The association between fear of crime and residential property values in the Netherlands

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Abstract. Multiple studies in the US and UK have shown that crime has a negative effect on residential property values. This study advances in this area by adding a focus on the association between fear of crime and property values next to the effect of actual crime rates on property values, as crime and fear of crime are not necessarily correlated. A hedonic pricing model is used to research the association between fear of crime and self-reported transaction prices in the Netherlands. Like in the US and the UK, crime is associated with lower residential property values (*N = 15.429*) in the Netherlands. The results show that higher levels of fear are generally associated with lower transaction prices, but this depends on the degree of urbanisation. The negative association between fear of crime and self-reported transaction prices, after controlling for actual crime rates, is stronger at higher degrees of urbanisation. Additional findings show that a higher household income decreases the association between fear of crime and transaction prices, but only at the highest level of fear. Also, the associations of crime and fear of crime with transaction prices are stronger in areas with a relatively low crime rate. This suggests that people get used to crime at some point, which decreases the negative association if crime increases further when crime rates are already high. This study provides further insights into how people value both objective and subjective safety and, importantly, if they are willing to pay for a higher perception of safety.

Keywords: real estate, hedonic price model, crime, fear of crime, property values, costs of crime, perception of safety, willingness to pay

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1. INTRODUCTION

The amount of people in the Netherlands that became a victim of traditional crime like violence, burglary, theft and vandalism has decreased significantly over the last years. The group that claims to be victimized by traditional crime has decreased with 31% in the past seven years, from 20% of all Dutch people in 2012 to 14% in 2019 (CBS, 2020a). Also, less people indicate that they experience a feeling of unsafety. This group decreased from 37% in 2012 to 32% of all Dutch people in 2019 (CBS, 2020b). The decrease of crime varies between different regions, ranging from -17% in Noord-Holland to -11% in Overijssel. The decrease in victimisation ranges from -40% in Overijssel to -26% in Noord-Holland (CBS, 2020a). Even though there seems to be a positive trend regarding crime in general, there is also an increase of alarming publications about violence and crime related to drugs. For example, in Amsterdam the amount of incidents with firearms more than doubled in a time span of 3 years (de Volkskrant, 2019). According to a report by Tops & Tromp (2019), drug crime has free rein in Amsterdam which negatively impacts overall safety and social neighbourhood dynamics. This is not only a problem in heavy crime areas, but also in relatively 'normal' neighbourhoods (NOS, 2019). An example for this is Amstelveen, which is supposed to be one of safest municipalities of the Netherlands based on crime statistics. Still, reports state that in Amstelveen society is undermined by crime through corruption and cases of money laundering in the real estate sector (Gerritsen, 2019). Despite the overall decrease of criminal activities, crime is still a relevant subject in different types of neighbourhoods in the Netherlands.

The social and psychological aspects of crime are already widely researched. For instance, Bernasco et al. (2017) focussed on the role of social interactions related to crime and how these interactions would influence the decision of people to get involved into criminal activities in the Netherlands. Existing criminological research shows that those who break the law tend to associate with others who also break the law. Social interactions play a significant role in whether or not people are drawn into criminal behaviour, especially among younger people (Bernasco et al., 2017). As a result, criminal activities usually occur at a few concentrated places. Weisburd et al. (2004) show that in most streets there is little to no crime, while a few streets house almost all the reported crime. Groff et al. (2010) researched street segments in Seattle for 16 years and found that high-crime places are remarkably stable over longer time periods. In addition, Lammers et al. (2015) state that previously targeted properties, victims or locations face an increased risk of being targeted by crime again. Not only the initial target has an increased risk but also potential targets nearby the initial target of crime (Baudains et al., 2013; Bowers & Johnson, 2005; Townsley et al., 2003; Townsley et al., 2015). Living in insecure and dangerous surroundings can result in various costs for the victims of crime (Brenig & Proeger, 2018). Previous research shows that criminal activities can affect victims by inflicting financial losses, physical pain, emotional suffering or

even trauma, which substantially reduce the quality of life (Moller, 2005; Davies & Hinks, 2010; Medina & Tamayo, 2012; Hanslmaier, 2013; Staubli et al., 2014; Mahuteau & Zhu, 2016). As a result, social life in the neighbourhood is greatly impacted, resulting in fear of crime and a lower perception of safety among civilians.

Policymakers need to decide upon an optimal allocation of limited state resources to deal with crime, which requires information on the economic value attributed to safety by citizens (McCollister et al., 2010; Dolan et al., 2005). Safety is generally a public good that is not directly traded in the market, which makes it difficult to determine its economic value. Brenig & Proeger (2018) tried this by studying the effect of public safety improvements on individual well-being in Europe and quantify this into a monetary value. Their research shows a substantial loss in life satisfaction for victimised individuals of €24.174. Yet, individual well-being is subjective and individuals commonly under- or overstate how they truly feel about certain topics (Frey et al., 2009). A more objective method to determine how people value safety is by comparing property values. When people consider safety as important, a property in a safe neighbourhood will be more expensive than a similar property in an unsafe neighbourhood. Thaler (1978) was one of the first who found a negative relation between property crime and property values. In his study, house values decreased with 3% when property crime increased with one standard deviation. Larsen et al. (2003) show that prices of houses in Ohio decrease significantly near a sex offender's home and Linden & Rockoff (2008) find similar results for North Carolina. However, these studies focus on the effect of the residence of a criminal nearby and not on the effect of the crime itself on the area where the crime took place. Studies from the US and UK that focus on the effect of crime rates show that crime has a significant negative effect on property values (Gibbons, 2004; Pope & Pope, 2012). Even though crime and fear of crime have similar negative social and psychological effects, fear of crime is not necessarily correlated with actual victimization by crime (Snell, 2001). Thus, it is possible that fear of crime in itself also has an effect on property values, separately from the effect of crime. This aspect is overlooked in current research, which results in a gap in the literature that requires further research. Therefore, the central question of this research is:

'What is the association between fear of crime and self-reported residential property values?'

The research aim of this study is to determine if there is an association between fear of crime and residential property values in the Netherlands. The existing literature is extended by focusing on the association between fear of crime and residential property values after controlling for the effect of crime. Furthermore, this study focusses on the Netherlands instead of the US or UK. The Netherlands has a relatively high density of inhabitants per km2 compared to the US and UK. In addition, crime rates are about 40% lower in the Netherlands than in the US and UK (World Population Review, 2021). As a

result, the association between crime and self-reported transaction prices could differ from what previous studies found in the US and UK. The research question will be addressed by analysing self-reported transaction prices of residential properties that were bought between 2002 and 2015. The choice for self-reported transaction prices instead of real transaction prices will be explained in chapter 3. The data for this study is retrieved from the 'Woononderzoek Nederland' database of 2015[1]. The dataset consists of the results of a nationwide survey held among households living in the Netherlands, resulting in 15.429 observations after cleaning the data. The survey focusses on subjects like household characteristics, current and desired living situation, housing costs and income. It is conducted every three years by the Dutch Ministry of Home Affairs and Kingdom Relations in combination with the Central Agency for Statistics (CBS) (Woononderzoek Nederland, 2020). A hedonic pricing model will be used to study the association between fear of crime and residential property values in the Netherlands. The outcome of this study provides further insights into how people value safety and if they are willing to pay for a higher perception of safety.

The remainder of this thesis is organized as follows. Chapter 2 includes the theory on the general social and psychological effects of crime. Chapter 3 describes the data and methodology that is being used. In chapter 4 the results of the analysis are presented. Chapter 5 provides the discussion and recommendations for further research. In chapter 6 the conclusions are drawn and the central research question is answered.

[1] It was not possible to use the most recent version of 2018 due to privacy regulations, which will be explained further in chapter 3.

2. THEORETICAL FRAMEWORK

2.1 The social and psychological effects of crime and fear of crime

One of the main functions of housing and the neighbourhood is to provide safety for its residents (Suttles, 1972). Crime can be seen as a threat to this safety and can greatly impact social life in neighbourhoods. St. Jean (2007) explains how crime rates can vary between certain areas in the same neighbourhood by using two well-known theories. These two theories try to explain the causes and effects of crime in neighbourhoods and are called 'broken windows' and 'collective efficacy'. According to the broken windows theory, crime starts with neighbourhood disorder. Later, this disorder turns into dynamics like fear of crime and weakened social control which increases the chance for crime to get hold of an area. Neighbourhood disorder consists of two components: physical disorder and social disorder. Physical disorder means that the physical environment is neglected, examples of this are abandoned buildings, broken windows and graffiti. Social disorder refers to unpleasant or intimidating social interactions in the neighbourhood, such as youth hanging around or public drinking and drug abuse (St. Jean, 2007). Neighbourhood disorder can serve as a breeding ground for more serious crime to arise over time if the disorders are not taken care of (Wilson & Kelling, 1982). According to the collective efficacy theorists, crime is the result of low collective efficacy or a low capacity for collective action in the neighbourhood. Collective efficacy can be seen as a combination of trust, solidarity and willingness of residents to take action for a safer neighbourhood. Areas with less collective efficacy are more vulnerable and therefore tend to attract more crime (St. Jean, 2007).

Crime can negatively impact people in various ways. The crime itself can cause financial loss, physical pain, mental problems or even death, which reduce the quality of life of the victim (Moller, 2005; Davies & Hinks, 2010; Medina & Tamayo, 2012; Hanslmaier, 2013; Staubli et al., 2014; Mahuteau & Zhu, 2016). Furthermore, crime affects non-victims by increasing their perception of being at risk for victimisation, which leads to fear of crime, anxiety and psychological distress (Brenig & Proeger, 2018). Previous exposure to crime plays a significant role in worrying about being victimised by crime. Feeling insecure as a result of crime is not limited to the perception that crime is a real threat which affects daily life on a personal level, but it also reflects citizen's anxiety about their overall quality of life (Tseloni & Zarafonitou, 2008). It is clear that both property and violent crime significantly impact the mental well-being of victims and non-victims (Cornaglia et al., 2014; Dustmann & Fasani, 2016). In comparison, the impact of local crime on individual mental well-being can be up to 2-4 times larger than a decrease in employment opportunities or the fear of losing a job (Dustmann & Fasani, 2016).

Crime does not only have negative effects at the individual level, but also at the neighbourhood level and society as a whole (McCrea et al., 2005). A lower perception of safety restricts personal freedom by

limiting how often people go outside and which routes they take through the neighbourhood (Liska et al., 1988). It also contributes to dissatisfaction with the community and the neighbourhood itself (Sirgy & Cornwell, 2002). In addition, fear of crime negatively affects the community feeling and decreases participation in associations, which results in less social cohesion (Riger et al., 1981; Perkins et al., 1990; Markowitz et al., 2001). Crime deteriorates the conditions for local businesses and decreases employment rates, which decreases the liveability of an area further (Cullen & Levitt, 1999; Detotto & Pulina, 2013). As a result, fewer commercial establishments are present to provide jobs and other important goods and services, which drives out human capital when people move to other places with less crime (Cullen & Levitt, 1999; Lens & Meltzer, 2016). All in all, these effects lead to lower levels of overall mental well-being and liveability in neighbourhoods with higher levels of crime.

2.2 The effect of crime on property values

In economics, real estate is generally treated as a heterogeneous good, consisting of physical characteristics (intrinsic) and locational characteristics (extrinsic). Examples of physical characteristics are floor space area, lot size and number of rooms. Proximity to work and the social composition of the neighbourhood are examples of locational characteristics (Dubin, 1998; Tse, 2002; Brunauer et al., 2013; D'Acci, 2014). Each property has a unique combination of these attributes. In standard market situations, higher house prices should reflect a better set of attributes and qualities of the property (Tse, 2002; Lisi, 2019). This means that qualities of the area around a house determine the price of the house itself (Boardman et al., 2006; Kuminoff et al., 2010; McNair & Abelson, 2010). As a result, house prices partially reflect the quality of the surrounding area, where better areas lead to higher prices (Ross & Yinger, 1999). This can be the case for qualities of the neighbourhood as a whole, but also for specific factors on a smaller scale (Abelson et al., 2013). Neighbourhood qualities like aesthetically pleasing buildings, green spaces, sports facilities and public services result in higher house prices and better community satisfaction (Dolan & Metcalfe, 2008; Knies et al., 2008; Shields & Wheatley, 2005; Florida et al., 2011). However, there are also attributes that have a negative effect on property prices (D'Acci, 2014). Well known examples of this are traffic, noise pollution and air pollution (Bateman et al., 2001; Blanco & Flindell, 2011; Husted & Anker, 2004; Schaerer et al., 2007; Jim & Chen, 2009; Graves et al., 1988).

Despite the fact that crime itself is not a characteristic or attribute of a house that is directly bought and sold by consumers, it can still have an effect on the price of a property (Dominguez & Raphael, 2015). Living in a neighbourhood with higher crime rates or where criminals live elevates the risk of facing crime. Residents generally have two options to respond to an increased crime risk: by voting for anti-crime policies or by voting with their feet by moving somewhere else (Linden & Rockoff, 2008). With the second option, the response to crime can be observed in the housing market. If people are willing to

pay for less crime nearby and a higher perception of safety, property prices should be lower in neighbourhoods with higher crime rates (Dominguez & Raphael, 2015). This seems to be the case, as residential property values decrease significantly in the US and UK when crime increases (Gibbons, 2004; Pope & Pope, 2012). In addition, the nearby residence of convicted criminals also has a negative effect on residential property values. For example, a registered sex offender significantly decreases property values within 0.1 mile of the sex offender's residence (Linden & Rockoff, 2008). Next to a decrease in value, the nearby residence of a criminal also affects the liquidity of the local housing market, as it can lengthen the time on market with up to 80% (Wentland et al., 2014).

Crime does not only affect residential property values, it also influences commercial real estate values. An increase of 1 violent crime within a radius of a quarter-mile reduces commercial real estate prices by $1.50 per square foot (Lens & Meltzer, 2016). This is because crime scares away customers and increases costs related to safety measures to compensate for the increased risk of facing crime. Also, criminal activities like extortion, corruption and robbery reduce investments and consumption in an area, which leads to a poorer business climate and discourages innovation and entrepreneurship (Carboni & Detotto, 2015; Astarita et al., 2018). A decrease of property values as a result of crime seems logical, since previously targets face an increased risk of being targeted again within a short time period (Lammers et al., 2015). The risk of facing crime also increases for potential targets located nearby the initial target (Baudains et al., 2013; Bowers & Johnson, 2005; Townsley et al., 2015; Townsley et al., 2003). Therefore, the negative effect is not only limited to the targeted property or area itself, but also influences properties in the surrounding areas. According to Ceccato & Wilhelmsson (2011), the effect of crime on property values is significantly greater when it comes to property crimes such as burglary than for other types of crime like violence.

2.3 The divergence between crime and fear of crime

It is clear that crime can have severe negative effects, not only socially and psychologically but also when it comes to property values. The negative effects of crime can cause people to experience fear of crime as they do not want to experience these negative effects. However, an increase of crime does not necessarily have to correlate with an increase of fear of crime (Snell, 2001). There are multiple reasons for a potential divergence between crime and fear of crime. First of all, some people are more likely to experience fear of crime than others. For example, women and elderly generally experience the most fear of crime, while they are in one of the demographic groups that is least victimised. Young men on the other hand generally experience less fear of crime, while they are more likely to face violent crime (Snell, 2001). In addition, low-income households generally experience more fear of crime due to a lack of resources to invest in safety measures (Pantazis, 2000). Other factors that influence the likeliness of experiencing fear of crime are age and education level (Pantazis, 2000; Hanslmaier, 2013). Also,

previous exposure to crime plays a significant role in worrying about being victimised by crime again (Tseloni & Zarafonitou, 2008). As a result, fear of crime can vary between people for the same amount of registered crime.

Secondly, neighbourhood dynamics play a role in the divergence between crime and fear of crime. Higher levels of social interaction allow residents to hear more about nearby crimes from their social networks which can increase their fear of crime (Lewis & Salem, 1986). Non-victimised residents can suffer from anxiety and psychological distress through these social networks when they perceive an increased personal risk of victimisation, even if they were not directly confronted with crime themselves (Brenig & Proeger, 2018). However, more social interaction can also help to decrease fear of crime. Social interactions increase the collective efficacy and social cohesion in the neighbourhood, resulting in more social control which provides a feeling of safety (St. Jean, 2007). Another factor that influences fear of crime is the amount of disorder in the neighbourhood. A neglected physical environment in combination with intimidating social interactions can increase the feeling of disorder, for example due to decaying buildings and youth hanging around at night (St. Jean, 2007). Signs of disorder can make residents feel more vulnerable, which increases their fear of crime (Snell, 2001). In addition, things like graffiti, fighting neighbours or public drug and alcohol abuse can increase fear of crime, while they are not included in crime rates (McCord et al., 2007). All of these factors influence the fear of crime that people experience without a change in actual crime rates, resulting in a gap between the perceived risk and the actual risk of victimisation from crime. Consequently, it is possible that fear of crime has a separate effect on property values that deviates from the effect of crime.

2.4 Hypotheses

The theoretical framework above describes the effects of crime and fear of crime on mental well-being, the liveability of a neighbourhood and on property values. Crime and fear of crime have similar negative social and psychological effects. However, multiple factors can cause a divergence between the amount of crime and the amount of fear of crime that people experience. Therefore, it is expected that there is a separate negative association between fear of crime and residential property values, resulting in lower property values in areas where people experience more fear of crime compared to properties in areas where people experience less fear of crime. Consequently, the following hypothesis will be tested in this study:

H1: Fear of crime is associated with lower residential property values in the Netherlands additional to the observed effect of actual crime.

People with higher incomes have more to lose in the case of crime, resulting in a higher need to feel save (Sakip et al, 2013). However, people with lower incomes generally live in cheaper, less safe neighbourhoods and lack the resources to invest in invest in safety measures such as surveillance cameras (McGarrell et al., 1997; McKee & Milner, 2000; Pantazis, 2000). Therefore, it is expected that household income plays a role in the association between fear of crime and residential property values. Accordingly, a second hypothesis will be tested in this study:

H2: The association between fear of crime and residential property values differs between low and high income households.

There are differences in neighbourhood characteristics and social dynamics between urban and rural areas. As a result, the degree of urbanisation of an area can influence how people experience fear of crime (Weisheit et al., 1995; Nofziger & Williams, 2005). In addition, crime rates are relatively higher in urban areas compared to rural areas (Wells & Weisheit, 2004; Ceccato & Dolmen, 2011). Consequently, it is expected that the degree of urbanisation also plays a role in the association between fear of crime and residential property values. Therefore, a third hypothesis will be tested in this study:

H3: The association between fear of crime and residential property values differs between urban and rural areas.

3. DATA & METHODOLOGY

3.1 Data

The dataset for this study comes from the Woononderzoek Nederland of 2015, which is the biggest housing market survey of the Netherlands. This survey covers topics related to the housing and living quality of Dutch households. The survey is held every three years and is commissioned by the Dutch Ministry of Home Affairs and Kingdom Relations in collaboration with the Central Agency for Statistics (CBS). The results of the survey are further supplemented with data from the Dutch tax authority (Woononderzoek Nederland, 2020). Due to new privacy regulations the dataset does not contain data related to the location of respondents from 2018 onwards. For example, the zip code or municipality of the respondents are not included, but also the neighbourhood scores for safety or services are not present. This study requires additional data on safety and crime based on location, therefore the version of 2015 will be used. The use of an older dataset is not regarded as problematic since the strong trend of decreasing crime rates was already present in 2015 (De Jong, 2018; CBS, 2020c). Furthermore, the version of 2015 is required to be able to differentiate between the association of fear of crime and the effect of actual crime rates. Before cleaning the data, the dataset of 2015 consists of 62.688 respondents and is officially used by the Dutch government to create and support policies related to housing and the housing market in the Netherlands (BZK & CBS, 2019). The downside of this dataset is that it only contains self-reported transaction prices of the properties instead of the official transaction prices, which decreases the reliability as people could intentionally or unintentionally report incorrect transaction prices. The dataset of the Dutch Association for Brokers and Appraisers (NVM), which is the biggest real estate broker association of the Netherlands, would be a more reliable option as this dataset contains the official transaction prices of all transactions that were processed by over 4400 brokers in the Netherlands (NVM, 2021). However, this dataset cannot be combined with the required information on fear of crime, which makes it impossible to use the dataset of the NVM for this study.

As this study focusses on the association between fear of crime and self-reported transaction prices, only respondents that live in owner-occupied properties were considered. The main currency used in the Netherlands changed from guilders to euros in 2002, but the euro was already used as calculation valuta since 1999 (European Union, 2020). To prevent currency irregularities in the transaction prices, only respondents that purchased their house between 2002 and 2015 were included in the analysis. Also, 2002 is considered by the CBS as the turning point towards a trend of decreasing crime which makes it a good starting point for this research (de Jong, 2018). The outliers for transaction price and floor space were removed by omitting all respondents that fell outside of the 1 and 99 percentile range[2][3] (Brooks &

[2] For transaction prices: below €45.000,- or above €900.000,-
[3] For floor space: less than 47 sq. m. or more than 382 sq.m.

Tsolacos, 2010). Respondents that reported a gross yearly household income of 0 or less were also removed as outliers. There were 7 respondents that caught the attention as they all live in a house built in 1005, while the next oldest house was built in 1368. It was assumed that this was the result of a mistake, so these 7 respondents were not included in the analysis. Lastly, all respondents that had missing values for one of the used variables were removed.

The Leefbaarometer is a tool created by the Dutch government to calculate the liveability of neighbourhoods in the Netherlands based on 5 different dimensions. The Dutch government uses the Leefbaarometer for official reports and to monitor the development of liveability in Dutch neighbourhoods (Leefbaarometer, 2021). In this study the Leefbaarometer score for the dimension 'safety' of 2014 is used as an indicator for actual crime rates. The score measures the amount of crime related to vandalism, violence, theft and burglary and calculates this into one score that represents the impact of crime on the liveability of an area (BZK, 2020). Because the crime rates for vandalism, violence, theft and burglary are combined into one score it is not possible to differentiate between types of crime in the analysis. According to the Leefbaarometer crime has a negative effect on liveability, so an increase of crime will decrease the Leefbaarometer score for safety. The Leefbaarometer score for safety is transformed from negative to positive to create a variable that represents the amount of crime. As a result, this variable will now increase when crime increases and a score of zero represents that there is no crime at all. The Leefbaarometer score for safety is calculated for blocks of 100 by 100 meters, which makes this variable more precise than the overall crime rates on a municipality level. The other four dimensions of the Leefbaarometer from 2014 are used as control variables for neighbourhood attractiveness and liveability. These four dimensions are: housing (e.g. type of housing or construction period), demographics (age groups, ethnicity, employment), services (distance to train station, schools within 1km, social-cultural services) and physical surroundings (neighbourhood density, nearby parks, proximity of train tracks) (BZK, 2020). The dataset does not include the absolute score for these dimensions, but the scores instead represent the deviation from the national mean score for that specific dimension.

The address density of the municipality is used as an indicator for the degree of urbanisation, following the definition of the Central Agency for Statistics (CBS). This variable consists of 5 categories transformed into dummy variables. The categories are the same categories that the CBS uses to determine the degree of urbanisation and are based on the amount of addresses per square kilometre (CBS, 2021). The 5 categories are; very strong urban (2500 addresses or more), strong urban (1500-2500 addresses), moderately urban (1000-1500 addresses), slightly urban (500-1000 addresses) and not urban (less than 500 addresses).

Finally, the regression analysis has to meet the assumptions regarding linearity, exogeneity, homoscedasticity and multicollinearity when performing a linear regression (Brooks & Tsolacos, 2010). As part of this, the dependent variable 'self-reported transaction price' and independent variables 'floorspace' and 'gross yearly household income' have a skewed distribution. Therefore, these variables were transformed into their natural logarithm to make them normally distributed. The variables 'afraid to be robbed or harassed in the neighbourhood', 'year of construction', 'degree of urbanisation', 'year of purchase' and 'province' were transformed into dummy variables to make them usable for the regression.

3.2 Descriptive statistics

The main independent variable in the analysis is fear of crime. The variable 'fear of crime' is split into 5 levels of fear, based on how the respondents answered the statement: 'I am afraid to be robbed or harassed in the neighbourhood'. Table 1 shows how often the respondents chose each option. The lowest level of fear is represented by 'totally disagree' and the highest level of fear is represented by 'totally agree'. Overall, most respondents feel safe in their neighbourhood, as 44,4% of the respondents totally disagree and 45,8% disagree with the statement. The group of respondents that are afraid to be robbed or harassed in the neighbourhood is minor, only 2,7% of the respondents agree and 0,8% totally agree with the statement.

Table 1: Fear of crime experienced by the respondents

Statement: "I am afraid to be robbed or harassed in the neighbourhood"	**Respondents**
Totally disagree (feels very safe)	6852 (44.4%)
Disagree (feels safe)	7073 (45.8%)
Neutral	965 (6.2%)
Agree (feels unsafe)	413 (2.6%)
Totally agree (feels very unsafe)	126 (0.8%)
TOTAL	15,429

The first bar in Figure 1 visualises the distribution of fear of crime that the respondents experience. The second and third bar show the differences in distribution between respondents that live in a house below the average transaction price of €251.105,40 and respondents that live in a house above the average transaction price. The percentage of people that are afraid to be robbed or harassed is slightly higher in the group that live in a house below the average transaction price. In the below-average group, 3% state that they agree with the statement and 0,9% totally agree, against 2,1% and 0,7% in the group that paid an above-average transaction price. This is in line with what other studies found regarding property values and fear of crime, these studies argue that people tend to experience more fear of crime in cheaper

neighbourhoods because these neighbourhoods tend to be less safe (McGarrell et al., 1997; McKee & Milner, 2000; Pantazis, 2000).

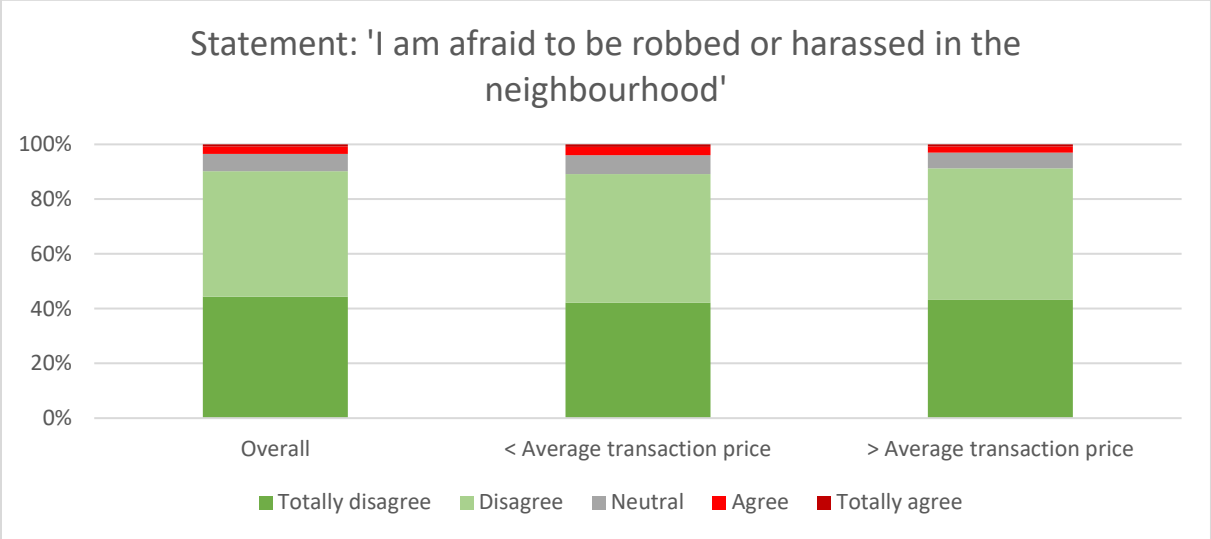

Figure 1: Distribution of answers to the statement regarding fear of crime

The descriptive statistics of the data can be found in Table 2. The average gross yearly household income of the respondents is around €67.400,-. On average, the respondents state that they paid €251.320,- for their house with an average floor space of around 129 sq. m. and building age of 41.7 years. The variable 'building age' is based on the year of construction of the property and is shown as a ratio variable in Table 2, but will be transformed into a categorial variable for the regression analysis. The urbanisation levels of the municipalities are shown in Table 3, including the frequency of each degree in the dataset.

Table 2: Descriptive statistics of the respondents and their house

Variable	Obs.	Mean	Std. Dev.	Min	Max
Self-reported transaction price (€)	15,429	251,105.40	124,154.70	45,000	900,000
Leefbaarometer score 'safety'	15,429	-.277	.114	-.738	-.038
Gross yearly household income	15,429	67,399.41	48,921.35	413	1,265,034
Floor space (sq. m.)	15,429	128.63	48.16	47	382
Leefbaarometer score 'houses'	15,429	.098	.088	-.472	.436
Leefbaarometer score 'demographics'	15,429	.025	.068	-.478	.182
Leefbaarometer score 'services'	15,429	-.053	.117	-.656	.734
Leefbaarometer score 'physical surroundings'	15,429	-.183	.079	-.807	.407
Building age	15,429	41.7	35.7	1	647

Table 3: Urbanisation level of the municipalities

Degree of urbanisation	Municipalities
Not urbanised	2846 (18.4%)
Slightly urbanised	4452 (28.9%)
Moderately urbanised	3642 (23.6%)
Strong urbanised	3360 (21.8%)
Very strong urbanised	1129 (7.3%)
TOTAL	15,429

Figure 2 visualises the relationship between the natural logarithm of self-reported transaction prices and the Leefbaarometer score for the dimension 'safety'. The fitted values line shows that there is a positive relationship between (the natural logarithm) of transaction prices and the Leefbaarometer score for safety. According to figure 2, a lower Leefbaarometer score for safety leads to lower transaction prices. This would mean that crime is associated with lower property values. This is in line with previous studies that found a negative effect of crime on house prices (Thaler, 1978; Gibbons, 2004; Pope & Pope, 2012).

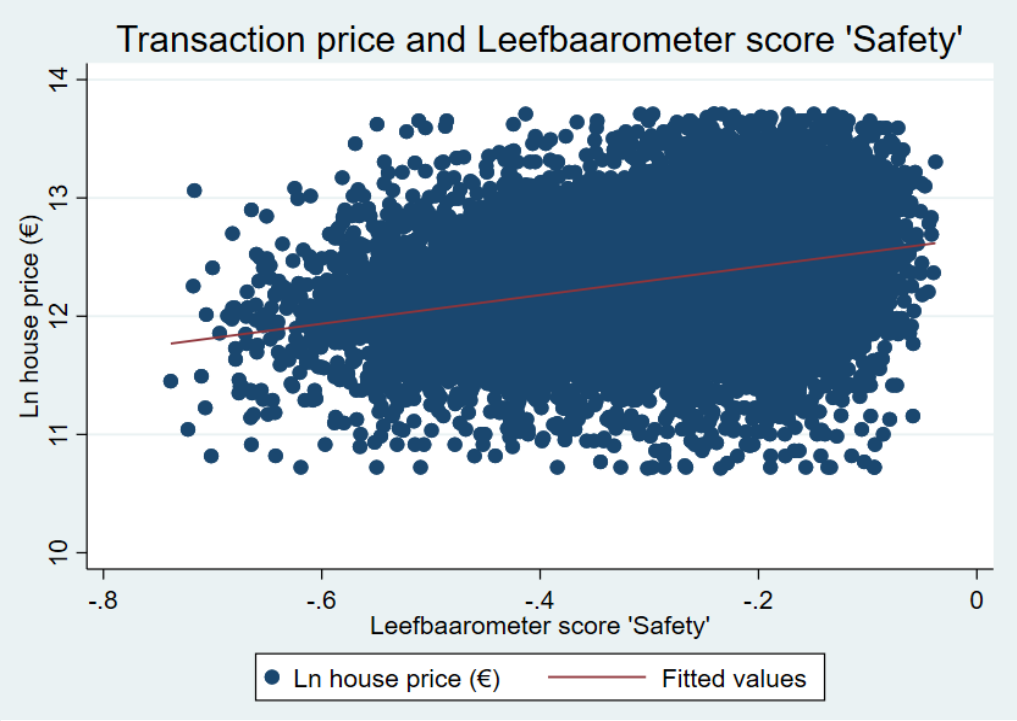

Figure 2: The relationship between the natural logarithm of transaction price and the Leefbaarometer score for safety

3.3 Hedonic pricing analysis

The theoretical foundation for hedonic pricing analysis was created by Lancaster (1966) and Rosen (1974). In hedonic pricing analysis it is assumed that the price of any good or service is determined by the combination of its characteristics and attributes. Following this assumption, it is possible to determine the price of each individual attribute of the good or service. Hedonic pricing analysis is frequently used in real estate research and property appraisals (Liao & Wang, 2012). Preferences of buyers can identified based on the price that is implicitly paid for an attribute (Ceccato & Wilhelmsson, 2011).

The heterogenous nature of real estate properties discussed in the theoretical framework causes problems when comparing or valuing properties. The building itself can be identical to another building, but the set of locational characteristics are always unique. Hedonic pricing analysis makes it possible to determine the value of a wide variety of specific building attributes and locational characteristics despite this heterogeneity. Since the price of a property is composed of its physical (intrinsic) attributes and the locational (extrinsic) characteristics, the following equation can be constructed (Dubin, 1998; Tse, 2002; Brunauer et al., 2013; D'Acci, 2014).

$$Transaction\ price = f(B, L) \tag{3.1}$$

3.4 The hedonic regression model

A multiple regression model will be used to determine the association between fear of crime and the self-reported transaction price of a house. The dependent variable is the natural logarithm of the transaction price that the respondents paid for their house, resulting in a log-linear form of the hedonic price model. The independent variables are the fear of crime, crime, the natural logarithm of gross household income and various control variables. Location and time fixed effects are added to the model to control for omitted variables that are constant for specific locations or transaction years (Brooks & Tsolacos, 2010). The regional differences between transaction prices are increasing on the municipality level (CBS, 2019). However, controlling for the location fixed effects on the municipality level caused problems regarding multicollinearity, so they were controlled for on the province level instead.

Accordingly, the following equation can be formulated:

$$lnTP_{ijtr} = \propto + \beta_1 Fear_r + \beta_2 Crime_i + \beta_3 Income_r + \beta_4 B_i + \beta_5 L_i + \delta_j + \gamma_t + \varepsilon_{ijt} \qquad (3.2)$$

where

$lnTP_{ijtr}$	is the natural logarithm of the self-reported transaction price of property i at location j in year t, owned by respondent r;
$Fear_r$	the fear of being robbed or harassed in the neighbourhood, reported by respondent r;
$Crime_i$	the amount of crime, based on the Leefbaarometer score for the dimension 'safety' of property i;
$Income_r$	the natural logarithm of the gross household income of respondent r;
B_i	a set of building characteristics of property i including floorspace and construction period;
L_i	a set of locational characteristics of property i including multiple Leefbaarometer scores and the degree of urbanisation;
δ_j	location fixed effects (province);
γ_t	time fixed effects (year of purchase)
$\propto$ and β_{1-5}	the parameters to be estimated;
ε_{ijt}	the error term.

In additional enhanced models, multiple interaction variables are added to the base model of equation 3.2 to determine how household income and degree of urbanisation influence the association between fear of crime and self-reported transaction prices, as stated in the second and third hypothesis in chapter 2. For the second hypothesis an interaction will be added between fear of crime and the natural logarithm of household income. This will provide insight into how household incomes influence the association between fear of crime and residential property values. For the third hypothesis an interaction will be added between fear of crime and the degree of urbanisation of the municipality. This will provide insight into how the degree of urbanisation influences the association between fear of crime and residential property values. Finally, the dataset is split between respondents that live in an area with relatively low crime rates and respondents that live in an area with relatively high crime rates to determine if the association differs between these types of areas.

4. RESULTS

4.1 The association between crime and residential property values

The results of the regression analysis based on equation 3.2 are shown in Table 4. Fear of crime is not yet included in the first model to create a base model that is consistent with previous studies that only focussed on crime. The adjusted R-squared of model 1 is 0.5383, which means that 53.83% of the variance in the natural logarithm of transaction price is explained by the independent variables that were used. The negative coefficient for crime shows that an increase in crime leads to lower transaction prices. This means that people do value safety and that crime decreases the attractiveness of an area, which results in lower residential property values in the Netherlands. Transaction prices decrease with 6.3% when crime increases with one standard deviation[4], which is a slightly weaker association than what previous studies found in the US and UK. The results of a study done by Pope & Pope (2012) show that property values in the US decrease with 7.4% to 9.7% when crime increases with one standard deviation, while the results of Gibbons (2004) show a decrease of 9.4% in the UK when crime increases with one standard deviation. An explanation for this difference could be the strong focus on creating heterogeneous neighbourhoods and increasing social cohesion in Dutch housing policies, which can decrease the negative effects of crime (Van Kempen & Bolt, 2009; Hanslmaier, 2013; Staubli et al., 2014).

4.2 The association between fear of crime and residential property values

In the second model the categorial variable for fear of crime is added to determine if fear of crime has a separate association with residential property values, next to the effect of crime. The VIF value of the variable for crime is 2.81 and for fear of crime 1.08, which indicates that there are no issues regarding multicollinearity. The adjusted R-squared of model 2 increased slightly to 53.85%. The coefficients of model 2 show that higher levels of fear are associated with higher transaction prices compared to the reference category ‘very safe’, starting from the level of fear ‘unsafe’. The association between fear of crime and transaction prices is stronger and more significant at higher levels of fear. Consequently, the level of fear ‘unsafe’ is associated with higher transaction prices compared to the lowest level, but only at 10% significance. The positive association between fear of crime and transaction prices is stronger at ‘very unsafe’ than at ‘unsafe’ and also has a higher significance level of 5%. These results suggest that fear of crime is associated with higher property values, which is opposite to what was expected. An explanation for this could be that people who live in expensive houses feel more like a potential target due to their wealth, which increases the fear of crime this group experiences (Sakip et al., 2013). However, the relatively weak significance levels must be taken into account when drawing conclusions

[4] 0.552 * 0.114 * 100% = 6.2928%

from these results. The negative association between crime and self-reported transaction prices became slightly stronger, as the coefficient changed from -0.552 to -0.557 and remains significant at the 1% level in model 2. An increase of crime with one standard deviation still leads to 6.3% lower transaction prices[5] when rounded to 1 decimal.

4.3 The role of household income and degree of urbanisation

Previous studies have shown that income and the degree of urbanisation play a role in how people experience fear of crime. Therefore, two interactions are added in model 3 to determine if these factors also play a role in the association between fear of crime and transaction prices. The first interaction is between the gross yearly household income and fear of crime, the second interaction is between the degree of urbanisation of the municipality and fear of crime. The adjusted R-squared of model 3 increased slightly to 53.96%.

The results of model 3 show that there is no association between the levels of fear 'safe', 'neutral' and 'unsafe' and the natural logarithm of transaction price in municipalities with the lowest degree of urbanisation. However, the coefficient of the added interaction between degree of urbanisation and fear of crime is significant. At 'unsafe' the interactions are significant starting from slightly urbanised and at 'safe' and 'neutral' starting from moderately urbanised. This means that there is a negative association between the levels of fear 'safe', 'neutral' and 'unsafe' and transaction prices in municipalities with a higher degree of urbanisation. The coefficients for the interactions are increasingly negative and significant at higher degrees of urbanisation, which means that the negative association becomes stronger when the municipality is more urbanised. In addition, the negative association also becomes stronger at higher levels of fear. For example, the association between the level of fear 'neutral' and lower transaction prices is stronger in a moderately urbanised municipality compared to a municipality that is not urbanised, and becomes even stronger in a very strong urbanised municipality. Likewise, when the degree of urbanisation stays at 'very strong urbanised' and the level of fear increases to 'unsafe', the negative association increases further again. In general, this means that higher levels of fear are associated with lower property values and that this association is stronger at higher degrees of urbanisation. This suggests that people are willing to pay for an increased feeling of safety and that their willingness to pay is higher in areas that are further urbanised. Also, most of the respondents that feel unsafe or very unsafe come from (strong) urban areas (see appendix A). An explanation for this could be that crime rates are relatively high in urban areas, which increases the need to feel safe for people in these areas (Wells & Weisheit, 2004; Ceccato & Dolmen, 2011).

[5] 0.557 * 0.114 * 100% = 6.3498%

Given the results for ‘safe’, ‘neutral’ and ‘unsafe’ it is notable that ‘very unsafe’, the highest level of fear, is associated with higher transaction prices regardless of the degree of urbanisation. The added interaction with household income is significant and should be included in the association. The negative coefficient of the interaction shows that an increase in household income decreases the association between the highest level of fear and transaction prices. According to the CBS (2017), the average gross yearly household income was around €60.000,- in 2015 (11 as the natural logarithm). This means that the highest level of fear is associated with higher transaction prices at the average household income compared to lower levels of fear. When the gross household income is doubled to €120.000,- (11.7 as the natural logarithm) the association becomes less strong. An explanation for this could be that people with a higher income have more resources to spend on protective measures, which decreases the effect of fear of crime (Pantazis, 2000). Again, the positive association between the highest level of fear and transaction prices can be explained by the increased fear of crime that people who live in expensive houses experience due to their wealth (Sakip et al., 2013). The negative association between crime and self-reported transaction prices is slightly weaker in the third model and remained significant at the 1% level. As a result, an increase of crime with one standard deviation leads to 6.2% lower transaction prices[6]. Contrary to the lower levels of fear, the interaction between the degree of urbanisation and fear of crime is insignificant at the highest level of fear. This means that the degree of urbanisation does not play a role in the association between fear of crime and transaction prices at the highest level of fear[7]. However, the insignificance of these interactions is probably caused by the limited amount of respondents in some of the interaction categories. For example, of all the respondents that experience the highest level of fear only 7 come from a municipality that is not urbanised and 9 come from a municipality that is slightly urbanised (see appendix A for frequency tables of the interaction categories). This reflects a lack of variance in the data, which may explain the insignificant coefficients for this interaction at the highest level of fear.

[6] 0.548 * 0.114 * 100% = 6.2472%

[7] Multiple studies state that education level can influence how people experience fear of crime (Austin et al., 2002; Hanslmaier, 2013; Dustmann & Fasani, 2016). An interaction between education level and fear of crime was added to the model to control for education level but this interaction turned out insignificant

Table 4: Regression results of model 1, 2 and 3.

	Model 1: Fear of crime not included	Model 2: Fear of crime included	Model 3: Interactions included
Feels safe		-.002 (.005)	.154 (.100)
Ln Income * Safe			-.010 (.009)
Very strong urbanised * Safe			-.066*** (.023)
Strong urbanised * Safe			-.049** (.022)
Moderately urbanised * Safe			-.053** (.022)
Slightly urbanised * Safe			-.031 (.022)
Neutral (not safe or unsafe)		.013 (.011)	.129 (.206)
Ln Income * Neutral			.003 (.019)
Very strong urbanised * Neutral			-.202*** (.055)
Strong urbanised * Neutral			-.164*** (.053)
Moderately urbanised * Neutral			-.142*** (.055)
Slightly urbanised * Neutral			-.070 (.058)
Feels unsafe		.028* (.016)	-.109 (.305)
Ln Income * Unsafe			.034 (.028)
Very strong urbanised * Unsafe			-.287*** (.078)
Strong urbanised * Unsafe			-.238*** (.076)
Moderately urbanised * Unsafe			-.222*** (.080)
Slightly urbanised * Unsafe			-.190** (.083)
Feels very unsafe		.069** (.028)	1.556*** (.480)
Ln Income * Very unsafe			-.129*** (.041)
Very strong urbanised * Very unsafe			-.084 (.130)
Strong urbanised * Very unsafe			-.223* (.134)
Moderately urbanised * Very unsafe			-.047 (.137)
Slightly urbanised * Very unsafe			-.004 (.160)
Crime	-.552*** (.037)	-.557*** (.037)	-.548*** (.037)
Ln Income	.107*** (.005)	.107*** (.005)	.113*** (.007)
Ln Floorspace	.662*** (.009)	.662*** (.009)	.661*** (.009)
Leefbaarometer score 'houses'	.161*** (.040)	.160*** (.040)	.156*** (.040)
Leefbaarometer score 'demographics'	.773*** (.051)	.792*** (.052)	.779*** (.052)
Leefbaarometer score 'services'	.858*** (.038)	.860*** (.038)	.855*** (.038)
Leefbaarometer score 'physical surroundings'	.406*** (.044)	.407*** (.044)	.409*** (.044)
Construction period: <1945	-.098*** (.008)	-.098*** (.008)	-.100*** (.008)
Construction period: 1945-1959	-.134*** (.011)	-.134*** (.011)	-.134*** (.011)
Construction period: 1960-1969	-.128*** (.011)	-.129*** (.011)	-.128*** (.011)
Construction period: 1970-1979	-.169*** (.010)	-.169*** (.010)	-.169*** (.010)
Construction period: 1980-1989	-.108*** (.010)	-.109*** (.010)	-.110*** (.010)
Construction period 1990-1999	-.012 (.009)	-.012 (.009)	-.012 (.009)
Very strong urbanised	-.028* (.016)	-.028* (.016)	.018 (.020)
Strong urbanised	-.034*** (.013)	-.034*** (.013)	-.001 (.017)
Moderately urbanised	-.009 (.012)	-.009 (.012)	.024 (.016)
Slightly urbanised	.001 (.011)	.002 (.011)	.021 (.016)
Constant	8.091*** (.086)	8.087*** (.086)	7.999***(.102)
Location fixed effects (province)	Yes	Yes	Yes
Time fixed effects (year of purchase)	Yes	Yes	Yes
Number of observations	15,429	15,429	15,429
Adjusted R-squared	0.5383	0.5385	0.5396

Note: Standard errors are in parentheses. The independent variable is the natural logarithm of the self-reported transaction price of the property. Reference categories: Feels very safe, not urbanized, construction period: 2000>, Province of Groningen, year of purchase: 2015. Significance at 0.10, 0.05 and 0.01 are represented by *, ** and *** respectively.

4.4 Further exploration of the association in low- and high-crime areas

As mentioned before, crime is usually concentrated in a few places and these places are remarkably stable over longer periods of time (Weisburd et al., 2004; Groff et al., 2010). Also, previously targeted victims and their surroundings face an increased risk of being targeted again (Lammers et al., 2015; Townsley et al., 2003; Bowers & Johnson, 2005; Townsley et al., 2015). As a result, some areas can suffer greatly from crime while other areas face almost no problems. To determine if this leads to differences in the association between fear of crime and residential property values, the dataset will be split into two sub-samples. The dataset will be split at the median of crime, resulting in one group of respondents who live in areas with relatively low crime rates and one group of respondents who live in areas with relatively high crime rates. The results of the regressions are shown in Table 5. Model 3 shows the results for the pooled sample. Model 4 shows the results of the regression for the respondents that live in a relatively low-crime area, which has an adjusted R-squared of 47.2%. Model 5 shows the results of the regression for the respondents that live in a relatively high-crime area, which has an adjusted R-squared of 56.5%.

In model 4, the model that considers the respondents who live in a relatively low crime area, the levels of fear ‘safe’, ‘neutral’ and ‘unsafe’ are associated with lower transaction prices. This negative association is stronger both at higher levels of fear and at higher degrees of urbanisation. The interaction between fear of crime and household income is insignificant, so household income has no effect on the association between level of fear and transaction price at these levels of fear. Contrary to the other levels of fear, ‘very unsafe’ is associated with higher transaction prices regardless of the degree of urbanisation. However, this is probably caused by the small interaction categories again (see appendix A). The interaction between fear of crime and household income decreases the association at the highest level of fear, but this interaction is only significant at the 10% level. Overall, the association of fear of crime in low-crime areas is similar to the association found in the pooled sample of model 3. However, the association is slightly less consistent and less significant than in the third model. Interestingly, the negative association between crime and self-reported transaction prices is substantially higher when only the respondents from relatively low-crime areas are considered.

Table 5: Regression results of model 3, 4 and 5

	Model 3: Pooled	Model 4: Low crime	Model 5: High crime
Feels safe	.154 (.100)	.149 (.149)	.158 (.142)
Ln Income * Safe	-.010 (.009)	-.010 (.014)	-.014 (.012)
Very strong urbanised * Safe	-.066*** (.023)	-.094** (.039)	-.025 (.060)
Strong urbanised * Safe	-.049** (.022)	-.049* (.028)	-.021 (.060)
Moderately urbanised * Safe	-.053** (.022)	-.071*** (.026)	.010 (.061)
Slightly urbanised * Safe	-.031 (.022)	-.027 (.025)	.004 (.063)
Neutral (not safe or unsafe)	.129 (.206)	.450 (.362)	-.068 (.259)
Ln Income * Neutral	.003 (.019)	-.024 (.033)	.009 (.022)
Very strong urbanised * Neutral	-.202*** (.055)	-.267*** (.091)	-.070 (.113)
Strong urbanised * Neutral	-.164*** (.053)	-.129* (.074)	-.061 (.113)
Moderately urbanised * Neutral	-.142*** (.055)	-.174** (.068)	-.007 (.115)
Slightly urbanised * Neutral	-.070 (.058)	-.127* (.068)	.151 (.124)
Feels unsafe	-.109 (.305)	.365 (.566)	-.462 (.414)
Ln Income * Unsafe	.034 (.028)	-.010 (.052)	.045 (.032)
Very strong urbanised * Unsafe	-.287*** (.078)	-.243 (.162)	-.047 (.211)
Strong urbanised * Unsafe	-.238*** (.076)	-.243** (.112)	-.011 (.211)
Moderately urbanised * Unsafe	-.222*** (.080)	-.204** (.100)	-.009 (.214)
Slightly urbanised * Unsafe	-.190** (.083)	-.187* (.097)	.021 (.222)
Feels very unsafe	1.556*** (.480)	1.929** (.947)	1.585*** (.506)
Ln Income * Very unsafe	-.129*** (.041)	-.161* (.083)	-.156*** (.047)
Very strong urbanised * Very unsafe	-.084 (.130)	.201 (.267)	.168* (.102)
Strong urbanised * Very unsafe	-.223* (.134)	-.206 (.189)	.014 (.106)
Moderately urbanised * Very unsafe	-.047 (.137)	.109 (.158)	
Slightly urbanised * Very unsafe	-.004 (.160)	-.042 (.177)	
Crime	-.548*** (.037)	-.800*** (.095)	-.384*** (.053)
Ln Income	.113*** (.007)	.112*** (.010)	.112*** (.010)
Ln Floorspace	.661*** (.009)	.671*** (.013)	.651*** (.012)
Leefbaarometer score 'houses'	.156*** (.040)	.163*** (.063)	.111** (.051)
Leefbaarometer score 'demographics'	.779*** (.052)	.638*** (.113)	.914*** (.058)
Leefbaarometer score 'services'	.855*** (.038)	.698*** (.061)	.901*** (.049)
Leefbaarometer score 'phyisical surroundings'	.409*** (.044)	.617*** (.069)	.294*** (.058)
Construction period: <1945	-.100*** (.008)	-.053*** (.013)	-.168*** (.011)
Construction period: 1945-1959	-.134*** (.011)	-.050*** (.018)	-.219*** (.015)
Construction period: 1960-1969	-.128*** (.011)	-.077*** (.016)	-.196*** (.015)
Construction period: 1970-1979	-.169*** (.010)	-.131*** (.014)	-.225*** (.013)
Construction period: 1980-1989	-.110*** (.010)	-.039** (.015)	-.184*** (.012)
Construction period: 1990-1999	-.012 (.009)	.010 (.013)	-.048*** (.013)
Very strong urbanised	.018 (.020)	.091*** (.031)	-.068 (.048)
Strong urbanized	-.001 (.017)	.036* (.022)	-.063 (.046)
Moderately urbanized	.024 (.016)	.053*** (.020)	-.044 (.047)
Slightly urbanized	.021 (.016)	.033* (.018)	-.040 (.047)
Constant	7.999***(.102)	7.892*** (.149)	8.155*** (.143)
Location fixed effects (province)	Yes	Yes	Yes
Time fixed effects (year of purchase)	Yes	Yes	Yes
Number of observations	15,429	7,714	7,715
Adjusted R-squared	.5396	.4723	.5653

Note: Standard errors are in parentheses. The independent variable is the natural logarithm of the self-reported transaction price of the property. Reference categories: Feels very safe, not urbanised, construction period: 2000>, Groningen, year of purchase: 2015. Significance at 0.10, 0.05 and 0.01 are represented by *, ** and *** respectively.

In model 5, the model that considers the respondents who live in a relatively high-crime area, there is only an association between the highest level of fear and transaction prices. Like in the third and fourth model, the highest level of fear is associated with higher transaction prices. Again, an increase in household income decreases the association between 'very unsafe' and transaction prices. The interaction between the highest degree of urbanisation and 'very unsafe' shows a positive coefficient, but is only significant at the 10% level. The small interaction categories cause problems in the analysis as the sub-sample of model 5 does not contain any respondents that both feel very unsafe and live in a municipality that is not urbanised or slightly urbanised (see appendix A). As a result, the interactions based on these empty categories are automatically omitted from the model. Subsequently, it is not possible to determine if these degrees of urbanisation play a role in the association between 'very unsafe' and transaction prices. This also means that the interaction between 'very unsafe' and 'not urbanised' can no longer function as a reference category for the highest level of fear. Therefore, 'moderately urbanised' is used as the reference category for the interaction between the highest level of fear and the degrees of urbanisation. Finally, the negative association between crime and self-reported transaction prices is smaller when only the respondents from relatively high crime rates are considered.

There are some notable differences between the association of crime and fear of crime in the fourth and fifth model. The results of the sub-group that consists of respondents from low-crime areas are largely in line with the results of the pooled sample. However, the results only show a significant coefficient at the highest level of fear for the sub-group that consists of respondents from high-crime areas. In addition, the negative association between crime and self-reported transaction prices is 2,5 times larger in the model with the respondents from low-crime areas than in the model with respondents from high-crime areas. Given these results, it seems that transaction prices are influenced more by crime and fear of crime in areas that currently have lower crime rates, while transaction prices are less influenced by crime and fear of crime in areas with higher crime rates. An explanation for this could be that people get used to crime at some point, weakening the association when crime increases further.

A Chow-test is performed to test if the sub-groups significantly differ from the pooled sample. The resulting F-statistic from the Chow test is 4.54 (see appendix B), which is higher than the critical value of 1.45 derived from the F-distribution at 1% significance. This confirms that there is a significant difference in the association of fear of crime between respondents from low-crime areas and respondents from high-crime areas.

5. DISCUSSION

5.1 Discussion of the results

In the first hypothesis it was expected that fear of crime would lead to lower residential property values in the Netherlands. Previous studies in the US and UK found that crime is associated with lower property values (Thaler, 1978; Gibbons, 2004; Pope & Pope, 2012). The results of this study show that this is also the case for the Netherlands, despite the differences in overall crime rates between these countries. Furthermore, the results show that there is not only an association between crime and residential property values, but also between fear of crime and residential property values when household income and the degree of urbanisation are considered. According to Snell (2001), crime and fear of crime are not necessarily correlated. A correlation matrix shows that this is also the case in this study, which legitimises the separate significant coefficients for crime and fear of crime in the third model. In general, fear of crime is associated with lower self-reported transaction prices, except for the highest level of fear. Sakip et al. (2013) state that people who live in expensive houses feel more like a potential target for crime, which may explain why the highest level of fear deviates from the overall pattern by being associated with higher transaction prices instead of lower transaction prices. However, it is more likely that the deviation from the pattern is caused by a lack of variance in the data due to the small interaction categories. Consequently, when the results for the highest level of fear are disregarded, the overall pattern shows that fear of crime leads to lower property values additional to the effect of crime. As a result, the first hypothesis cannot be rejected. Interestingly, the degree of urbanisation plays an important role in the association between fear of crime and residential property values.

In the second hypothesis it was expected that the association between fear of crime and residential property values would differ between low- and high-income households. Some studies state that people with higher incomes experience more fear of crime, while others found that people with lower incomes experience more fear of crime (Sakip et al., 2013; McGarrell et al., 1997; Mckee & Milner, 2000; Pantazis, 2000).

The second hypothesis cannot be rejected for all levels of fear. In particular, the results of this study show that household income only plays a role at the highest level of fear. At this level of fear the household income decreases the positive association with transaction prices. As such, the positive association between the highest level of fear and transaction prices is relatively stronger for low-income households. This is in line with what McGarrell et al. (1997) and Pantazis (2000) state about low-income households living in less safe neighbourhoods and lacking the resources to take protective measures, which explains the stronger association between fear of crime and transaction prices for these low-income households.

In the third hypothesis it was expected that the association between fear of crime and residential property values would differ between urban and rural areas. Previous studies are inconclusive when it comes to the effect of the degree of urbanisation on how people experience fear of crime (Weisheit et al., 1995; Nofziger & Williams, 2005). The third hypothesis cannot be rejected as the results show that the degree of urbanisation plays a significant role in the association between fear of crime and transaction prices. When the municipality is not urbanised, there is no association between the levels of fear 'very safe', 'safe', 'neutral' and 'unsafe' and transaction prices. Yet, these levels of fear are associated with lower transaction prices when the municipality is moderately urbanised or higher (or starting from slightly urbanised at 'unsafe'). According to Nofziger & Williams (2005), this may be caused by the weaker informal ties and less social coherence found in urban settings, which influences how people experience fear of crime. In addition, crime rates tend to be relatively high in urban areas compared to rural areas (Wells & Weisheit, 2004; Ceccato & Dolmen, 2011). As a result, the negative association between fear of crime and transaction prices is stronger at higher degrees of urbanisation.

5.2 Recommendations for further research

In this study around 90% of the respondents feel safe or very safe in their neighbourhood while only 0,8% of the respondents feel very unsafe. The relatively small amount of respondents who experience the highest level of fear causes problems in the analysis. When working with interactions the categories become too small (see appendix A for frequency tables of the interaction categories), which reduces the reliability of the results of the analysis. Consequently, it is difficult to draw sound conclusions for the highest level of fear, resulting in a less complete overview of the association between fear of crime and residential property values. In future research this should be taken into account, a possible solution could be to use a larger dataset or to create fewer interaction categories to increase the amount of respondents in each category. In addition, this study is based on self-reported transaction prices instead of official transaction prices, which decreases the reliability of the results as respondents could have reported incorrect prices (either intentionally or unintentionally).

Secondly, the parameter estimates in hedonic pricing analysis will be biased if the segmentation of the housing market is not taken into account (Ceccato & Wilhelmsson, 2011). In this study the construction period of the house and urbanisation level of the municipality were added to control for different sub-markets. However, controlling for other sub-markets can also be relevant based on how some types of neighbourhoods attract more crime than others (Tita et al., 2006). For example, single-family housing attracts more residential crime, while multi-family housing increases the amount of offenders (Ceccato & Wilhelmsson, 2011). Another sub-market division can be made between different types of land-use. Areas with a mixed land-use are more socially disorganised and therefore tend to attract more crime than purely residential areas (McCord et al., 2007; Ceccato, 2009). Controlling for these sub-markets in

further research would extend the knowledge on the association of crime and fear of crime with residential property values in different types of neighbourhoods.

Lastly, Ceccato & Wilhelmsson (2011) found that the effect of crime on property values is significantly greater when it comes to property crimes than for other types of crime like violence. In this study the fear of crime experienced by respondents was measured by if they were afraid to be robbed or harassed in the neighbourhood, which means that the fear of property crime was not considered in the analysis. In follow-up research the other types of fear should be included to provide a more complete overview of the association between fear of crime and residential property values. This also makes it possible to determine if the association between residential property values varies between types of fear associated with different types of crime.

5.3 Policy implications

It was already known that crime and fear of crime can have significant negative psychological effects, which greatly impacts citizen well-being and overall quality of life (White et al., 1987; Cornaglia et al., 2014; Dustmann & Fasani, 2016). However, this study shows that crime also has negative effects on the housing market in the Netherlands by influencing property values. These effects are not only caused by crime, but just the fear of crime can also have significant effects. To deal with crime, policymakers need to decide upon an optimal allocation of limited state resources, which requires information on the economic value attributed to safety (Dolan et al., 2005; McCollister et al., 2010). This study provides policymakers with insights into how people value safety and if they are willing to pay for a higher perception of safety. This information can be helpful for the allocation of funds to urban renewal projects and anti-crime policies. In addition, the results of this study show that urban renewal projects do not directly have to result in less crime, just an increase in the perception of safety can already lead to positive economical and psychological effects. Finally, the results of this study show that properties located in areas with more crime could provide an attractive investment opportunity if the area shows a positive trend regarding safety and crime or if it is likely to be included in crime prevention programmes or urban renewal projects in the near future.

6. CONCLUSION

This study focussed on the relationship between fear of crime and self-reported transaction prices of residential properties in the Netherlands. The following research question is answered in this study: *'What is the association between fear of crime and self-reported residential property values?'*. The results of the hedonic regression analysis show that crime is associated with significantly lower residential property values in the Netherlands. The analysis also shows that fear of crime leads to lower property values, additional to the effect of actual crime. Additionally, the negative association between fear of crime and residential property values is stronger in areas with a higher degree of urbanisation. The highest level of fear seems to be an exception to this pattern as it is associated with higher transaction prices, but this is likely caused by a lack of variance in the data. Furthermore, the highest level of fear is the only level where household income decreases the association between fear of crime and property values. Interestingly, the negative associations of crime and fear of crime are stronger in relatively low-crime areas than in high-crime areas. This study provides further insights into how people value not only safety from actual crime but also perceived safety and if they are willing to pay for higher safety.

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Appendices

APPENDIX A: FREQUENCY TABLES OF INTERACTION CATEGORIES

Frequency table of the interaction categories in Model 3

*	Very safe	Safe	Neutral	Unsafe	Very unsafe	TOTAL
Very strong urbanised	1038	1382	261	116	49	**2846**
Strong urbanised	1811	2122	334	146	39	**4452**
Moderately urbanised	1768	1574	201	77	22	**3642**
Slightly urbanised	1671	1499	127	54	9	**3360**
Not urbanised	564	496	42	20	7	**1129**
TOTAL	**6852**	**7073**	**965**	**413**	**126**	**15429**

Frequency table of the interaction categories in Model 4 (Low crime areas)

*	Very safe	Safe	Neutral	Unsafe	Very unsafe	TOTAL
Very strong urbanised	207	205	25	6	2	**445**
Strong urbanised	679	595	62	19	7	**1362**
Moderately urbanised	1157	954	98	31	12	**2252**
Slightly urbanised	1348	1145	96	37	9	**2635**
Not urbanised	521	440	34	18	7	**1020**
TOTAL	**3912**	**3339**	**315**	**111**	**37**	**7714**

Frequency table of the interaction categories in Model 5 (High crime areas)

*	Very safe	Safe	Neutral	Unsafe	Very unsafe	TOTAL
Very strong urbanised	831	1177	236	110	47	**2401**
Strong urbanised	1132	1527	272	127	32	**3090**
Moderately urbanised	611	620	103	46	10	**1390**
Slightly urbanised	323	354	31	17	0	**725**
Not urbanised	43	56	8	2	0	**109**
TOTAL	**2940**	**3734**	**650**	**302**	**89**	**7715**

APPENDIX B: CHOW TEST FOR TABLE 5

$$\text{F-statistic} = \frac{RSS_{Pooled} - (RSS_1 + RSS_2)}{RSS_1 + RSS_2} * \frac{T - 2k}{k}$$

$$\text{F-distribution} = F(k, T - 2k)$$

where

RSS_{Pooled} = residual sum of squares for the whole sample;

RSS_1 = residual sum of squares for sub-sample 1;

RSS_2 = residual sum of squares for sub-sample 2;

T = number of observations;

k = number of regressors in the unrestricted regression, including a constant.

$$\text{F-statistic} = \frac{1493.91 - (830.90 + 634.31)}{830.90 + 634.31} * \frac{15429 - 2 * 66}{66} = 4.54$$

$$\text{F-distribution} = F(66, 15429 - 2 * 66) = F(66, 15297)$$

Critical values (66, 15297)

90% ≈ 1.22

95% ≈ 1.30

99% ≈ 1.45