance policy. There is no repayment, but only paying interest on the loan, and paying a premium for the life-insurance policy. There is no direct relation between the interest rate of the mortgage loan and the savings interest rate of the life-insurance policy (in contrast with an improved life-insurance mortgage, where there is a relation between those two interest rates).

Improved life-insurance mortgage: this is a modernized version of a traditional life-insurance mortgage. It consists of a loan and a life-insurance policy. There is no repayment, but only paying interest on the loan, and paying a premium for the life-insurance policy. In this case, the interest rate of the mortgage-loan and the savings interest rate of the life insurance policy are related, which causes monthly net-costs to be rather stable.

Linear mortgage: the periodic payments include paying off a fixed percentage of the total mortgage loan, and paying interest on the loan that is left at that moment. Over time, the amount you pay on interest becomes less and less, such that total monthly costs go down through the years. In the first period of the term of the mortgage, the costs of a linear mortgage are higher than the costs of an annuity mortgage.

Endowment mortgage: it is possible, during the term of the mortgage, to get a new loan on (part of) the amount that you have already paid off.

Investment mortgage: this is a new variation on the (traditional) life-insurance mortgage. As is the case with the other life-insurance mortgages, also for most of the investment mortgages the loan is paid off out of the benefits of a whole life-insurance policy linked to the mortgage at the end of the mortgage period. Contrary to an (improved) life-insurance mortgage, the returns of the life-insurance policy are based on the returns of an investment portfolio.

Interest only: one only pays interest during the term of the mortgage with a balloon payment due at the end. [13]

[13] In addition the DHS contains two other mortgage types, namely the annuity construction and the life-insurance mortgage. We do not include them in our analysis because of the very limited number of observations associated to these mortgage types. For informative purposes we report their characteristics below.
ANNUITY CONSTRUCTION: During the term of the mortgage one pays interest only, but at the same time one contributes to an annuity, which becomes available at the end of the mortgage period. The annuity does not have to be used to pay off the mortgage at the end of the mortgage period. It can be used as a supplementary pension provision.
LIFE-INSURANCE: the lifelong mortgage with life-insurance is a variation on the interest only mortgage. This mortgage is taken out for an indefinite period. To be sure that the mortgage is paid off after death (at the latest), the mortgage holds a term life insurance policy.

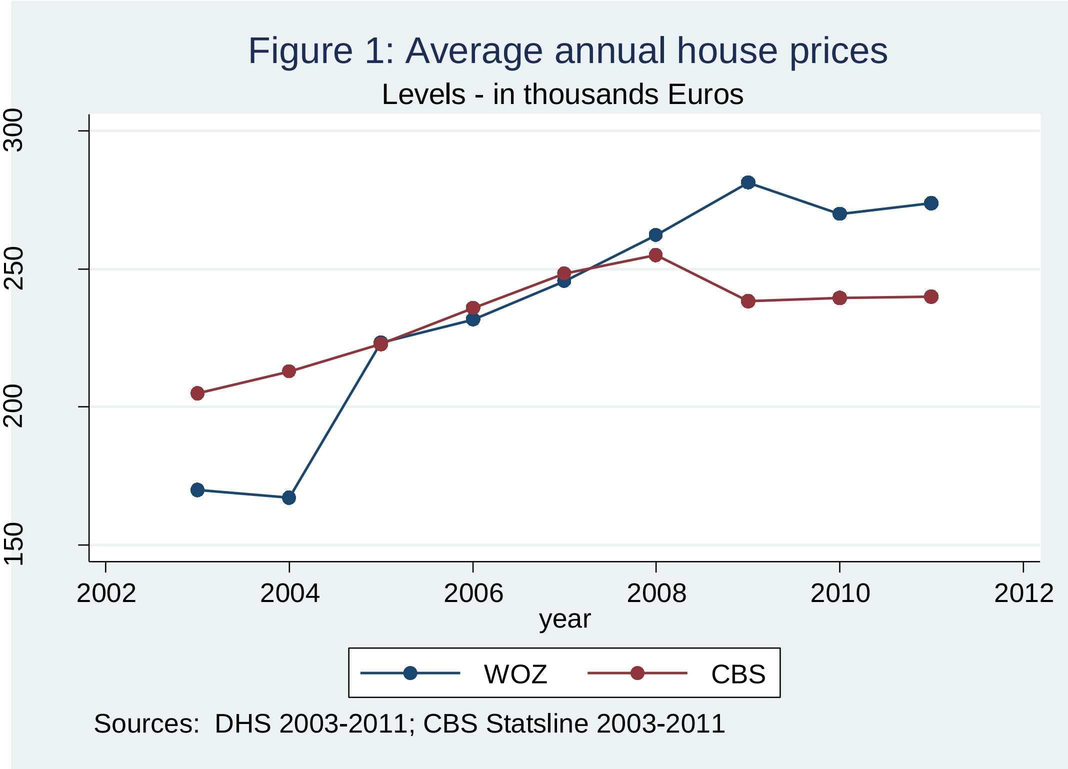

Figure 1: Average annual house prices
Levels - in thousands Euros
300
250
200
150
2002
2004
2006
2008
2010
2012
year
WOZ
CBS
Sources: DHS 2003-2011; CBS Statsline 2003-2011

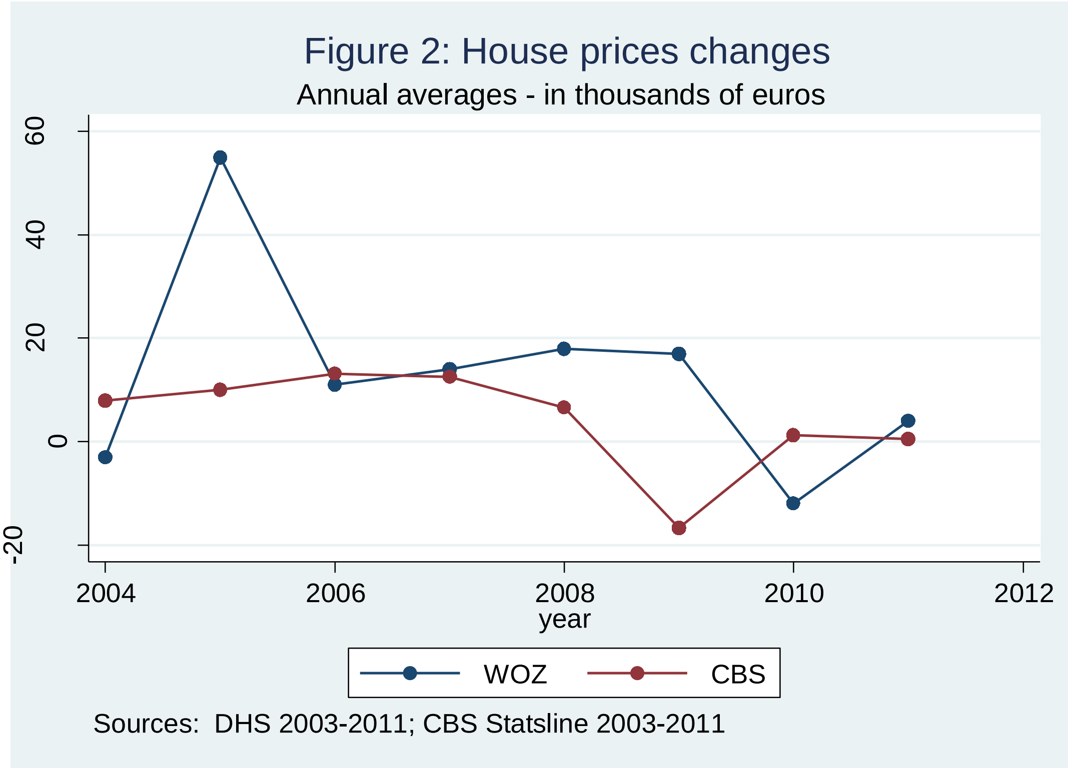

Figure 2: House prices changes
Annual averages - in thousands of euros
60
40
20
0
-20
2004
2006
2008
2010
2012
year
WOZ
CBS
Sources: DHS 2003-2011; CBS Statsline 2003-2011

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