7 General conclusion

Since the 2007-2008 Global Financial Crisis (GFC), a great deal of research has been conducted in various countries into the dynamics and risks associated with house prices in an attempt to find innovative ways of reducing these risks and resuscitating a depressed housing market. This dissertation contributes to that literature by providing comprehensive analyses of the spatial diffusion and risks associated with house prices in the Netherlands. It also studies the efficiency and loss coverage of home-value insurance in the context of the Dutch housing market and suggests modifications to the index-based insurance scheme that would minimise the residual idiosyncratic risks for home-owners. The dissertation innovatively adopts empirical methods that combine standard statistical analyses with more complex and recent econometric models.

The contributions of the dissertation are presented in five main chapters. Four of these chapters have already been published separately in international journals and one is under review. Chapter 2 provided a general overview of the Dutch housing market and the risks involved in home-ownership. Chapters 3, 4 and 5 were devoted to the diffusion mechanism of house prices in the Netherlands. Chapter 5 also dealt in part with house price risks, while Chapter 6 focused on the house price risks and home-value insurance. Each chapter has provided a detailed conclusion on each aspect of the research questions addressed in this dissertation. This concluding chapter summarises the main findings of the dissertation as a whole. The limitations of the analyses are discussed, together with potential applications for its findings and directions for further research.

§ 7.1 Main findings

§ 7.1.1 Diffusion

Housing researchers define the "diffusion" or "ripple effect" as a housing market phenomenon whereby house price movements in one region spread to house prices in other parts of a country, with a transitory or permanent impact (Meen, 1999; Giussani and Hadjimatheou, 1991). The diffusion mechanism of house prices in the Netherlands is covered in Chapters 3, 4 and 5 of the dissertation. Chapter 3addresses the following research question:

> *To what extent does house price diffusion exist in the Netherlands? Which regions predominate in the house prices diffusion mechanism? How does the diffusion mechanism vary over time?*

A graphical network method was adopted to address these questions. The graphical network is a relatively new econometric approach to modelling the complex and hidden interrelations between multivariate time series variables. The method used in this dissertation specifically applies the Bayesian graphical vector autoregression (BG-VAR) model of Ahelegbey et al. (2016a), which combines graphical techniques and vector autoregression models. The advantage of this approach is that both the region that predominantly drives diffusion and the direction of diffusion can be deduced from the graph. Network statistics can also be computed to reveal the characteristics of the diffusion mechanism (see Section 3.5).

The empirical analysis used the twelve provinces/regions of the Netherlands as the spatial units and their respective house price indexes from 1995 to 2016 provided by Statistics Netherlands. The results show existing diffusion pattern of house prices in the Netherlands, which varies over the sample period. The diffusion pattern seems to have been more intense from 1995 to 2005 and weaker from 2005 until 2008, after which the diffusion again began to intensify (Figure 3.5).

A formal empirical test identifies a structural break at 2005Q2 (see Figure 3.6), which delineates a period of sustained house price appreciation in the Netherlands from the so-called bubble period, consisting of the pre- and post-crisis periods. A more detailed study of the sub-periods 1995Q1–2005Q2 and 2005Q3–2016Q1 identifies Noord-Holland and Drenthe respectively as the regional housing markets that predominate in house price diffusion. The result for Noord-Holland, which is one of the more economically significant Dutch provinces, is unsurprising. Similar findings in the UK and other countries also suggest that major economic regions are more influential in house price diffusion (Meen, 1999; Holly et al., 2011; Gong et al., 2016b). It is interesting, however, that Drenthe, one of the smaller regions, has also played a central role in the house price diffusion mechanism during certain periods in the Netherlands.

Chapter 4 focuses on house price diffusion from the Dutch capital Amsterdam, which is located within the province of Noord-Holland. Amsterdam's housing market is one of the largest and most dynamic in the Netherlands. The chapter specifically looks at the extent to which house price movements in Amsterdam drive house prices in other regions of the Netherlands, and it confirms the existence of house price diffusion from economically more significant regions, as existing literature from other countries has suggested.

In methodological terms, a section of the existing literature argues that the diffusion of house prices manifests itself as a lead-lag or long-run effect (see Giussani and Hadjimatheou, 1991; MacDonald and Taylor, 1993). Adopting this paradigm, the lead-lag and long-run effects are examined using the Toda-Yamamoto Granger (Toda and Yamamoto, 1995) aand the ARDL bounds co-integration techniques (Pesaran et al., 2001), both of which allow the use of stationary and non-stationary time series in the analyses. The real Amsterdam and regional house price indexes between 1995 and 2016 were used for the analyses, while controlling for common house price fundamentals.

The results of the Granger causality analysis confirm that a lead-lag effect exists in house prices from Amsterdam to all regions of the Netherlands except for Zeeland. The co-integration test concludes that a pairwise long-convergence exists between Amsterdam house prices and only six regions, including Friesland, Groningen, Limburg, Overijssel, and Utrecht. The commutative evidence thus suggests the existence of house price diffusion from Amsterdam to all Dutch regions except Zeeland (a small region that is located some distance away from Amsterdam). This result is unsurprising; it corroborates findings in the UK, for example, where house price movements in the South-East, mainly London, are found to diffuse to other parts of the country (MacDonald and Taylor, 1993; Giussani and Hadjimatheou, 1991).

Chapter 5 analyses the house price diffusion pattern within Amsterdam itself. The Amsterdam housing market is spatially divided into fifteen districts and hedonic house price indexes were created for each of these districts using individual transaction data between 1995 and 2014, supplied by the Dutch National Association of Real Estate Agents (NVM). The empirical method adopts simple pairwise Granger causality analysis (Granger, 1980), without controlling for the common fundamentals. The result does not show a clear diffusion pattern, but there appears a predominant causal flow emanating from areas within the central business districts out to more peripheral areas. Empirical analyses in other countries have shown a similar unidirectional causal flow of house prices from main cities to surrounding peripheral areas (see Gong et al., 2016a; Chen et al., 2011).

§ 7.1.2 House price risk

The analysis of house price risks is partly covered in chapters 5 and Chapter 6. Chapter 5 is specifically concerned with the spatial distribution of house price risks and over-time variations in house prices. The empirical methodology adopts simple descriptive statistics for the hedonic indexes created for the different districts, which form the spatial units. The statistics generally show that the house price risk is higher in the central business districts than in peripheral areas. Similarly, decreasing variation between the central business districts and the peripheral area is observed over time.

Chapter 6 addresses two issues: the residual idiosyncratic risks of house prices, and the efficiency and loss coverage of index-based home-value insurance schemes. The empirical approach to residual idiosyncratic risks uses the home-value approach of Sommervoll and Wood (2011). Assuming that each property is covered by a home-value insurance policy with a pay-out, which is proportional to the decline in a reference house price index, the residual idiosyncratic risks are the losses that would not be covered by the insurance policy (Sommervoll and de Haan, 2014; Sommervoll and Wood, 2011). The analysis was carried out for different property types, using individual transaction data as in Chapter 6. The results show that the residual idiosyncratic risks are largest for houses, followed by smaller apartments (number of bedrooms up to 3) and larger apartments (number of bedrooms greater than 3).

The analysis of index-based home-value insurance using the same data reveals a 45% target efficiency, which defines the probability that a home-owner selling a property at a loss will receive pay-outs. The average loss coverage is estimated at between 13% to 15%, which means a large proportion of idiosyncratic risks are not covered by index-based home-value insurance policy. Earlier results by Sommervoll and de Haan (2014) and Sommervoll and Wood (2011), also revealed very low loss coverage for home-value insurance policy.

Chapter 6 also proposes modifications to the index-based home-value insurance scheme which would lead to much higher efficiency and loss coverage. The modification uses a pay-out scheme based on aggregate measures of the index and restricts the pay-out to properties sold at a loss. In the analysis, the modified version has approximately 100% target efficiency and the loss coverage is enhanced to 51%. The results also show that loss-coverage may be improved to 54%-70% when the market is segmented into more homogeneous sub-markets. Loss coverage and efficiency do not differ much between the reference hedonic and repeated sale house price indexes used in the analysis.

§ 7.2 Reflections

This dissertation covers important aspects of the diffusion mechanism of house prices and house price risk in the Netherlands. There were three specific objectives; firstly, to discover the diffusion mechanism of house prices in the Netherlands and the role played by the capital city, Amsterdam; secondly, to examine the spatial distribution of house price risks; and thirdly, to investigate the efficiency of the index-based home-value insurance for protecting home-owners against house price risks in the Dutch context.

The innovative empirical methods used were based on standard statistical analysis and more recent and complex econometric models. However, as with any scientific research, there are methodological and data limitations that require further consideration. Here, the methodological and data limitations of the empirical analyses are summarised. Possible ways to address these limitations in a further research are also discussed.

§ 7.2.1 Methodological limitations

There are methodological weaknesses with the analyses of the house price diffusion and risks. The empirical analyses of the house price diffusion mechanism adopt econometric techniques. The econometric approaches here basically investigate the interrelationships between regional house prices, without including the variables that drive the diffusion mechanism. Meen (1999) argues that the diffusion of house prices may be driven by economic activity, such as migration, equity transfer, and spatial arbitrage. The econometric applications in this dissertation, however, do not include these variables, which limits the economic explanations behind the diffusion process specifically in the Netherlands.

In Chapter 3, the empirical methods adopt a Bayesian graphical method. This method, ideally, allows for prior information regarding the spatial interactions to be incorporated into the analysis. However, the estimation is more complex for an arbitrary prior distribution and it is currently estimable for a uniform prior distribution, which stipulates that each region is equally likely to influence others. The uniform prior may be more restrictive. However, the results of the analysis tend to corroborate earlier results in other countries, where house price diffusion is found to emanate from certain major urban areas.

Chapter 3 also lacks a control for house price fundamental determinants, which constitutes another methodological weakness. Omitting these house price fundamental determinants may confound the spatial interrelations between house prices (Duranton et al., 2015; Lütkepohl, 2005). In Chapter 4, an attempt is made to control for these fundamentals. However, only the national fundamentals are used rather than regional/provincial-level fundamental house price determinants, which would be more suitable. The part of Chapter 5 which addresses house price interrelationships also lacks control for the district-level fundamental house price determinants.

In the study of the spatial distribution of house price risks in Chapter 5, the methodology adopts simple summary statistics, from which conclusions are drawn through ocular observation. A more rigorous empirical analysis involving the testing of a hypothesis could be implemented. The current approach, however, is exploratory and provides results that may serve as a guide for the more detailed empirical testing of hypotheses.

Chapter 6, which examines residual idiosyncratic risks, relies on the assumption that each property is covered by home-value insurance policy that pays benefits based on a reference house price index. In principle, such an insurance policy does not exist in the Netherlands and the assumption is therefore entirely hypothetical. Nevertheless, the assumption provides a way of investigating the efficiency and loss coverage of the index-based home-value insurance policy for possible future implementation.

The efficiency and loss coverage of the hypothetical insurance policy analysed in Chapter 6 also depend heavily on the level of aggregation for which the reference index is created. Aggregation at a smaller and more homogeneous level is more appropriate for such an analysis. The aggregation in Chapter 6, however, combines all houses together, which may not lead to a homogeneous group.

Furthermore, a complete analysis of residual idiosyncratic house price risk, such as in Chapter 6, should consider the outstanding mortgage loan in addition to the sale value of a property. This would give a broader picture of the residual risks, while also accounting for the total home-value equity. Outstanding loans were not considered in the analysis.

§ 7.2.2 Data limitations

Data plays an important role and determines the validity of results in any empirical research. Most of the methodological weaknesses of the analyses in this dissertation are inherent in the data limitation. More specifically, the omission of the house price fundamental determinants in the analyses of the house price diffusion mechanism in Chapters 3, 4, and 5 is due to the lack of data on these variables at the provincial and district levels. Where these do exist, the frequency and length were too limited for the time series applications adopted in the empirical analyses.

The aggregation of all houses into one class for the analyses of the residual idiosyncratic risks, efficiency and loss coverage of the index-based home-value insurance policy, is specifically due to the lack of sufficient (repeated sale) data to enable house price indexes to be separately and reliably created for each type of house.

House prices indexes generally suffer from noise and are less reliable when only a few transaction data are available.

The lack of repeated transaction data for each house is, however, partly due to the data source. The Dutch Organisation for Real Estate Agents (NVM), which supplied the data, does not cover transaction sales for all properties. The coverage for the NVM data does not generally extend beyond 75% of all transactions, and this also introduces a selection or sampling bias that may affect the results of the analyses.

As stated earlier, one extremely important element for the risk analysis and the efficiency and loss coverage of the home-value insurance, is the outstanding mortgage loan data. This kind of data is highly confidential in the Netherlands and unfortunately was not accessible for this research, despite the several requests to officials of the national mortgage guarantee (NHG), which collects such data.

§ 7.2.3 Suggestions for future research

In future research, it would be essential to collect data on the fundamental house price determinants at the regional and district levels. This would allow an empirical investigation of house price diffusion, eliminating possible confounding effects of house price fundamentals. In addition, future research of the diffusion mechanism could consider an economic model, for which the driving factors suggested by Meen (1999) are explicitly modelled (see discussions in Section 4.5).

Methodologically, the Bayesian graphical autoregressive (BG-VAR) approach is a promising effective way to study the diffusion mechanism. The method effectively combines the traditional VAR model with a more efficient identification strategy, thereby avoiding the complications when estimating structural parameters in a typical spatial analysis. It can also easily differentiates between direct and indirect interaction between spatial variables. In effect, the BG-VAR method may make it possible to avoid the estimation of the structural parameters, which involves an ad-hoc and often inaccurate specification of the spatial weighting matrix in spatial analysis (see e.g. Gibbons and Overman, 2012; Pinkse and Slade, 2010). This could be done by transforming the conventional spatial (autoregressive) model into the structural VAR framework, and then applying the BG-VAR. Future research could investigate this issue further. Additionally, the current application of the BG-VAR, which assumes a uniform prior distribution for the interaction between the spatial variables, could be relaxed in a future research.

In relation to the spatial distribution of house price risk in Chapter 5, the current treatment is exploratory in nature, using simple statistics and ocular observation. In future research, a more detailed empirical investigation involving hypothesis testing could be adopted. For example, using the summary statistics, the variation of the house price risk with respect to the distance of designated local areas or the individual residential properties from the central business district could be tested. However, this would require the collection of more detailed geographical data on the properties (see Gong et al., 2016a).

In the current analysis of the residual idiosyncratic house price risk, a comparison is made between the sale price of the residential property and its purchase price only. For further investigation, it would be important to consider the outstanding mortgage loan. This would enable overall housing equity to be taken into account. Furthermore, because residential properties are highly heterogeneous, it may be useful to consider a smaller and more homogeneous level of aggregation for the properties, possibly at the neighbourhood or post-code level. However, these smaller housing markets may be very thin and would require appropriate indexes methodology as suggested by, for example Francke (2010) or Schwann (1998).

§ 7.3 Applications of the research findings

The tremendous effort that the existing literature has channelled into understanding the dynamics and risks of house prices has partly been in order to find ways of resuscitating the depressed housing market following the 2007-08 GFC and innovative ways of reducing significant housing risks. Despite the methodological and data limitations, the research findings in this dissertation are applicable in several ways for governments, households, commercial investors and financial institutions, who are actors in the housing market.

§ 7.3.1 Governments

To stimulate the national housing market, the interrelations between the regional markets play an important role, determining whether a basket of regionally interrelated policies or a single national policy framework is appropriate (see Gong et al., 2016b; Cotter et al., 2011). A single policy framework would be more appropriate for a well-integrated and convergent market (Bekaert and Harvey, 2003; Pukthuanthong and Roll, 2009). However, where diffusion occurs predominantly from a certain region, policy regulations could be focused on that market, with the effects then trickling down to other regions. In Chapters 3, 4 and 5, the findings suggest that there is a house price diffusion mechanism in the Netherlands, predominantly existing from Amsterdam or the wider province of Noord-Holland. Policy makers attempting to stimulate the Dutch market as a whole may be able to focus regulations on the housing market in Amsterdam or Noord-Holland, from where the effect would be likely to spread to the rest of the country.

The centrality of the Amsterdam or Noord-Holland market also means that any overheating is likely to spread throughout the country. Therefore, by treating the Amsterdam or Noord-Holland housing market as systemically important, policies markers are likely to mitigate the spill-over effects of price volatilities, which may adversely impact on the entire Dutch housing market (Stephens, 2006; Harrington, 2009; Castro and Ferrari, 2014).

§ 7.3.2 Households and commercial investors

For households and commercial investors, it might be more important to know the areas and type of houses that are associated with higher risks and better returns. The results from Chapter 5 suggest that house prices have greater growth potential and involve higher risk as we move from peripheral areas to the central business districts. Such a finding could help households and commercial investors to make home investment choices based on their appetite for risk. Moreover, Chapter 6 indicates that idiosyncratic risks are higher for houses, followed by smaller apartments (number of bedrooms up to 3) and larger apartments (number of bedrooms greater than 3). This result is also relevant to the decisions made by households and commercial investors.

Of course, it would also be of great interest, particularly for households, to know the best form of home-value insurance to protect their housing equity, and this would also yield many welfare benefits. The analysis of Chapter 6 shows that the current index-based home-value insurance scheme has very low loss coverage (see Sommervoll and Wood, 2011; Sommervoll and de Haan, 2014). The suggested modification is promising, but such products still require better insights into its pricing.

§ 7.3.3 Financial institutions

Like the households and commercial investors, financial institutions and particularly lenders, would benefit from better knowledge of which locations and types of residential properties are associated with higher risks and better returns. This would enable them to improve the pricing of mortgage loans and other housing-related products. For instance, reverse mortgages, which are equity release products that enable older home-owners to convert their home equity into cash, have recently been growing in popularity. Lenders could significantly reduce the risks of these products if they knew which housing market segments are more likely to appreciate and yield the lump sum advanced to home-owners. On the other hand, these lenders may also be interested in purchasing index-based home-value insurance from insurers to protect the value of the collateral involved in such reverse mortgages.

The wider interest of insurance companies lies in the proposed home-value insurance product in Chapter 6, which promises higher loss-coverage. Beside the lenders, most households may wish to purchase such products as means of protecting their equity. However, the insurance companies need to investigate the practicalities of the scheme in relation to pricing and issues of moral hazard discussed in Chapter 6 (see Case Jr et al., 1993; Shiller, 2003).

§ 7.3.4 Statistical agencies

Like Statistics Netherlands, many statistical agencies are interested in publishing indices that summarise important information on the housing market. One such indicator in the results of the empirical analyses in this dissertation is network density (Figure 3.5), which could also be referred to as the spill-over index. The network density is basically a simple aggregate index which crudely represents the extent of interdependencies between the growth in regional house prices over time. It is similar to the Granger causality index proposed by Billio et al. (2012), which estimates the interconnectedness between the returns of financial institutions. Such indexes are useful for monitoring contagion among financial institutions and identifying periods of overheating, which may lead to a systemic breakdown (see Ahelegbey, 2016).

It can be seen from Figure 3.5 that the degree of interdependence between regional house price growth varies over time; it was particularly high between 1995 and 2005, before decreasing until 2008, after which it again started to rise. These periods correspond to important and recognisable stages in the development of Dutch house prices (De Vries, 2010; Xu-Doeve, 2010; Toussaint and Elsinga, 2007), and the figure reveals the potential for house price diffusion during these periods. The periods

2005-2008 and 2008-2016 are interesting as they coincide with the pre- and post-GFC periods. Network density could also be created by statistical agencies at the city level to show the degree of diffusion and interdependence between different local housing markets.

In relation to house price risk, it would be useful for statistical agencies to periodically publish simple statistics for smaller district, neighbourhood and postcode levels. One possible indicator could take the form of the standard deviation or the semi-deviation and decline-severity adopted in this dissertation (see Section 5.3 for the mathematical definitions). The semi-deviation and decline-severity consider, respectively, only the returns below the average and zero; thus, they generally do not overestimate house price risk as with the standard deviation (see Table 5.2 and Figure 5.4). Semi-deviation and decline-severity indicators could also be published for different house types. Such information would be useful for households and other housing market players.