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AN EX-DURANTE EVALUATION OF THE EFFECT OF THE BUY-UP PROTECTION ON SQUARE METER PRICES AND RENTS IN ROTTERDAM

Utrecht University
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Abstract

This thesis features an analysis towards the effect of the buy-up protection on housing unaffordability in Rotterdam. As housing was becoming more unaffordable during the 2020's, the municipality of Rotterdam has implemented the buy-up protection in 16 of its 71 neighbourhoods on the first of January 2022. In this research, the effect of the buy-up protection on housing unaffordability was analysed through a Difference-in-Difference analysis of the average square meter price and rents in Rotterdam. From this analysis, it becomes clear that the buy-up protection was able to prevent the average square meter price of housing in buy-up protection neighbourhoods from being € 29,22 (±1%) higher than if the buy-up protection was not implemented. However, this analysis also shows that the buy-up protection was responsible for a € 0,80 (±5%) increase in the average square meter monthly rent in buy-up protection neighbourhoods. Nonetheless, it is worth noting that the results of this research should not be viewed in isolation. The effects of the buy-up protection on square meter prices/rents are a singular factor within a larger framework of possible effects of the buy-up protection.

Key words: buy-up protection, buy-to-let, Difference-In-Difference analysis

Foreword

In this document you will find the Master thesis titled: "*An ex-durante evaluation of the effect of the buy-up protection on square meter prices -and rents in Rotterdam*". I have written this thesis in the context of graduating from the Master Spatial Planning at the University of Utrecht. As I am a part-time student of Spatial Planning, I have executed the research, analysis, and writing of this thesis between February 2022 – June 2022 & February 2023 – June 2023.

However, the selection of the subject featured in this thesis was based on an aggregation of experiences *before* the start-date of my thesis (February 2022). During my Bachelor course (Human geography and Spatial Planning) and both my Master courses ((1) Spatial Planning & (2) Geographic Information Management and Application) I have developed a curiosity for the housing market, large-scale data analysis, and policy evaluation. With this thesis, I aspire to have combined these three different fields of enthusiasm in one comprehensive document.

At minimum, I can confidently state that during this thesis period, I have gained a substantive amount of knowledge regarding this subject, which I hope to be able to implement in practice in the future. Even if the subjects that I will study in the future are not directly related to this thesis, the developed methods, conceptual understandings, and analytical views will be able to support me regardless of the topic I will be keeping busy with. Therefore, I can assert that I am looking back at this thesis-period with a positive attitude.

I would like to thank the following individuals for guiding me in the process of writing my thesis. First of all, I want to thank Claudia Basta PhD. for being my thesis supervisor throughout these two (half) years. Secondly, I want to thank prof. dr. Edwin Buitelaar for input/recommendations regarding the type of analysis & case selection. Furthermore, I want to thank dr. Egbert van der Zee & Bram Roozen Msc. for recommendations regarding 'web scraping' as form of data-gathering. Additionally, I want to thank dr. Oliver Schmitz for validating the correctness of my Python-based methods. Lastly, I would like to thank Ramon Vermeulen for giving me Python-related tips that helped me in developing the web scraper.

Ruben Welkers
Utrecht, June 12th 2023

1. Introduction

For the first time since 1980, predicaments within the Dutch housing market have caused protests to ensure that housing unaffordability and -availability retrieves a higher position on the political agenda (Verheul & Hobma, 2022). These 'predicaments' include, but are not limited by, a housing shortage of 315.000 dwellings in 2022 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties [BZK], 2022), a 54% increase in the average value of dwellings between 2015 and 2022 (CBS, 2020; CBS, 2022a), a 68% increase in the average transaction price of dwellings between 2015 and 2021 (CBS, 2022b), and a 64% increase in the average rental price per m2 between Q2 2015 and Q2 2022 (NVM, 2022). The above-described increases have led 35% of the active housing-seeking population to appoint dwelling prices as the reason for their misfortunes in their pursuit to find suitable housing (BZK, 2022). These complications have caused the minister of housing and spatial planning to suggest that article 22 of the constitution – the obligation of the government to ensure sufficient- and affordable housing for their citizens (art. 22 lid 2 GW) – is not reached (de Jonge, 2022). According to de Jonge (2022) the contemporary predicaments on the housing market are caused by insufficient intervention of the state, which de Jonge (2022) aspires to increase.

However, the contemporary issues of affordability and scarcity of housing are a *symptom* of an underlying *cause*. The state therefore is unable to intervene in the scarcity or price increases itself, but has to identify what is causing these problems, and then intervene in these causes (Edwards & Imrie, 2021). Within the current debate surrounding causes of these housing market issues, the amount of buy-to-let practices – buying a residence to rent it out – is often cited as a possible contributor (Bosma et al., 2018; Hochstenbach, 2022; Baggerman, 2021). This attitude towards private investors is shared by both the current minister responsible for housing (de Jonge, 2022) as the preceding minister responsible for housing (Ollongren, 2020). Therefore, initiated by Ollongren (2020) and continued by de Jonge (2022), the '*temporal rule regarding buy-up protection*' was added to the Housing Act 2014 on the first of January 2022 (art. 39-50 Hvw). This temporal rule allows municipalities to implement a buy-up protection (Dutch: 'opkoopbescherming'), which prohibits buy-to-let practices (BZK, n.d.[1]).

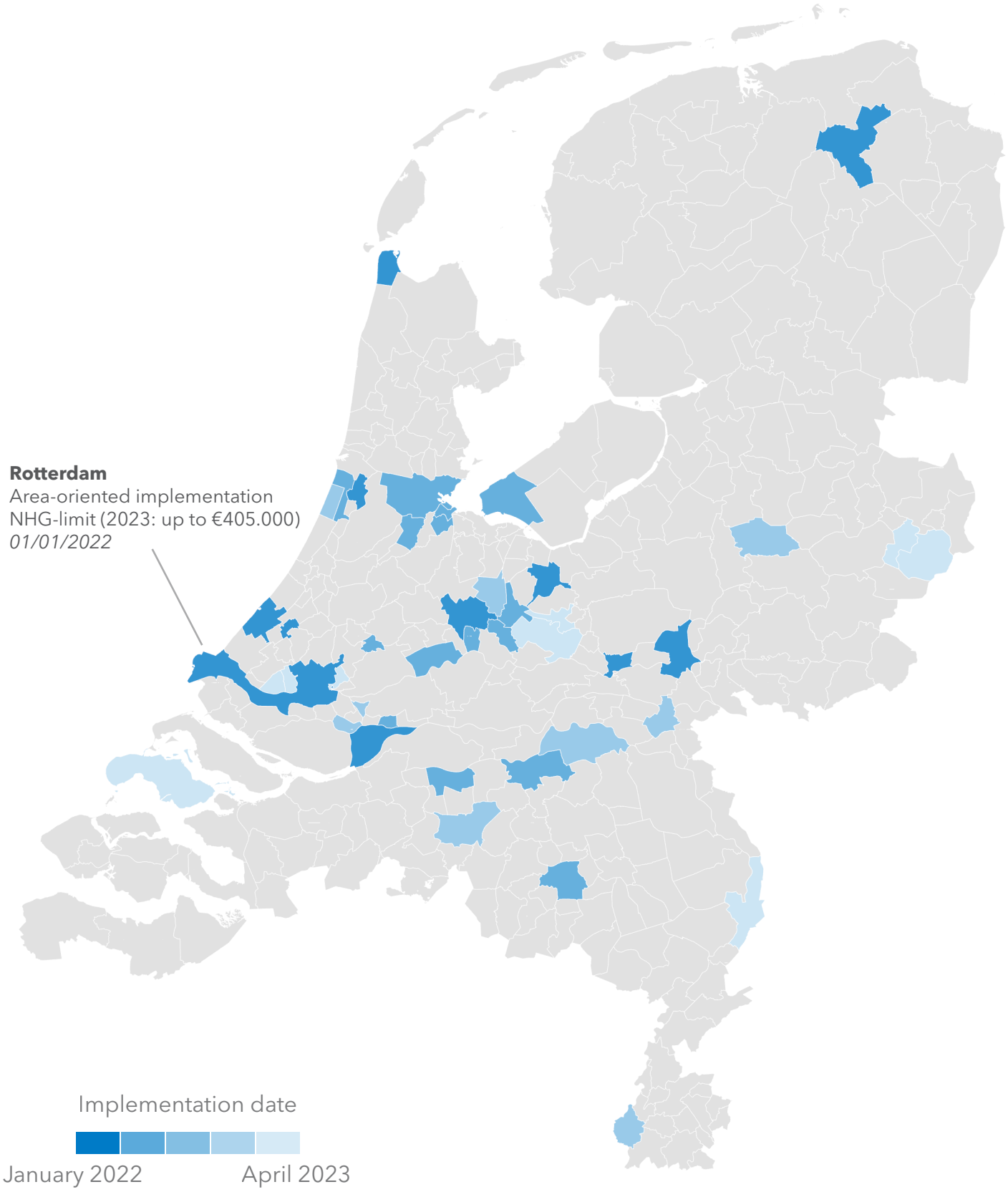
While the goal of the policy is straight forward, the initial implementation endured certain legal obstacles (Steenbakkers & Halsema, 2021). Limiting the ability of individuals to rent out their property is a direct infringement of the undisturbed use of private property as stated in the European Convention of Human Rights (art. 1 ECHR). This infringement is exclusively legally justified when it is 1) an absolute necessity with regards to the public interest, 2) stated by law and 3) a 'fair balance' between the desired public interest goals and the interests of private property owners [proportionality] (BZK, 2019). While the proportionality requirement regarding the buy-up protection was not met in the earlier stages of the development of the policy (Pentenga, 2020; Top, 2021), this changed as the severity of the housing crisis increased, leading the law change to be legally viable. Nevertheless, the requirement of the policy needing to be an absolute necessity with regards to the public interest is still reflected in the requirement that the law places on municipalities aspiring to implement the buy-up protection (art. 40 lid 1 Hvw).

As of the 11th of April 2023, 43 out of 342 municipalities have deemed the implementation of the buy-up protection an absolute necessity and have applied the policy on (parts of) their territory (figure 1; appendix table 1). However, some scepticism can be raised surrounding to which degree municipalities have complied with the inherent requirements of the buy-up protection. As the ability to implement the buy-up protection is recent, all of the 43 municipalities base the necessity for the implementation of the buy-up protection on an ex-ante evaluation. For most municipalities, this ex-ante evaluation is based on a comparison of rising house prices and the presence of investors in the housing market (appendix table 1).

However, an ex-ante evaluation encounters certain shortcomings surrounding being able to demonstrate if a policy functions in a proportional manner regarding the interplay between the infringement of private property rights and the desired public interest goals (Haarhuis & Keulemans, 2014). Firstly, due to an ex-ante evaluation happening before a phenomena, the effects can exclusively be theorized and suggested to a certain degree of accuracy (van Wee & Tavasszy, 2008). Even if the exact copy of a policy was implemented in another municipality, the inherently place-based character of the social reality implies that policies are never fully-replicable in different geographical contexts (de Pater, 2014). The social reality and its innumerable contextual influences are too complex for humans to comprehensively grasp and delineate (Hayek, 1989), making it impossible to predict the outcome of a policy with full confidence (van Wee, 2012). In other words, the buy-up protection is not implemented in a laboratory setting where all contextual influences can be adjusted accordingly, but in an urban context where an unpredictable amount of factors have the ability to influence the development of the policy (Hayek, 1989). Boulton (2010) therefore argues that *"Top-down design will certainly have an effect, but may not lead where intended."* (Boulton, 2010, p. 33). Therefore, arguing that the buy-up protection acts proportionally in the public interest exclusively based on an ex-ante evaluation is insufficient.

An example of a shortcoming of an ex-ante evaluation in this specific context is the conflicting existence of the *transfer tax increase-policy* (2021) relative to the buy-up protection. Both policies were implemented with the same goal (reducing investor attention), but the transfer tax increase-

Figure 1: Municipalities that have implemented the buy-up protection as of the 11th of April 2023



Source: appendix table 1

policy does so by increasing the transfer tax from 2% to 8% for investors purchasing a dwelling (art 15 lid 1p WBR). After increasing the transfer tax for investors from 2% to 8% on the first of January 2021 (Rijksoverheid, n.d.[1]), the amount of buy-to-let purchases decreased significantly (de Vries & Hans, 2022). Nevertheless, most ex-ante evaluations of the buy-up protection do not take the effects of changes within the extent of transfer taxes into account. For example, the justification for implementing the buy-up protection in the municipalities of Amsterdam, Rotterdam and The Hague all use pre-transfer tax data, measuring the amount of buy-to-let or private investor attention exclusively before the first of January 2021 (Gemeente Amsterdam, 2021; Schalkwijk, 2021; ABF Research, 2021). The ex-ante evaluation of the buy-up protection policy by the municipality of Utrecht did use data after the implementation of the transfer tax policy, but failed to comment on the decrease of investor purchases of housing after the first of January 2021 (Vlek et al., 2021). To summarise, most ex-ante evaluations of the buy-up protection significantly overestimate the degree of buy-to-let purchases and therefore the need for the buy-up protection.

Therefore, this thesis addresses the shortcomings of the previously applied ex-ante evaluations with an ex-Durante evaluation of the buy-up protection (Guyadeen & Seasons, 2018). In essence, this implies measuring – instead of predicting – the extent to which the policy is able to reach the desired effects regarding the housing market, and therefore the extent to which it was in the public interest to implement the policy (Josselin & Le Maux, 2017).

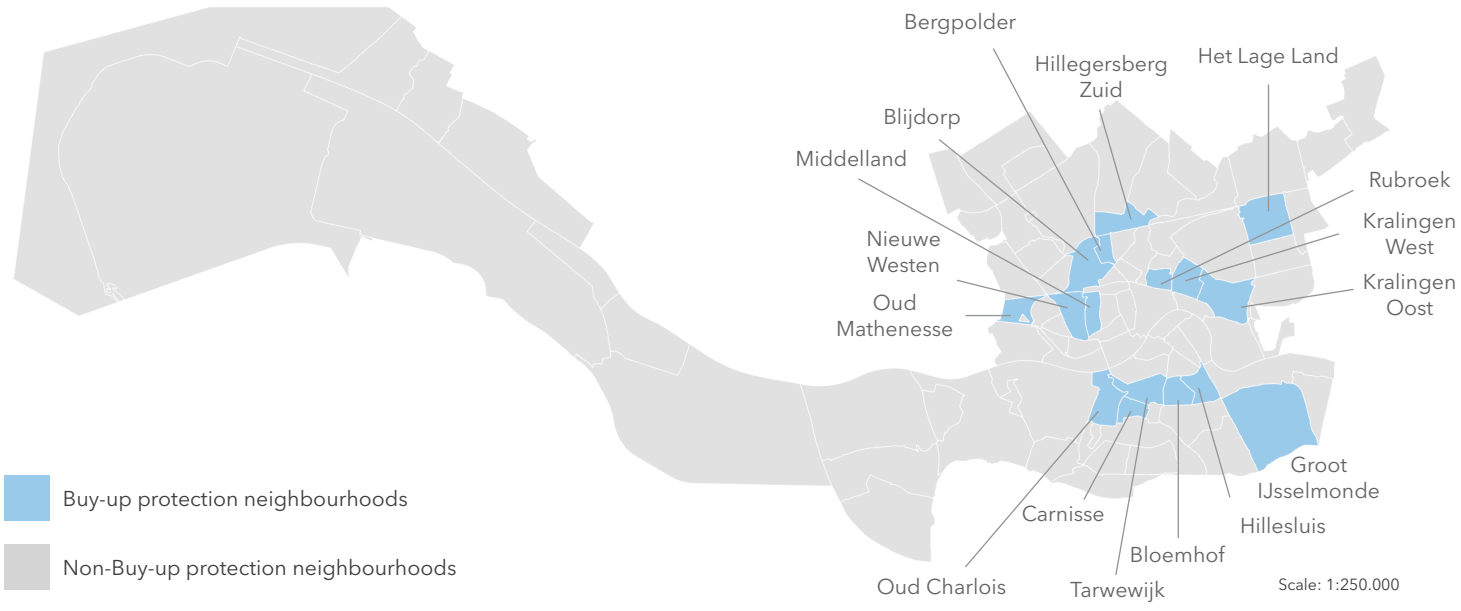
While – as of the 11th of April 2023 – the buy-up protection was implemented in 43 municipalities with different geographical contexts, the choice was made to exclusively analyse the municipality of Rotterdam for reasons of feasibility. The municipality of Rotterdam has implemented the buy-up protection in 16 out of 71 neighbourhoods on the first of January 2022 (Gemeente Rotterdam, 2022; figure 2). The selection of the municipality of Rotterdam is based on the fact that the municipality has implemented the buy-up protection in an area-oriented manner, which makes a comparative analysis of the buy-up protection possible within the municipality. Concretely, This thesis aspires to provide an answer to the following research question:

> *"To what extent has the buy-up protection resulted in a reduction of housing unaffordability in Rotterdam?"*

Answering the above research question through an ex-Durante evaluation – instead of ex-post – provides a strong societal relevance. Firstly, the results of this evaluation have the ability to complement the ex-ante evaluation of the municipality of Rotterdam. The results of this research may serve as a basis for arguments to (dis)continue the policy within the municipality, as a well-founded basis for infringing on private property rights is prerequisite (art 1 ECHR; BZK, 2019). Secondly, the results of this research have the ability to function as a stronger foundation for the ex-ante evaluation of other municipalities researching the desirability of implementing the buy-up protection. Instead of exclusively having to base the ex-ante evaluation on theorized suggestions that the buy-up protection will serve in the public interest, other municipalities may use empirically collected data to create a better foundation for the ex-ante evaluation. As mentioned before, the inherent place-based character of the social reality (de Pater, 2014) does mean that these findings would have to be adjusted for the municipality-specific geographic context (Been et al., 2019).

This thesis is structured according to the following framework. Firstly, the intricacies of the buy-up protection are described in the theoretic framework. Furthermore, a method is elucidated surrounding how the research question was answered. Subsequently, the results of applying these methods are demonstrated in the results chapter, finalizing with a conclusion and discussion of those results.

Figure 2: Neighbourhoods of Rotterdam, with all buy-up protection neighbourhoods highlighted.



Source: Gemeente Rotterdam, 2021 (Edited)

2. Theoretic framework

In this chapter, the intricacies of the buy-up protection are elucidated. Firstly, the context of the housing market in which the buy-up protection developed is described on the basis of theory and empirical evidence. Subsequently, how the buy-up protection came to be within this context is described in the 'origin of the buy-up protection' paragraphs. Then, the practical features of the buy-up protection which are relevant to this research are clarified. Lastly, the effect of the buy-up protection on the presented problem of housing unaffordability is theorized based on similar (international) policies.

2.1 The context of the buy-up protection

As mentioned in the introduction, the main contextual factor for the development of the buy-up protection is the *symptom* of unaffordability within the housing market. However, the buy-up protection does not have a direct effect on this symptom, but focusses on one of the underlying presumed *causes* of this symptom. This cause is identified as the amount of buy-to-let transactions, which the buy-up protection aims to limit. However, it is worth noting that exclusively assuming that the buy-up protection is the sole cause of the symptom of housing unaffordability is misguided (Boulton, 2010).

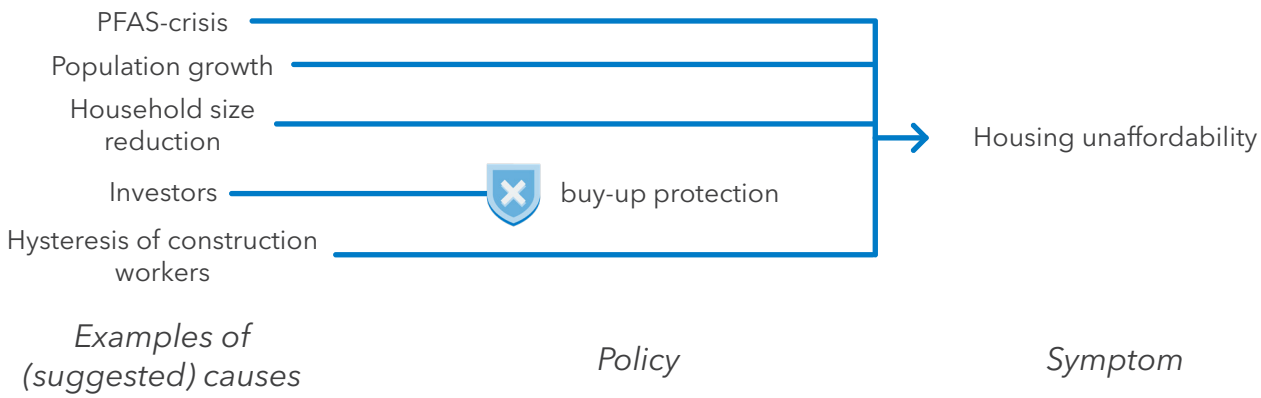
While isolating the exact cause of the unaffordability of housing is challenging due to difficulties surrounding disentangling the complexities of the social reality (Hayek, 1989), various authors have tried to do so and cite different reasons. The motivator for the development of the buy-up protection – the amount of investors in the housing market – fits within a larger framework of suggested causes such as for example 1) the nitrogen and per- and polyfluoroalkyl substances [PFAS] crisis, shutting down large parts of the housing construction business due to environmental concerns (Companen, 2021), 2) a growing amount of households due to a combination of population growth and household-size reductions (Groenemeijer et al., 2021) and 3) the occurrence of *hysteresis* relating to the amount of construction workers changing professions due to the low demand of the financial crisis of 2008, causing a contemporary shortage of construction workers (Buitelaar, 2021a; figure 3).

Regarding the investor-cause of housing unaffordability, Klapwijk et al. (2017) argue that in 2017, investors contributed to a real estate investment market of a substantial size. Within the wider context of the overall phasing out of the welfare state, this market originated due to the transformation of housing from a social right into an investment asset. General economic downturn pushed governments to implement certain policies to stimulate homeownership. Within the economic climate of the time, these policies were initially endorsed due to the possibility of 'regular people' being able to retrieve some profit in case their home increased in value. However, this more accessible method to secure wealth and a passive income also created a market for buy-to-let practices, attracting investor attention (Bosma et al., 2018). This shift from the general public purchasing a dwelling exclusively with the intention to live there [buy-to-live] to the possibility of buy-to-let is referred to as the financialization- or commodification of housing. Within this paradigm-shift, housing is not seen as a necessary fundamental right, but as an asset with which one can make a profit (Rolnik, 2013).

However, the initial endorsement of these policies weakened as certain problems arose for those same 'regular people'. For example, the financialization of housing causes households aspiring to buy-to-live for the first time [starters] to face a more difficult path in acquiring a residence due to both a quantitative and a qualitative reason (Bosma et al., 2018).

Quantitatively, referring to the Dipasquale-Wheaton Four-Quadrant model [4Q-model] (Geltner et al., 2014), the increased demand from investors shifts the demand curve, resulting in an increase of rent and house-prices until the housing-supply is able to react. When the supply is able to 'react' and mimic the increase of demand, the rents and prices of houses are pushed down again towards a market

Figure 3: The location of the buy-up protection in a model of suggested causes and the symptom of housing unaffordability



Source: Companen, 2021; Groenemeijer et al., 2021; Buitelaar, 2021a; BZK, n.d. (Edited). Note: The model depicted in figure 2 illustrates the inability of one policy 'solving' the issue of housing unaffordability. While the buy-up protection might remove one cause of housing unaffordability, it does not need to affect other causes. Furthermore, it is not claimed that the figure contains a hermetically sealed list, as the causes of housing unaffordability (can) have a broader range.

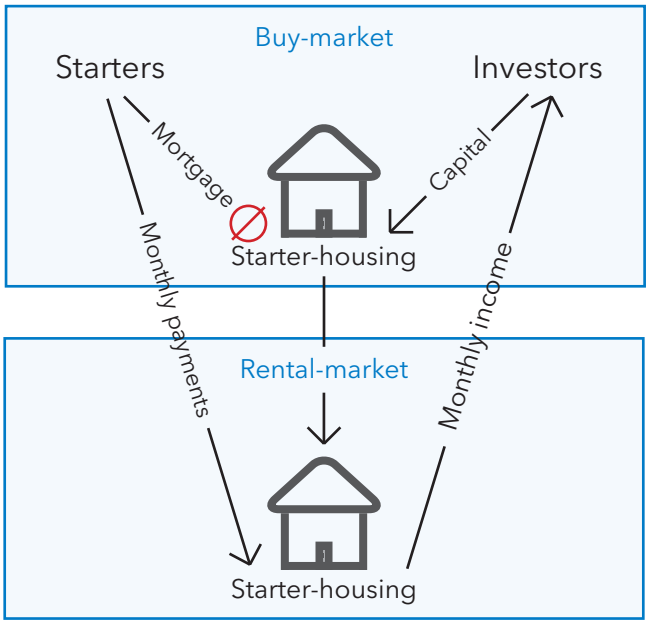
equilibrium. However, the *supply elasticity* – the degree to which the supply can react to the demand – is relatively low in the housing market due to limitations such as the longevity- (construction times) and immobility (unable to move housing towards high-demand areas) of real estate (Hudson-Wilson et al., 2005). Next to the above physical limitations, restrictive land-use zoning prohibiting the construction of housing also complicates the increase of supply to mimic the increased demand (Ball, 2013; Glaeser et al., 2003). The above logic implies that the shift of prices and rents caused by the increased investor-demand are difficult to decrease into a market equilibrium again by increasing the supply (Geltner et al., 2014). Therefore, both those desiring to buy-to-live and buy-to-let face increased prices for a prolonged amount of time (Bosma et al., 2018). While this price increase is not necessarily a harmful development for investors that consider housing a commodity due to the inherent need for economic growth, it can be harmful for starters (van Loon & Aalbers, 2017). Those who already possess a (or multiple) residence(s) benefit from price increases and can use the surplus value of their residence to purchase a new residence, while starters have to enter this high-price housing market *without* the benefit of rising prices (Fulong, 2015; Ray & Yosuke, 2015).

Qualitatively, a more difficult path is created because investors have a stronger competitive position regarding the purchase of a house relative to a starter. In general, the amount of capital an investor can extend in an economically-efficient manner is based on the investment return, which, in the case of real estate, is based on the rent. For the starter, this amount of capital is determined by the maximum retrievable mortgage. Since 2010, rents have been rising in a steeper manner than the maximum retrievable mortgage, increasing the competitive position of investors relative to starters (Conijn et al., 2019). Furthermore, a consequence of this stronger competitive position of investors relative to starters is referred to as the rent-trap. This entails that starters are forced to rent from the investors they compete with on the buy-market – because one needs to live *somewhere* –, limiting the accumulation of enough capital to compete with those same investors on the buy-market (Ryan-Collins et al., 2017; fig. 4). This implies that starters without a substantive amount of inherited capital are in a difficult position regarding the buy-market (Conijn et al., 2019).

2.2 Origin of the buy-up protection

The origin of the buy-up protection is found in its relatively similar predecessor, the *self-occupancy obligation* policy. The self-occupancy obligation entails the possibility to designate certain residences where the owner of that residence is obligated to live there (Top, 2021). Although very similar, the main difference between the self-occupancy obligation and the buy-up protection is that with the self-occupancy obligation, the municipality is exclusively allowed to apply *private* means to prohibit buy-to-let, while in the buy-up

Figure 4: A model of how starters fall into the rent trap due to investors



Source: Ryan-Collins et al., 2017; Conijn et al., 2019 (Edited)

protection *public* means are allowed (Piekema, 2021). In other words, the self-occupancy obligation is contractually arranged in a horizontal manner with the purchaser of a residence, implying that the purchaser of the residence voluntarily agrees to this obligation (Penner, 1996). The private property rights are therefore *not* infringed upon with the self-occupancy obligation. This infringement *is* the case with the buy-up protection, which *enforces* the buy-up protection on private property owners instead of in a contractually arranged manner. In practice, this implies that the self-occupancy obligation is exclusively applicable to housing of which the municipality can legally influence contracts – newly constructed housing on municipal soil –, while the buy-up protection is applicable to the entire housing stock (Steenbakkers & Halsema, 2021). Since 1980, the self-occupancy obligation has been applied by municipalities in periods defined by a relatively high demand for housing and dismissed again in periods characterized by a relatively low demand for housing (Eerenbeemt et al., 2021).

During these years, municipalities could exclusively implement the self-occupancy obligation – instead of also the buy-up protection – because of the essential difference between private and public means (van Gent, 2020). As mentioned in the introduction, the initiators of the buy-up protection struggled with the proportionality of infringing on the rights of private property owners (art 1 ECHR) and the public interest benefits the policy would have (Ollongren, 2020). Before the development of the law change that made the buy-up protection possible, the – contemporarily outdated – consensus was that municipalities could prohibit buy-to-let through a private manner, but applying public means would be a disproportionate infringement of private property rights (Pentenga, 2020; BZK, 2019; Hochstenbach & Ronald, 2020). However, after the government deviated

further from their constitutional responsibility of guaranteeing sufficient housing (art 22 lid 2 GW) and the push for an alteration of the governmental view on the proportionality of using public means intensified (van Gent, 2020), the view of the national government changed. Therefore, at the first of January 2022, the Housing Act 2014 was appended with the *'temporal rule regarding buy-up protection'* (art 39-50 Hvw) that allowed municipalities to use public means to prohibit buy-to-let, referred to as the buy-up protection (BZK, 2021b).

2.3 The features of the buy-up protection

While, the essence of the buy-up protection is straightforward – prohibiting buy-to-let –, an unconditional version of this policy would be considered disproportionate regarding the interplay between private property rights and the public interest (Steenbakkers & Halsema, 2021). To conform with the proportionality requirement of private property rights (art 1 ECHR), the law change to the Housing Act 2014 (art 39-50 Hvw) limits the extent to which municipalities are able to implement the buy-up protection and sets some additional requirements (BZK, 2019; BZK, 2021b). These limitations and requirements are elucidated in the following paragraphs.

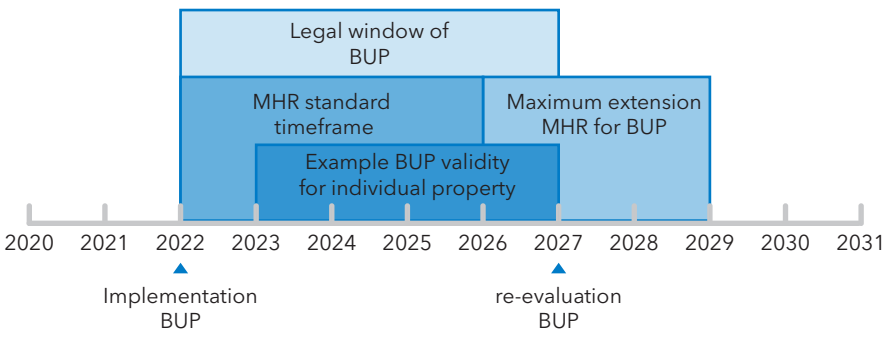
2.3.1 Temporary character

The buy-up protection possesses three features that give the policy a temporary character. Firstly, as mentioned before, municipalities are able to implement the buy-up protection due to the addition of the '***temporal*** *rule regarding buy-up protection*', negating the assumption that municipalities are allowed to implement the buy-up protection permanently (act 39-50 Hvw). This temporary arrangement is valid for 5 years after its implementation, obliging the minister of the Interior and Kingdom Relations to re-justify the buy- up protection before the first of January 2027 based on *"the necessity and relevance within the economic situation of that specific moment"* (Art. 51 Hvw; fig. 4). For municipalities, this temporary limit implies that municipalities are free to implement the buy-up protection until the first of January 2027, with a possible extension if the buy-up protection is still considered proportionate regarding the *national* state of the housing market (Wever, 2022). In other words, if the minister of the Interior and Kingdom Relations deems the Housing Act amendment disproportionate in relation to property rights before 2027, the legality of the buy-up protection is omitted regardless of the socio-economic justification for implementing the policy as produced by the municipal council itself (BZK, 2021c).

Secondly, a temporal component is added to the buy-up protection because of technicalities of implementing the policy itself. To implement the policy, municipalities are required to append their municipal housing regulation (Dutch: 'Huisvestingsverordening') with a chapter surrounding the buy-up protection, which only takes effect after the publication of this appended municipal housing regulation (Wever, 2022). This municipal housing regulation however, is required to be reviewed every four years (art 4 Hvw), implying that the municipal necessity for the buy-up protection is required to be re-justified as well. As an addition, the amended Housing Act 2014 states that in case of a national abolition of the buy-up protection on the first of January 2027 (art 51 Hvw), the municipal housing regulation is still allowed to enforce a buy-up protection (VNG, 2021). If, for example, a municipality deems the buy-up protection a necessity in a municipal housing regulation on the first of January 2026 while the minister of the Interior and Kingdom Relations deems it disproportionate on a national scale on the first of January 2027, the buy-up protection is still legally in force in that specific municipality until the first of January 2029 (fig. 4).

Thirdly, an individual property is exclusively being prohibited from being rented out for four years after the purchase of the property (art 41 lid 1 Hvw; fig. 4). After those four years, the property-owner is free to rent out their property out again. This specific temporal limitation further signifies that the buy-up protection does not limit investment in the housing market all together, but exclusively buy-to-let practices. For example, investors can still buy a residence, live there for four years, buy a new residence and rent out their old residence [leave-to-let] (VNG, 2021).

Figure 5: The timeframe of the legal applicability of the buy-up protection



MHR = municipal housing regulation
BUP = Buy-up protection

Source: VNG, 2021; art 4 Hvw; art 41 lid 1 Hvw; art 51 Hvw;

2.3.2 Exemptions

Regarding the exemptions of the buy-up protection, municipalities are faced with legally required- and facultative exemptions. Firstly, the buy-up protection is limited to the cheap and middle-expensive housing segment (Art. 41 lid. 2a Hvw). In these segments, the buy-to-live versus buy-to-let competition problems are the most severe due to the – elucidated in §2.1 – higher cap-rates, investment returns and a stronger dependency on mortgages (Conijn et al., 2019; Ryan-Collins et al., 2017). Expensive housing segments are less interesting for investors due to the lesser tension between supply and demand in those segments (Bosma et al., 2018; Marlisa, 2019), causing a restriction of property rights to be disproportionate and therefore legally unjustifiable (Art. 1 ECHR; BZK, 2019).

However, what exactly defines the cheap and middle-expensive segment is up to municipalities themselves. Adhering to the decentral ethos, national legislators have deemed municipalities best equipped in defining up to which price housing is considered cheap or middle-expensive (VNG, 2021). VNG (2021) advises municipalities to define this based on the cost-limit applied to the national mortgage guarantee limit [NHG-limit]. Under this cost-limit, the national government provides a safety net for households in case that they are faced with payment-problems. As of 2023, this limit is set at € 405.000, - implying that mortgages for residences under this limit are protected by the national government (NHG, n.d.). As the NHG is produced to assist households in retrieving cheap to middle-expensive housing (Kerste & Rosenboom, 2011), municipalities can justify applying this limit as the definition of cheap and middle-expensive housing. In practice, municipalities such as Rotterdam (Gemeente Rotterdam, 2022), Eindhoven (Gemeente Eindhoven, 2022) and The Hague (Gemeente Den Haag, 2022) adhere to this advice and limit the buy-up protection to those residences valued under the NHG-limit. The municipalities of Utrecht and Amsterdam went in a different direction and defined the cheap and middle-expensive market as 60% of the residences within the territory of the municipality. For the municipality of Utrecht this implied all residences below the value of € 440.000 (Gemeente Utrecht, 2022) and in Amsterdam this implied all residences below the value of € 521.000 (Gemeente Amsterdam, 2022). The municipality of Nieuwegein went one step further and based their definition of cheap and middle-expensive housing on the limit set by their neighbouring municipality, the municipality of Utrecht (Gemeente Nieuwegein, 2022). Furthermore, as illustrated in appendix table 1, some municipalities do not provide a basis for their definition of cheap and middle-expensive housing and provide a seemingly arbitrary number as limit.

Furthermore, the municipality is – upon request – either free or legally required to extend a permit releasing a property from the buy-up protection based on certain situations. Regarding the legally required exemptions, it is mandatory for municipalities to provide a permit in the case of first- or second degree family relations (Art. 41 lid. 3a Hvw), short-term non-touristic rental up to 12 months (Art. 41 lid. 3b Hvw) and in the case that a property is inseparable from a retail or office space (Art. 41 lid. 3c Hvw). Regarding the first legally required exemption, this implies that, for example, (grand)parents are free to buy a dwelling to rent it out to their (grand)children (VNG, 2021). The exact definition of 'family' goes further than simply blood-relationships and are defined in the Dutch Civil Code (Art. 3 lid. 1 BW 1). Regarding the second legally required exemption, this permit is exclusively to be requested when the property owner has already occupied the dwelling themselves for a period of 12 months. This exemption was implemented to reduce the possibility of unnecessary – legally obliged – vacancy in case an owner is not occupying a dwelling for a short period of time (VNG, 2021). The last legally required exemption is exclusively viable in case the housing space is inseparable from the retail or office space (VNG, 2021). What suffices as 'inseparable' is specified in the Dutch Civil Code (Art. 106 lid. 1 BW 5).

Next to the above exemptions that municipalities are legally required to adhere to, municipal councils can implement some facultative exemptions in their municipal housing regulation. Municipal councils have the ability to do this to further target 'undesirable' practices or prevent the arrival of adverse effects. VNG (2021) provides examples such as allowing housing corporations a permit of exemption or those looking to rent out dwellings to vulnerable social groups such as students and the elderly. Furthermore, municipalities are also free to act in a case-by-case manner and provide an exemption in, for example, distressing cases such as the death of an owner-occupier. In practice, these municipal-specific exemptions inhabit a fairly wide range. For example, the municipality of Amsterdam exempts the buy-up protection in case an owner-occupier desires to rent out a part of their residence (gemeente Amsterdam, 2022), the municipalities of Utrecht and Eindhoven exempt housing corporations from the policy (gemeente Utrecht, 2022), the municipality of Rotterdam exempts healthcare organisations (gemeente Rotterdam, 2022) and the municipality of Nieuwegein applies an ad hoc practice allowing lawmakers to exempt based on what they argue as necessary (Gemeente Nieuwegein, 2022). The above list is far from comprehensive and the full list of exemptions per municipality is to be found in appendix table 1.

2.3.3 Area-oriented implementation and justification

A fundamental feature of the buy-up protection is the area-oriented character of the policy (Art. 41 lid. 1 Hvw). With regards to the inherent condition of proportionality when infringing on property rights (Art. 1 ECHR), municipalities can exclusively implement the buy-up protection in areas where the effect of the policy on the public interest is proportional relative to the infringement on individual

property rights. What this necessity of proportionality implies is that municipal councils are forbidden from simply implementing the policy for the entire municipality, and an area-specific justification is necessary. In practice, this entails that municipal councils are obliged to prove the presence of buy-to-let problems such as, for example, those specified in §2.1 in every area they aim to implement the policy. However, it is worth noting that the term 'area' is not a legally defined concept. The definition of the term is left to municipalities, which can, for example, base it on neighbourhood-, district- or postal code boundaries (VNG, 2021).

In practice, municipalities seem to deviate from the legal necessity of an area-oriented implementation more as time goes on. Municipalities that implemented the buy-up protection in the first two months of 2022 such as Rotterdam, Den Helder, Wageningen and Arnhem implemented the buy-up protection exclusively in certain neighbourhoods or districts based on the degree of investor presence. A substantial amount of municipalities that implemented the buy-up protection from March 2022 onwards however, implemented the policy municipality-wide (appendix table 1).

As specified in the Housing Act 2014, this area-oriented justification of the buy-up protection is only applicable when it is a "*…necessity with regards to contesting scarceness of cheap and middle-expensive housing* ***or*** *the conservation of the liveability of the housing environment.*" [emphasis added to 'or'] (Art. 40 lid 1 Hvw). Municipal councils thus need to prove per area that 1) there is either a problem with regards to the cheap and middle-expensive housing stock or with regards to the liveability of the housing environment and 2) the buy-up protection can solve this problem in a *proportional* manner relative to the infringements on property rights.

In practice, the justification for implementing the buy-up protection is commonly given in the form of a research report. Municipal councils interested in the implementation of the policy assign consultancy organisations the responsibility of analysing the presence of investors in the housing market together with the potential benefits of applying the buy-up protection. For example, the municipality of Utrecht employed 'Fakton Consultancy' to analyse the above components (Gemeente Utrecht, 2021a) and the municipality of Amersfoort used research from 'Kadaster' to justify the implementation (Gemeente Amersfoort, 2022)

The subjective character of the concept of justification implies that there is no legal framework surrounding what constitutes as an area where the buy-up protection is 'justified'. VNG (2021) therefore recommends supplying a strong foundation for the implementation to prevent any future abolishment of the policy by a court of law. Furthermore, the recency of the Act implies that – up to the 20th of May 2023 – there exist no judicial statements yet surrounding what justifications constitute as valid (Rechtspraak, n.d.). What has been stated with regards to the justification of the policy is that the 'waterbed effect' does *not* suffice as a valid justification. This implies that municipalities are prohibited from implementing the policy exclusively based on the fear that the implementation of the policy in a neighbouring area will result in – currently non-existing – problems in the area in question (VNG, 2021). Despite this statement, the waterbed effect is a frequently cited theme in discussions surrounding the buy-up protection (Vos, 2021; Vreugdenhil, 2022; Frielink, 2021). While the waterbed-effect argument on the area-scale within a municipality (Lagrouw, 2021) has no judicial foundation, the effect can be used as an argument between municipalities. The validity of this argument stems from the fact that the Housing Act 2014 states that any amendments in the municipal housing regulations ought to happen in coordination with municipalities present in the same *housing market region* (Art. 6 lid. 2 Hvw). Figure 6 illustrates the housing market region of 26 municipalities in which the municipality of Rotterdam is located.

Figure 6: The location of the housing market region where the municipality of Rotterdam is situated in.

Source: Blok, 2016 (Edited)

2.3.4 Enforcement

To ensure principles of equal treatment by the state and effectiveness of the policy, it is of importance that the policy is actually enforced in practice (Maas-Coymans et al., 2019). The adherence to the buy-up protection is therefore – such as is a standard procedure in policy implementation – enforced through the application of fines. A breach of the buy-up protection by an individual implies a fine of which the amount is decided upon by the municipality (Art. 45 Hvw). However, the amount of the fine is restricted by a specific fine-limit. The municipality can impose a fine within the fourth category (as of 2022: up to €16.750.-) for first-

time offenders of the buy-up protection. However, if the offender has breached the buy-up protection once (or more) before in the previous four years, the municipality is free to impose a fine within the fifth category (as of 2022: up to €67.000) (Art. 45 Hvw; Art. 23 lid 4 WvS). This distinction between first- and multiple time offenders fits within the contemporary debate surrounding the undesirability of large-scale private landlords (Dutch: 'huisjesmelkers') as these large-scale private landlords possess multiple properties and are therefore more likely to become multiple-time offenders. The larger fines for multiple-time offenders correlate with initial motives for the buy-up protection as limiting these large-scale private landlords was an important feature (Ollongren, 2020).

2.4 Specifications of the buy-up protection in the municipality of Rotterdam

Table 1: Specific parameters of the municipality of Rotterdam

Municipality	Rotterdam
Date of implementation	01/01/2022
Price segment (WOZ)	<=405.000
Included areas	16/71 neighbourhoods
Municipality-specific exemptions	Housing corporations, the municipality, those commissioned by the municipality and health-care providers are exempted.
Fines	1st offence: €8.000 2nd offence: €12.000 3rd offence: 18.500 4+th offence: 21.750
Justification	Applied in neighbourhoods where scarcity and a substantial amount of private investors were observed in 2020 (Gemeente Rotterdam, 2021a). Municipal-wide implementation was rejected because of the attached judicial risks of not being able to fully justify this (Gemeente Rotterdam, 2021b).

Source: appendix table 1; Gemeente Rotterdam, 2022

2.5 Theoretical effect of the buy-up protection on housing unaffordability

After having illustrated the context, origin, and specification of the buy-up protection, the following paragraphs theorize the effect of the buy-up protection on the predicaments of housing unaffordability. Although the context of the buy-up protection is illustrated in the context of the Netherlands in paragraph 2.1, the context of rising prices, buy-to-let, and housing unaffordability is not unique to the Netherlands, but is an international trend (Bo, 2020). As such, while the buy-up protection is a concept specific to the Netherlands, the theoretical aspects of the policy can be extracted from relatively similar policies in the international sphere.

While a positive effect regarding the decrease of house prices as a result of the buy-up protection can be derived from simple mathematical supply-demand models (Geltner et al., 2014), the simplicity of these models wrongly suggest an 'isolated' effect of a policy (DeSalvo, 2017). In other words, while the theory derived from the 4Q-model (paragraph 2.1) surrounding the effect *less investor demand = less demand for the same supply of housing = more affordable housing,* there are more factors at play that distort this 'simple' relation (Been et al., 2019). From literature, two key issues can be identified that have the possibility to distort this relation. The first potential hinderance is found in the assumption that it is possible to artificially decrease the demand for housing without affecting the supply of housing. The second potential hinderance is found in the semantics of housing affordability, as the buy-up protection might lead to cheaper owner-occupier housing, but not cheaper *rental* housing. These two theoretical effects are elucidated in the following paragraphs, concluding with a summarising hypothesis of this research.

2.5.1 A lesser construction rate

While the supply elasticity of housing is low due to the longevity of construction and immobility of the product (Hudson-Wilson et al., 2005), the extent of the addition of newly constructed housing to the supply is not inelastic. The incentive for housing developers to develop housing is the result of a 'round' business case, implying that the proceeds of the development are larger than the costs for the development (Musiç, 2021). If the costs for the development of a housing project are larger than the proceeds, the developer will lose capital, entailing that any profit-oriented developer will not continue the project (Crook & Kemp, 2019). Furthermore, developers and investors prefer a stable regulatory climate to develop in so that profits, costs, and margins can be predicted to a more certain extent. The frequent implementation/alteration of policies or regulations does not contribute to a stable policy climate, and often discourages development (Duca et al., 2010). In financial terms, (housing) developers calculate *future* proceeds and costs before starting a project, but as in an unstable policy climate these proceeds and costs are more difficult to predict, this creates an unfavourable risk.

For example, Been et al. (2019) analyse certain case studies where regulations in the housing market were implemented. In one of these cases, A San Francisco neighbourhood got issued a certain form of 'rent control', disallowing rents from rising any further. This had a positive effect on sitting renters, as – intended by the policy – their rents remained low. However, Been et al. (2019) also illustrate that the incentive to develop housing

in that neighbourhood slowed down, stopping the increase of housing supply. Furthermore, some current owners of housing could not rent out their buildings against a feasible price anymore, which made them demolish the buildings in favour of more financially feasible non-housing buildings. As a result, while some current renters enjoyed the benefits of a lower rent, the overall housing supply decreased creating a scarcity of housing (Been et al., 2019). Referring back to the same 4Q-model used to suggest a decrease in house prices as a result of the (investor-)demand being limited, this decrease in the supply of housing entails a *higher* price in the end (Geltner et al., 2014). In other words, regulatory policies help individuals searching for a residence on the short term, but on the long term it can result in a lower construction rate.

Kholodilin & Kohl (2023) confirm the findings of the case study of Been et al. (2019) by analysing the relation between regulatory policies and lower construction rates. They argue that, on average, regulatory policies in the housing market can be identified as the cause for lower construction rates. However, as Kholodilin & Kohl (2023) argue, this is not a universal rule of thumb as this relation is dependent on the place of a regulatory policy within the larger framework of policies. Therefore, most regulatory policies are combined with a supply-side incentive policy to counter the described negative supply-related side effects (Kholodilin & Kohl, 2023). Furthermore, while the existence of an 'average' effect of regulatory policies on construction rates can be proven, the exact extent of the effect on construction rates is highly context-dependent due to differences in land uses, policies, markets, etc. (Gyourko & Malloy, 2015).

Translating the above theory into the context of the buy-up protection, the above illustrated issues regarding the relation between regulation and construction rates are recognized. Contemporary aspirations regarding the new construction of housing are not fulfilled, and a standstill in housing development is expected (De Jonge, 2023a; De Jonge, 2023b). While the exact cause of this standstill in housing development has not been theoretically identified, housing developer advocacy groups suggest that one of the reasons for this standstill is the accumulation of regulatory policies within the housing market (NEPROM, 2022; NEPROM, 2023; Koets, 2023).

2.5.2 A lesser number of rental units

The second theoretical issue regarding the effect of the buy-up protection on housing affordability is found in the semantic aspect of the word 'housing affordability'. If the definition of housing affordability exclusively includes owner-occupier housing, then the argument for the buy-up protection lays on a more solid foundation. However, taking a more generally accepted perspective on housing affordability and also including the affordability of rental units (Stone, 2006), this foundation is weakened. This weakened foundation exists due to the fact that the buy-up protection does not result in an increase of owner-occupier housing out of thin air, but is the result of a reduction of the number of dwellings that are transformed into rental units. In other words, the buy-up protection results in a lesser share of (privately-owned) rental units relative to the amount of owner-occupied units.

Referring back to the requirement of the buy-up protection having to be a necessity regarding the public interest (paragraph 2.3), the decrease in rental units can result in issues within the justification. While cheaper prices for owner-occupier housing can be justified as being in the public interest, the effect that the buy-up protection has on rental units cannot be disregarded within the given definition of housing affordability. Theoretically, the following arguments can be made regarding the effect of the buy-up protection on the (privately-owned) rental side of the housing market.

Firstly, the rental side of the housing market is subject to the same simple mathematical model used to suggest a decrease in house prices due to the buy-up protection (Geltner et al., 2014). As owner-occupied housing becomes cheaper due to a lesser (investor-)demand to buy housing, these same investors are unable to transform that housing into rental housing. This therefore implies that the growth of the supply of rental units is decreased, which – assuming that the demand remains the same – increases the rent for the scarcer amount of available rental units (Hulse & Yates, 2017; Crook & Kemp, 2014).

However, this strictly economic argument does not necessarily imply that it is not in the public interest to decrease the share of rental units relative to owner-occupier dwellings. If those same individuals currently in the rental sector are able to buy a dwelling, the argument can still be made that this is in the public interest (Lux et al., 2020). However, this argument assumes that nobody in the private rental sector actually desires to be there. Haffner & Hulse (2021) refute this claim by arguing that middle-income households often miss out on affordable housing-programs due to their income being too high and also are not (financially) ready yet for owner-occupied housing. Furthermore, households/individuals interested in residing in a dwelling for a shorter period of time such as students or expats, could also prefer the private rental sector over the owner-occupier sector (Hochstenbach et al., 2021). Introducing a policy such as the buy-up protection therefore reduces the amount of middle-incomes (that desire to rent), students, and expats, which has an influence on the demographic of a neighbourhood.

The question then becomes if reducing the amount of private rental units is still in the public interest. As the buy-up protection does not affect social housing – which is a large subset of all rental units in the Netherlands (De Jong & Van der Moolen, 2014) – neighbourhoods can experience a polarizing divide between cheaper social housing and more expensive owner-occupier housing. Those households

that have a too high income for social housing but do not have enough capital (or desire) to purchase a dwelling are essentially excluded from these neighbourhoods. This growing sector of households (Hochstenbach & Ronald, 2020) is contemporarily enduring high rents due to the relative scarcity of rental units in the liberalized housing market. Reducing the supply of rental units for this sector by implementing the buy-up protection is another price-increasing measure (Geltner et al., 2014). In other words, when implementing the buy-up protection it is of importance to take into account the possibility of polarizing neighbourhoods between cheaper social housing and more expensive rental units / owner-occupier housing. Both the demographic- and social effects of the removal of this 'intermediate step' within the housing market should be taken into account when evaluating the placement of the buy-up protection within the public interest.

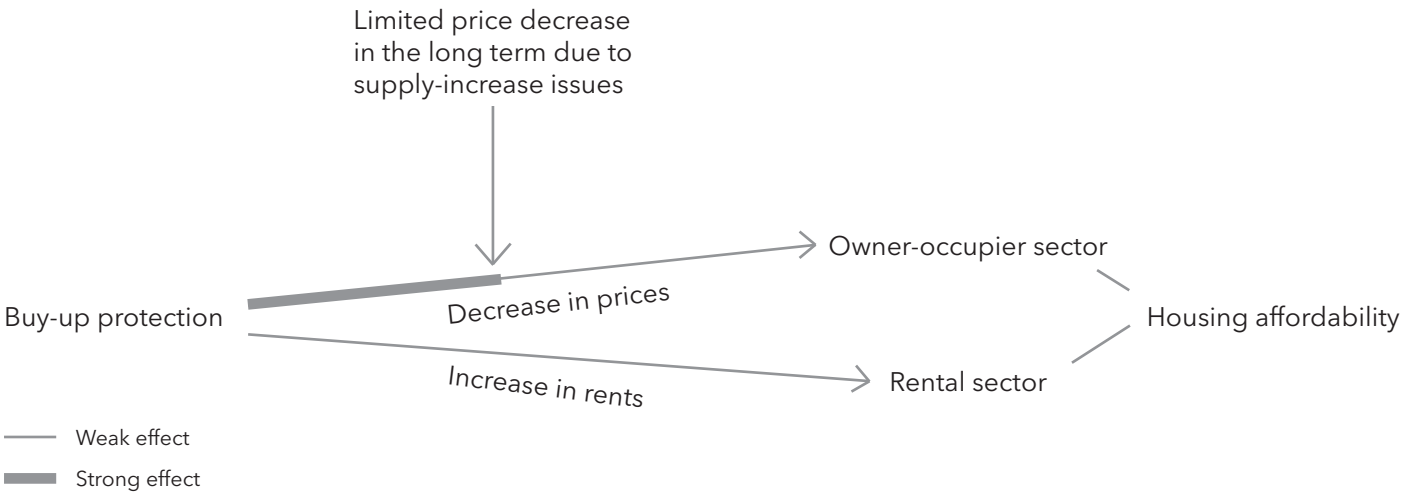
The result of the buy-up protection on the rental sector is interesting in the larger framework of regulatory policies as most policies are often focussed on helping renters rather than owner-occupiers. Throughout history, the renter was seen as the lower-class relative to the upper-class owner-occupier, which is why policies were focussed on assisting renters (Kholodilin, 2020). However, the buy-up protection might deviate from this consensus if those same liberalized rental units that are diverted from the middle-class are sold for a price that is still too high for this same middle-class. The buy-up protection does not feature a clause that 'requires' the housing not converted to the rental market to be sold for a price that is acceptable to these same middle-incomes, implying that these middle-income households might miss out on these dwellings. However, to nuance this with a counterargument, the buy-up protection does not act in isolation, and numerous policies have been implemented that actually *promote* middle-expensive renting (BZK, 2022). This way, the negative effect of the buy-up protection on the liberalized rental market is aspired to be reduced. A key argument to note here is the one made in paragraph 2.5.1, where an accumulation of (contradicting) regulatory policies might disincentivise developers even more.

2.5.3 Hypothesis

In the following paragraphs, a hypothesis is derived surrounding the effect of the buy-up protection on housing affordability based on the theory cited in this chapter. In general, three (conflicting) effects on housing affordability can be recognized, which are illustrated in figure 7. Firstly, the (intended) effect of the buy-up protection in causing cheaper house prices for owner-occupiers can be theoretically substantiated. However, it is possible that this effect is exclusively visible in the short term as the rate of construction might slow down due to an artificially limited demand, creating a scarcity in the supply which can increase house prices again. Thirdly, the theory suggests that the buy-up protection will have a price *increasing* effect on the rental market, which brings the effect of the buy-up protection on the concept of housing affordability in doubt.

Therefore, in short, the hypothesis of this research is that the buy-up protection will be beneficial for house prices in the short term, but disadvantageous for the rental market and therefore the integral concept of housing affordability.

Figure 7: Conceptual framework of the effect of the buy-up protection on housing affordability



3. Methods

The following paragraphs illustrate the methods that were applied to answer the research question: *"To what extent has the buy-up protection resulted in a reduction of housing unaffordability in Rotterdam?"*. Answering this in a well-founded manner required the main component of the research question – '*housing unaffordability*' – to be properly operationalised (§3.1). Afterwards, data was collected (§3.2) to empirically ground the performed analysis (§3.3) that resulted in an answer to the research question.

3.1 The operationalisation of housing unaffordability

Housing unaffordability is seen as the predominant concept that the buy-up protection aims to reduce (BZK, n.d.[1]). However, the concept of housing unaffordability is not quantifiable in the conventional sense, implying that an indicator that indicates the unaffordability of housing was required to be used in this research (Guyadeen & Seasons, 2018).

As the goal of the policy is to reduce – or at minimum stagnate the increase – in house prices, the indicator that was selected in this research is the price per square meter of houses. The 'square meter price' is an often used indicator in the Netherlands to compare the affordability of housing in different areas (Hypotheker, n.d.; Deijkers & Folkerts, 2022; Academica, 2020) as it reduces distortions caused by qualitative characteristics such as house sizes. Therefore, this research also uses the square meter price of housing as comparison factor and indicator of housing unaffordability.

However, next to an indicator that measures the intended effect of the policy, this research also featured an indicator to measure the unintended effect of the buy-up protection on housing affordability. As discussed in paragraph 2.5, the buy-up protection is not only suggested to decrease house prices for owner-occupier housing, but also *increase* rental prices. Therefore, adhering to a more comprehensive interpretation of the concept of housing affordability, this research analyses both the effect on the price of owner-occupied housing and the rent paid for rental housing. However, it is worth noting that these concepts remain *indicators* of housing affordability, implying that they do not necessarily *determine* housing affordability. If another research analyses housing affordability from a different perspective with different indicators, the outcome could potentially be different (Guyadeen & Seasons, 2018).

3.2 Data collection

After having operationalised the concept of housing unaffordability, the next step was to collect the data necessary to attach a quantitative value to the indicators. The method required to collect this data is described in the following paragraphs. This data was retrieved from the website of Funda (Funda, n.d.[1]) through a method called *web scraping*. 3.2.1 offers an explanation of the concept of web scraping and 3.2.2 describes how this was applied for the specific case of Funda.

3.2.1 Web scraping

In essence, the method of web scraping entails transforming unstructured data from an internet source into a more structured source such as a locally saved excel sheet (Sirisuriya, 2015). Web scraping is applied when the host of a public website does not offer a downloadable link or an application programming interface [API] that allows the user to directly request the data (Glez-Peña et al., 2014). In this case, the user is essentially required to 'copy and paste' the data that is hosted on a public website into a local dataset to apply further analyses. This actual copying and pasting of data is also referred to as manual web scraping, which can be applied to smaller and easily accessible datasets (Zhao, 2017).

However, when a website-based dataset is of a substantial size or has its data structured in a hard-to-copy manner, an *automated* or *programmed* web scraping technique is often used. While the act of copying and pasting data from a website into a local dataset remains the same, this is then done by a program instead of the user themselves (Diouf et al., 2019). For example, Roozen (2021) applied an automated form of web scraping to retrieve a large-scale dataset from the geosocial sources of Instagram and Tripadvisor to determine movement patterns. Furthermore, Haddaway (2015) applied an automated web scraping tool to find 'grey literature' that is ordered in a less structured manner than academic literature. Specific to the scope of this research, Boeing & Waddel (2017) scraped 'Craigslist' rental listings to determine market activity within the US rental housing market. As the act of web scraping is a data collection method, this method is applied in a wide array of different research subjects, reaching further than the above offered examples (Sirisuriya, 2015). Within this research, exclusively an automated form of web scraping is applied.

However, due to numerous authors citing the 'grey area' relating to the ethics and legality of web scraping (Roozen, 2021), it is worth elucidating this domain. If a website hosting a dataset does not offer a downloadable link or an API, this is usually done to 'protect' their data from being used by external actors. (Krotov & Silva, 2018). For example, the website included in this research – Funda –, wants to prohibit other websites from offering the Funda-collected data as their own dataset. Funda has invested a substantial amount of capital in their framework to display specific housing-listings, and retrieves this capital back through the revenue from users visiting their website. They therefore consider another website scraping and re-uploading the Funda-collected data as their own as a theft of this revenue and have taken legal steps in the past to prohibit this behaviour (Imperva, 2019). For example, in 2002, the scraping and re-uploading of Funda-data by a website labelled 'El Cheapo' was considered illegal and blocked by a court of law in the Netherlands (Hoge Raad, 2002). However, to illustrate the 'greyness' of this legal area, the 2006 case of Funda against another website labelled 'ZoekAlleHuizen.

nl' was lost by Funda due to the website in question not claiming the data as their own, but properly citing Funda in all the published data. Instead of scraping and re-uploading the Funda-data, the website in question merely indexed the data of Funda through the same method how Google indexes search results (Rechtbank Arnhem, 2006).

The legal grounds for the above decisions are for the majority based on the Database Act 1999 (Dutch: 'Databankenwet' 1999). Article 2 of the Database Act 1999 states that the producer of a publicly available dataset has the right to block individual users from either scraping a *"…substantial…"* (art. 2 lid. 1a Dbw) amount of the dataset or *"…repeatedly scraping both a substantial or non-substantial…"* (art. 2 lid. 1b Dbw) amount of the dataset. To relate this law to the producer of a dataset featured in this research, Funda makes use of this right by not allowing users to copy/scrape their data (Imperva, 2019). However, article 5 of the Database Act states that in certain specific cases, users are allowed to scrape website data without this above mentioned permission from the producer of the dataset. Relating to the case of this research, a user is allowed to scrape a substantial part of a dataset when it is *"available to the public in any way"* (art. 5 lid 1 Dbw) and this scraping is exclusively done for academic purposes and with proper citation (art. 5 lid 1b Dbw). As this research complies with the above statement, the web scraping that was applied in this research is completely legal.

Next to these exclusively legal issues regarding web scraping, there also exist some issues in the legal-ethical dimension. Ethically, it is considered unjust to harm research entities when conducting research (Scheepers & Tobi, 2021). While a website is incapable of experiencing physical or mental distress, it is possible that the server that hosts the website becomes overloaded by the amount of requests that are being done by an automated web scraping program. This overloading should be avoided out of ethical considerations, but also considering the fact that article 4 of the Database Act states that even with righteous use of the database, the user cannot perform actions that *"…endangers the general exploitation of the database or causes damage to the producer of the database."* (art. 4 Dbw). When applying an automated method of web scraping, it is therefore essential to remain within a human-like speed of requesting data from a website (Roozen, 2021). If, for example, an automated web scraping program would request multiple pages of data per second, it would start to function as a 'denial of service' [DoS] program which would cause damage to the producer of the database (Bawany et al., 2017). The amount of requests per second done by the automated web scraping program applied in this research remained between 0.5 and 1 seconds, which is humanly possible and could resemble general (non-automated) exploitation of the database, making it not harmful for the producer.

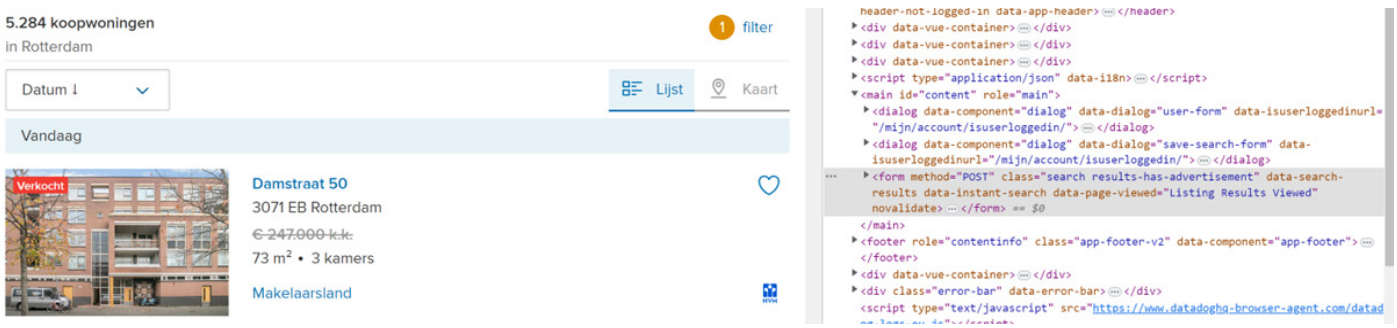
Furthermore, while this research does not act in a commercial manner, allowing commercial actors to essentially scrape the data that was scraped from the producer in question could be considered as unethical. Therefore, this research exclusively published the aggregated data and the results of the analyses based on the scraped data. The 'raw' scraped dataset on which the analyses were based was therefore not published as an appendix to this thesis.

3.2.2 Funda

To retrieve the necessary information surrounding the indicators, the website of Funda was scraped. This website features a search engine for housing that is currently for- rent or sale, together with historic data about housing that was sold or rented out in the last twelve months (Funda, n.d.[1]). As this website is set up by the Dutch Cooperative Association of Real Estate Agents and Valuers (Dutch: 'De Nederlandse Coöperatieve Vereniging van Makelaars en Taxateurs in onroerende goederen') [NVM], this website covers a wide array of housing transactions in the Netherlands (Funda, n.d.[2]). Imperva (2019) estimated that about 95% of all free-market housing transactions were featured on Funda.

As the scope of this research comprises of a policy evaluation, it is of importance to analyse the historical data of sale- and rental transactions within Funda. As mentioned in §3.2.1, Funda does not desire to aid individuals in retrieving this data outside of their sphere of revenue by providing a downloadable link or API, which is why this data had to scraped. As figure 8 exemplifies, this data is structured in a manner that is not easily copyable, with the majority of relevant data hidden behind a to be clicked link. Assuming that clicking this link, loading the page and copying the relevant data to a local dataset would take about 30 seconds per listing, manually scraping all housing sales in Rotterdam in the last 12 months would take about 31 hours (fig. 8).

Figure 8: Funda interface and underlying HTML code



Source: Funda, n.d.1

Therefore, an automated web scraper was constructed to retrieve all relevant housing data for this research. This creation was executed within the 'Integrated Development Environment' [IDE] labelled 'Visual Studio Code' (Visual Studio, n.d.), using the programming language 'Python' (Python, n.d.). In essence, the program that was created for this research requests a web page in the same way that a general user requests a webpage when they go to the specific site. However, this general user is then met with the interface that the producer of the website has programmed, while the program that was written for this research requests the 'HyperText Markup Language' [HTML] that is the foundation for this interface. Next to the interface that a general user observes when visiting a website, the HTML providing this interface is also publicly available, and can be accessed by right clicking any page and clicking 'inspect' (figure 8). The created program then selects the relevant data such as price, date of transaction, address, etc. by searching for the HTML-tags that the creator of the program has specified. This data is then appended to a dataframe, after which the program selects the next listing on Funda and repeats the process.

The following paragraphs elucidate the most important code snippets that were necessary for the creation of the program, with the full code being featured in the appendix (appendix figure 2). As Funda exclusively possesses historic transaction data for twelve months after the transaction, the code had to be run multiple times. The code was executed once on the 14th of April 2022 and once on the 17th of March 2023 for both rental and sale transactions. The resulting datasets were then combined and duplicates were removed. This implies that data was collected on transactions between the 14th of April 2021 and the 17th of March 2023.

Figure 9a features the first code snippet. This is a function that searches the requested HTML text for the location of the postal code on Funda. The requested data string is then cleaned into a format that is comparable with other data sources so that the listing can be matched with a specific neighbourhood.

Figure 9a: code snippet 1

```
  def get_postcode(woning_pagina):
        locatie_ruw = woning_pagina.find('span',
class_='object-header__subtitle fd-color-dark-3')
     if len(locatie_ruw.find_all('a', class_='fd-m-
left-2xs--bp-m fd-display-block fd-display-inline--
bp-m')) == 1:
       locatie_ruw.find('a', class_='fd-m-left-2xs-
-bp-m fd-display-block fd-display-inline--bp-m').
extract()
    postcode = locatie_ruw.text[:8].strip()
    postcode = postcode.replace(' ', '')
    return postcode
```

This process is repeated for the surface area of a listing in figure 9b. However, the surface area is not always found in the same place in every listing, which means that some 'ifelse' statements were necessary to pinpoint the exact location of the surface area within the listing.

Figure 9b: code snippet 2

```
  def get_oppervlakte(woning_pagina):
   oppervlakte_ruw = woning_pagina.find(text='Wonen')
    if oppervlakte_ruw != None:
          oppervlakte_ruw2 = oppervlakte_ruw.find_
next('span').text
     oppervlakte = int(''.join(re.findall(r'\b\d+\b',
oppervlakte_ruw2)))
    else:
              oppervlakte_ruw = woning_pagina.
find(text='Oppervlakte')
     if oppervlakte_ruw != None:
          oppervlakte_ruw2 = oppervlakte_ruw.find_
next('span').text
       if '/' in oppervlakte_ruw2:
            oppervlakte_ruw2 = oppervlakte_ruw2.
split('/')[0]
          oppervlakte = int(''.join(re.findall(r'\b\
d+\b', oppervlakte_ruw2)))
     else:
       oppervlakte = '??'
    return oppervlakte
```

Furthermore, figure 9c illustrates the same process for retrieving the price of a listing. The location of the price is structured differently for sold and rented properties, and features some exceptions such as 'price upon request' which had to be accounted for.

Figure 9c: code snippet 3

```
  def get_prijs(woning_pagina, type_input):
    if type_input == 'verkocht':
        prijs_ruw = woning_pagina.find(text='Laatste
vraagprijs')
      if prijs_ruw != None:
        prijs = prijs_ruw.find_next('span').text
      else:
        prijs = '??'
    elif type_input == 'koop':
     prijs_ruw = woning_pagina.find(text='Vraagprijs')
      prijs = prijs_ruw.find_next('span').text
    elif type_input == 'verhuurd':
        prijs_ruw = woning_pagina.find(text='Laatste
huurprijs ')
      if prijs_ruw != None:
        prijs = prijs_ruw.find_next('dd').text
      else:
        prijs = '??'
    elif type_input == 'huur':
       prijs_ruw = woning_pagina.find(text='Huurprijs
')
      prijs = prijs_ruw.find_next('dd').text
    else:
      prijs = '??'
    if 'servicekosten' in prijs:
      prijs = prijs[:-30]
    if contains_number(prijs):
        prijs = int(''.join(re.findall(r'\b\d+\b',
prijs)))
    else:
      prijs = 'Prijs op aanvraag / bij inschrijving'
    return prijs
```

Figure 9d features the code snippet required for the address. This is a simple code snippet as the address is always located in the same place within a Funda listing.

Figure 9d: code snippet 4

```
  def get_adres(woning_pagina):
    adres = woning_pagina.find('span', class_='object-
header__title').text.strip()
    return adres
```

Figure 9e features the code snippet that is required to retrieve the date of transaction. The program also allows the user to scrape listings currently for sale/rent, which has to be accounted for in case exclusively sold/rented out listings are being scraped.

Figure 9e: code snippet 5

```
  def get_verkoopdatum(woning_pagina, type_input):
    if type_input == 'koop' or type_input == 'huur':
      return 'Nog niet verkocht/verhuurd'
    else:
                verkoopdatum_ruw = woning_pagina.
find(text='Verkoopdatum')
      if verkoopdatum_ruw != None:
        verkoopdatum_ruw = verkoopdatum_ruw
      else:
                 verkoopdatum_ruw = woning_pagina.
find(text='Verhuurdatum')
        if verkoopdatum_ruw == None:
          return '??'
      verkoopdatum = verkoopdatum_ruw.find_next('dd').
text
      if verkoopdatum != None:
        verkoopdatum = replace_months(verkoopdatum)
      else:
        verkoopdatum = '??'
      return verkoopdatum
```

Figure 9f features the structure of the URL based on user input. As the webscraper function is started with the city-input being the province of South Holland and (in this example) the type being rental transactions (figure 9g), the URL-request is structured along this manner. Using the formulated url based on the entered parameters returns the webpage of all rented out properties in the province of South-Holland. The reasoning behind selecting the province of South-Holland instead of just the city of Rotterdam is that the city of Rotterdam is different than the municipality of Rotterdam. As the municipality-scale does not exist within Funda, it is important to search within a larger area and then later specify it to the municipality of Rotterdam.

Figure 9f: code snippet 6

```
  if type == "verkocht":
    saleOrRental = "koop"
  if type == "verhuurd":
    saleOrRental = "huur"
  base_url = 'https://www.funda.nl'
   url = f'{base_url}/{saleOrRental}/{city}/{type}/
sorteer_afmelddatum-af/'
```

Figure 9g: code snippet 7

```
scraper("provincie-zuid-holland", "verhuurd")
```

Figure 9h illustrates the creation of an empty dataframe that stores all scraped data. This dataframe features an abundance of headers as the program is also usable for other purposes than this research, but for this research exclusively the 'PC6', 'address', 'surface area', 'price' and 'date of sale' headers are relevant. Furthermore, a baseline count is set up, as the program needs to keep track of the amount of listings/pages that are scraped to not create unnecessary duplicates.

Figure 9h: code snippet 8

```
housingAttributes = ['City', 'Type', 'PC6', 'adres',
'woningtype',  'label',  'bouwsoort',  'bouwjaar',
'woonlagen', 'kamers', 'badkamers',
    'perceel', 'oppervlakte', 'prijs', 'aangeboden_
sinds', 'verkoopdatum', 'Scraped on']
  df = pd.DataFrame(columns=housingAttributes)

  countTotal = 0
  countTotalOnPage = 0
  countPages = 0
```

The code in figure 9i features the main navigation engine within the program. Firstly, the main page of the Funda query is requested, and a total of listings is established. Then, a while loop is started that runs as long until every listing is scraped. Within this while loop, every listing is opened and the HTML is requested.

Figure 9i: code snippet 9

```
    firstPageHTML = requests.get(url, headers={"User-
Agent": "Mozilla/5.0"}).text
  firstPageSoup = BeautifulSoup(firstPageHTML, 'lxml')
  amountOfListingsText = firstPageSoup.find('h1',
                      class_='search-output-result-
count fd-m-none fd-m-bottom-s fd-flex fd-flex-column').
text
    amountOfListings  =  int(''.join(re.findall(r'\b\
d+\b', amountOfListingsText)))

  while countTotal < amountOfListings:
      pageHTML  =  requests.get(url,  headers={"User-
Agent": "Mozilla/5.0"}).text
    pageSoup = BeautifulSoup(pageHTML, 'lxml')
         listingsOnPage   =   pageSoup.find_all('li',
class_='search-result')

    for listing in listingsOnPage:
     listingUrl = base_url + listing.find('a')['href']
           listingHTML   =   requests.get(listingUrl,
headers={"User-Agent": "Mozilla/5.0"}).text
     listingSoup = BeautifulSoup(listingHTML, 'lxml')
```

Figure 9j illustrates how for every listing, a check is executed if the listing actually concerns a relevant listing. Funda also hosts listings for parking spaces, building grounds, and 'objects', which had to be disregarded for this research.

Figure 9j: code snippet 10

```
          if 'parkeergelegenheid' in listingUrl or
'bouwgrond' in listingUrl or 'object' in listingUrl:
       print('irrelevant listing, skipped')
     elif len(listingSoup.find_all('p', class_='fd-m-
none fd-color-dark-1 fd-text--emphasis')) == 1:
       print('Broken link, skipped')
```

Then, figure 9k illustrates how the program executed the defined functions in code snippet 1 to 5 (figure 9a to 9e) and appended them to the created dataframe.

Figure 9k: code snippet 11

```
    else:
        listingInformation = {
        'City': city,
        'Type': type,
        'PC6': get_postcode(listingSoup),
        'adres': get_adres(listingSoup),
        'woningtype': get_woningtype(listingSoup),
        'label': get_label(listingSoup),
        'bouwsoort': get_bouwsoort(listingSoup),
        'bouwjaar': get_bouwjaar(listingSoup),
        'woonlagen': get_woonlagen(listingSoup),
        'kamers': get_kamers(listingSoup),
        'badkamers': get_badkamers(listingSoup),
        'perceel': get_perceel(listingSoup),
        'oppervlakte': get_oppervlakte(listingSoup),
        'prijs': get_prijs(listingSoup, type),
                'aangeboden_sinds':  get_aangeboden_
sinds(listingSoup, type),
        'verkoopdatum': get_verkoopdatum(listingSoup,
type),
        'Scraped on': get_scraped_on()
        }

        df.loc[len(df)] = listingInformation
```

Figure 9l illustrates the last snippet of relevant code. After every listing that is scraped, the variable 'CountTotal' is increased with 1 so that the program knows when the amount of listings scraped reaches the total amount of listings. Furthermore, after 15 listings scraped, the program needs to navigate to the next page on Funda. Therefore, the base url is altered and the program is run again for the next page. Lastly, After every listing scraped, the program is told to 'sleep' for 1 second. This is done to resemble human behaviour and not act in a harmful manner towards the website of Funda (paragraph 3.2.1).

Figure 9l: code snippet 12

```
      countTotal += 1
      countTotalOnPage += 1
      print(countTotal)

      if countTotalOnPage == 15:
        countPages += 1
       print(f'All listings on page {countPages} have
been scraped')
        countTotalOnPage = 0
              paginationList  =  pageSoup.find('nav',
class_='pagination')
          nextPageText = paginationList.find_all('a')
[-1]
        if nextPageText != url:
          url = base_url + nextPageText['href']

      time.sleep(1)
```

3.3 Data analysis

The method behind the analysis of the data collected in paragraph 3.2 is featured in the following paragraphs. A distinction is made between a more descriptive analysis that illustrates how buy-to-let purchases were identified and a statistical analysis that compares the difference in the square meter price/rents between different areas in Rotterdam.

3.3.1 Buy-to-let identification

In an effort to provide an integral descriptive analysis, it was first important to distinguish which transactions took place in which neighbourhoods, and if they were included in the buy-up protection. Therefore, first, a dataset had to be prepared that featured all postal codes that are found within the municipality of Rotterdam, together with a value if they belong in a buy-up protection neighbourhood. This required a manipulation of a dataset provided by the CBS which contains all postal code areas and the neighbourhood and municipality they belong to (CBS, 2022c). Figure 10 illustrates this manipulation of the dataset, with the end result being a csv called 'PC6Rotterdam' that contains all postal code areas in Rotterdam, together with the neighbourhood they are found in and if that neighbourhood is a buy-up protection neighbourhood (Gemeente Rotterdam, 2021).

Figure 10: Code to manipulate the CBS dataset containing postal code areas in a usable dataset for this research

```
import pandas as pd

dfBuurten = pd.read_csv('Datasets\Losse datasets\
PC6\\brt2022.csv', sep= ';', header=0)

municipality = 'Rotterdam'
opkoopbeschermingWijkenLijst = {'Rotterdam':
[5990531, 5990532, 5991081, 5991572, 5991289,
5990661, 5991082, 5990842, 5990841, 5991449, 5990325,
5990324, 5991574, 5990327, 5990814, 5991571]}
opkoopbeschermingWijken = opkoopbeschermingWijkenLij
st['Rotterdam']

dfBuurtenSelection = dfBuurten[dfBuurten['GM_NAAM']
== municipality]
dfBuurtenSelection['opkoopbescherming'] = dfBuurtenS
election['buurtcode2022'].apply(lambda x: 1 if x in
opkoopbeschermingWijken else 0)

dfPC6 = pd.read_csv('Datasets\Losse datasets\PC6\
pc6hnr20220801_gwb.csv', sep= ';', header=0)
dfPC6Selection = dfPC6[dfPC6['Gemeente2022'] == 599]
# 599 = Rotterdam

dfMerge = pd.merge(dfPC6Selection,
dfBuurtenSelection, left_on='Buurt2022', right_
on='buurtcode2022', how='outer')
dfClean = dfMerge[['PC6', 'Buurt2022',
'Gemeente2022', 'opkoopbescherming']]

dfClean.to_csv('Datasets\Losse datasets\PC6\
PC6Rotterdam.csv', index=False)
```

After having identified which transactions occurred in which neighbourhood, and if that neighbourhood is a buy-up protection neighbourhood, buy-to-let transactions could be identified. Figure 11 illustrates the code that was used to identify buy-to-let purchases within the municipality of Rotterdam. Firstly, the dataset of the transactions (paragraph 3.2) and the dataset of the neighbourhoods of Rotterdam (figure 10) were loaded in into one data frame, which was cleaned so that it only contains the necessary information. Subsequently, a check was executed to see per sale transaction, if a rental transaction occurred afterwards. These sale transactions were then assigned a value to indicate that they are buy-to-let purchases. Lastly, these buy-to-let purchases were grouped based on the date of the transaction, splitting between before the implementation of the buy-up protection and after the implementation.

Figure 11: Code to identify buy-to-let transactions in the municipality of Rotterdam

```
import pandas as pd

def identifyBuyUp(datasetTransactions,
datasetNeighbourhoods):
  df = pd.read_excel(datasetTransactions)
    dfNeighbourhoods = pd.read_
csv(datasetNeighbourhoods)

  df = pd.merge(df, dfNeighbourhoods, left_on='PC6',
right_on='PC6', how='left')
  df = df.drop_duplicates()
  df = df[df['opkoopbescherming'].notna()]
  df['municipality'] = 'Rotterdam'
    df = df[['adres', 'Type', 'verkoopdatum',
'opkoopbescherming']]
  df['verkocht'] = df['Type'].apply(lambda x: 1 if x
== 'verkocht' else 0)
  df['verhuurd'] = df['Type'].apply(lambda x: 1 if x
== 'verhuurd' else 0)

  countAdresses = df.groupby('adres').size()
   multipleMentions = countAdresses[countAdresses >
1].index.tolist()
    dfMultipleMentions = df[df['adres'].
isin(multipleMentions)]
    dfPivot = pd.pivot_table(dfMultipleMentions,
values=['verkocht', 'verhuurd'], index=['adres'],
aggfunc=sum)

   buyToLetAdresses = dfPivot[(dfPivot['verhuurd'] >
0) & (dfPivot['verkocht'] > 0)]
  buyToLetAdresses = buyToLetAdresses.reset_index()
   buyToLetAdressesList = buyToLetAdresses['adres'].
tolist()

    df['buyToLet'] = ((df['Type'] == 'verkocht')
&      (df['adres'].isin(buyToLetAdressesList))).
astype(int)
      df['naInvoeringWet'] = pd.to_
datetime(df['verkoopdatum']) >= pd.to_
datetime('2022-01-01')
```

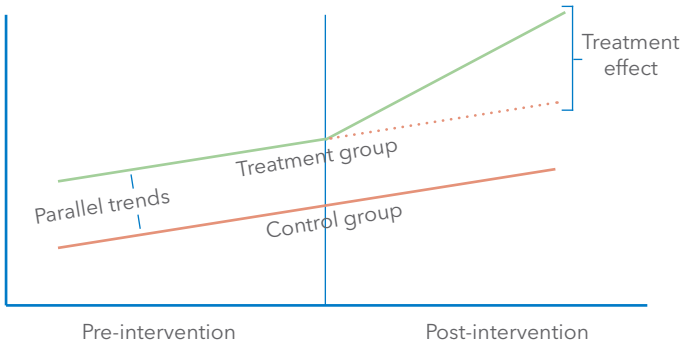
Continues on next page >

```
    df['naInvoeringWet'] = df['naInvoeringWet'].
astype(int)

        dfPivotBuyToLet = pd.pivot_table(df,
values=['verkocht', 'buyToLet'],
index=['opkoopbescherming', 'naInvoeringWet'],
aggfunc=sum)
  dfPivotBuyToLet = dfPivotBuyToLet.reset_index()
  dfPivotBuyToLet['percentageBuyToLet'] = round(dfPiv
otBuyToLet['buyToLet'] / dfPivotBuyToLet['verkocht']
* 100, 2)

  return dfPivotBuyToLet

result = identifyBuyUp('Datasets\Provincie Zuid
Holland volledig.xlsx', 'Datasets\Losse datasets\
PC6\PC6Rotterdam.csv')
```

3.3.2 Difference-in-Difference analysis

To assess to what extent the buy-up protection was influential in reducing housing unaffordability, a Difference-in-Difference [DiD] analysis was executed. In short, this method compares the difference in the development of trends between a treatment group and a control group to determine the effectiveness of a 'treatment' (Goodman-Bacon, 2021). This entails a comparison of the post-treatment state and the pre-treatment state of a treatment group and a relativisation to these states of a control group (Figure 13). The difference between the observed treatment group and the unobserved counterfactual outcome trend based on the control group is then considered to be the treatment effect (Joselin & le Maux, 2017). This method of analysis stems from the field of clinical research (Callaway & Sant'Anna, 2021; Dimick & Ryan, 2014; Athey & Imbens, 2017), but also has been applied frequently in the field of policy research (Wing et al., 2018; Stuart et al., 2014; Dimick & Ryan, 2014).

Figure 12: Examle of DiD analysis



Source: Columbia, n.d. (Edited)

In terms of this research, a causal relation is established by comparing the trend in square meter prices/rents between the treatment group (the 16 neighbourhoods receiving the buy-up protection) and the control group (the 51 other neighbourhoods in the municipality of Rotterdam).

However, For the DiD to be able to properly provide information surrounding causal effects, it is important that the research subjects abide by the parallel trend assumption. This assumption entails that if the treatment group did not receive its treatment, it would develop in a parallel manner to the control group (Athey & Imbens, 2017). In the words specific to this case, if the 16 neighbourhoods did not have the policy implemented, the square meter price/rent would develop parallel to the square meter price of the other 51 neighbourhoods in the control group. In DiD analyses, this assumption is often satisfied by referring to the trends in the pre-treatment state of the dataset (Autor, 2003; Callaway & Sant'Anna, 2021). In terms of this research, this implies observing if before the first of January 2022, the square meter price/rent developed the same in the neighbourhoods which would receive the buy-up protection and those which did not.

Furthermore, it is worth noting the following points surrounding the validity of using DiD analysis within the complex social reality of the housing market with the presence of an abundance of possible influences in square meter prices. Where a general multiple regression establishes causality by trying to capture all these possible influences as control variables (Zou et al., 2003), the DiD method disregards the need for this by establishing causality through the implementation of control *observations* (in the case of this research, neighbourhoods). In other words, the results of this research do not suffer under the consequences of the fluctuating policy-climate regarding the housing market. Contemporary policies/trends such as transfer tax increases (Kadaster, 2021), inflation (van Oirschot, 2023), rental regulations in the middle-expensive sector (Pragt & Korthout, 2023) and many more affect *all* neighbourhoods, while exclusively the buy-up protection influences only some neighbourhoods. Therefore, as long as the parallel trend assumption is met, it is a valid claim to conclude that the 'treatment effect' is a fair representation of a causal relation between the buy-up protection and square meter prices (Goodman-Bacon, 2021, Joselin & Le Maux, 2007).

In this research, The DiD analysis was conducted along the following method illustrated in figure 14. Firstly, the dataset of the transactions (paragraph 3.2) and the dataset of the neighbourhoods of Rotterdam (figure 10) were loaded in into one data frame, which was cleaned so that it only contains the necessary information. Subsequently, the dates of sale were grouped into the month that they occurred in. Furthermore, a square meter price was calculated based on the variables of 'surface area' and 'price', and outliers (more than 3 std. deviations) were removed. Then, a loop was executed twice, one for transactions in the buy-up protection neighbourhoods and one for transactions not in buy-up protection neighbourhoods. For both groups, three time stamps were identified:

1. t1 = The average square meter price of transactions *before* the buy-up protection took effect
2. t2 = The average square meter price of transactions at the date of implementation
3. t3 = The average square meter price of transactions after the date of implementation

To identify the 'treatment' effect, the post treatment percentual change (t3/t2) of buy-up protection neighbourhoods was then subtracted by the post treatment percentual change (t3/t2) of the non buy-up protection neighbourhoods. Lastly, the difference between the pre treatment percentual change (t2/t3) of both the treatment and control group was checked to see if the parallel trends assumption was abided by in this dataset.

As the concept of housing affordability is indicated by both the change in prices for owner-occupier housing and rental units, the DiD analysis was executed twice. Firstly, the code as illustrated in figure 13 was executed to conduct a DiD analysis of the prices for owner-occupier housing. Afterwards, the line 'df = df[df['Type'] == 'verkocht']' was changed to 'df = df[df['Type'] == 'verhuurd']', to apply the DiD analysis for the change in rental prices.

Figure 13: Code used to execute the DiD analysis

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

def DiD(datasetTransactions, datasetNeighbourhoods):
  df = pd.read_excel(datasetTransactions)
            dfNeighbourhoods       =       pd.read_
csv(datasetNeighbourhoods)

  df = pd.merge(df, dfNeighbourhoods, left_on='PC6',
right_on='PC6', how='left')
  df = df.drop_duplicates()
  df = df[df['opkoopbescherming'].notna()]
  df['municipality'] = 'Rotterdam'
   df  =  df[['municipality',  'Type',  'verkoopdatum',
'prijs', 'oppervlakte', 'opkoopbescherming']]
  df = df[df['Type'] == 'verkocht']

            df['verkoopdatum']       =       pd.to_
datetime(df['verkoopdatum'])
  df = df[df['verkoopdatum'] >= '2021-05-01']
  df['month'] = df['verkoopdatum'].dt.to_period('M')

      df['prijs']    =    pd.to_numeric(df['prijs'],
errors='coerce')
 df['oppervlakte'] = pd.to_numeric(df['oppervlakte'],
errors='coerce')
       df.dropna(subset=['prijs',    'oppervlakte'],
inplace=True)
  df['prijsPerM2'] = df['prijs'] / df['oppervlakte']
      z_scores    =    np.abs((df['prijsPerM2']    -
df['prijsPerM2'].mean()) / df['prijsPerM2'].std())
  df = df[z_scores < 3]

  i = 0
  while i < 2:
    dfSplit = df[df['opkoopbescherming'] == i]
        dfSplitAverage   =   dfSplit.groupby('month')
['prijsPerM2'].mean()
    dfSplitAverage = dfSplitAverage.reset_index()

    t1 = dfSplitAverage.loc[0:6, 'prijsPerM2'].mean()
    t2 = dfSplitAverage.loc[7, 'prijsPerM2'].mean()
    t3 = dfSplitAverage.loc[8:, 'prijsPerM2'].mean()
     preTreatmentChangePercentual = round(t2/t1*100)
- 100
    postTreatmentChangePercentual = round(t3/t2*100)
- 100

    if i == 0:
      NonBuyUpProtectionPreTreatmentChangePercentual
= preTreatmentChangePercentual
     NonBuyUpProtectionPostTreatmentChangePercentual
= postTreatmentChangePercentual
    elif i == 1:
       buyUpProtectionPreTreatmentChangePercentual =
preTreatmentChangePercentual
      buyUpProtectionPostTreatmentChangePercent
ual = postTreatmentChangePercentual
            treatmentEffect = buyUpProtectionPos
tTreatmentChangePercentual - NonBuyUpProtectio
nPostTreatmentChangePercentual
    i += 1
DiDResults  =  DiD('Datasets\Provincie  Zuid  Holland
volledig.xlsx',    'Datasets\Losse    datasets\PC6\
PC6Rotterdam.csv')
```

4. Results

The following paragraphs contain the results of executing the methods described in the preceding chapter. Firstly, several paragraphs are dedicated to describing certain descriptive statistics, with subsequently, a result of the DiD analyses.

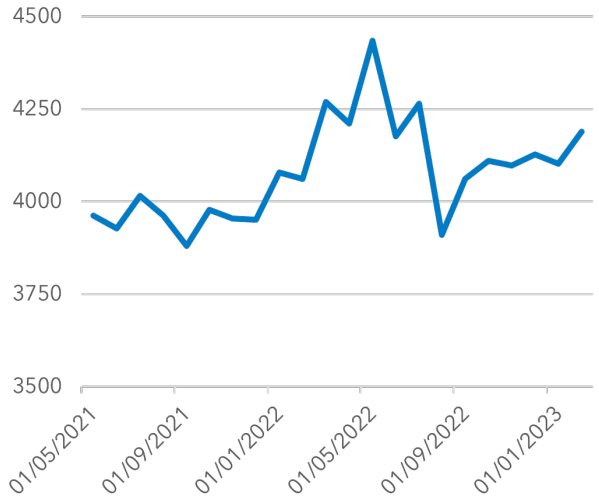
4.1 Descriptive statistics

Figure 14 illustrates all housing transactions that have taken place between the 14th of April 2021 and the 17th of March 2023 in the municipality of Rotterdam. Furthermore, all transactions that have been identified as buy-to-let are marked with an orange colour. What can be noticed is that all buy-to-let transactions have taken place in the east of the municipality of Rotterdam (within the *city* of Rotterdam), and that the villages of Pernis, Hoogvliet, Rozenburg, and Hoek van Holland to the west of the municipality of Rotterdam did not have any buy-to-let transactions.

Furthermore, from a visual analysis of this map, no pattern can be recognized surrounding the amount of buy-to-let transactions in buy-up protection neighbourhoods and non-buy-up protection neighbourhoods. The identified buy-to-let transactions seem to be spread out evenly over the city of Rotterdam.

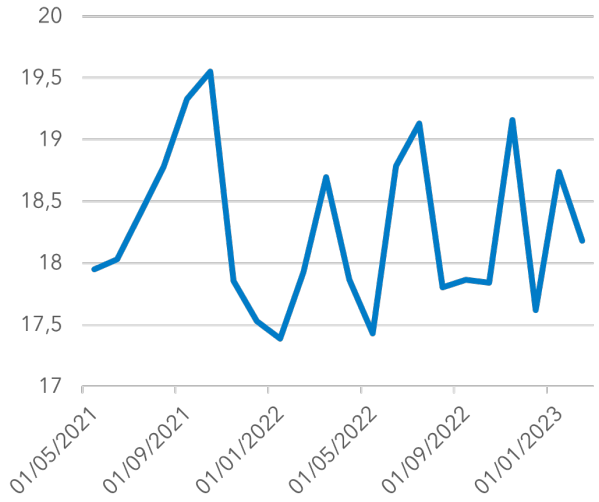
Figure 15 & 16 illustrate the average square meter price/ rent in Rotterdam, generalized per month. After the implementation of the buy-up protection at 1-1-2022, a steep increase followed by a steep decrease is visible regarding owner-occupied house prices, with afterwards the square meter price returning to its original trend. However, it is worth noting that this remark is not a claim for causation, as figure 15 illustrates the average square meter price for the entire municipality. As mentioned in paragraph 3.3.2, a claim for causation would either have to be grounded by applying control variables, or through a DiD as is done in paragraph 4.2. Regarding the average square meter rent in Rotterdam (figure 16), no visual trends are recognized from this descriptive statistic.

Figure 15: The average square meter price in Rotterdam, split out over time (corrected for outliers (>3 st.d. deviations)



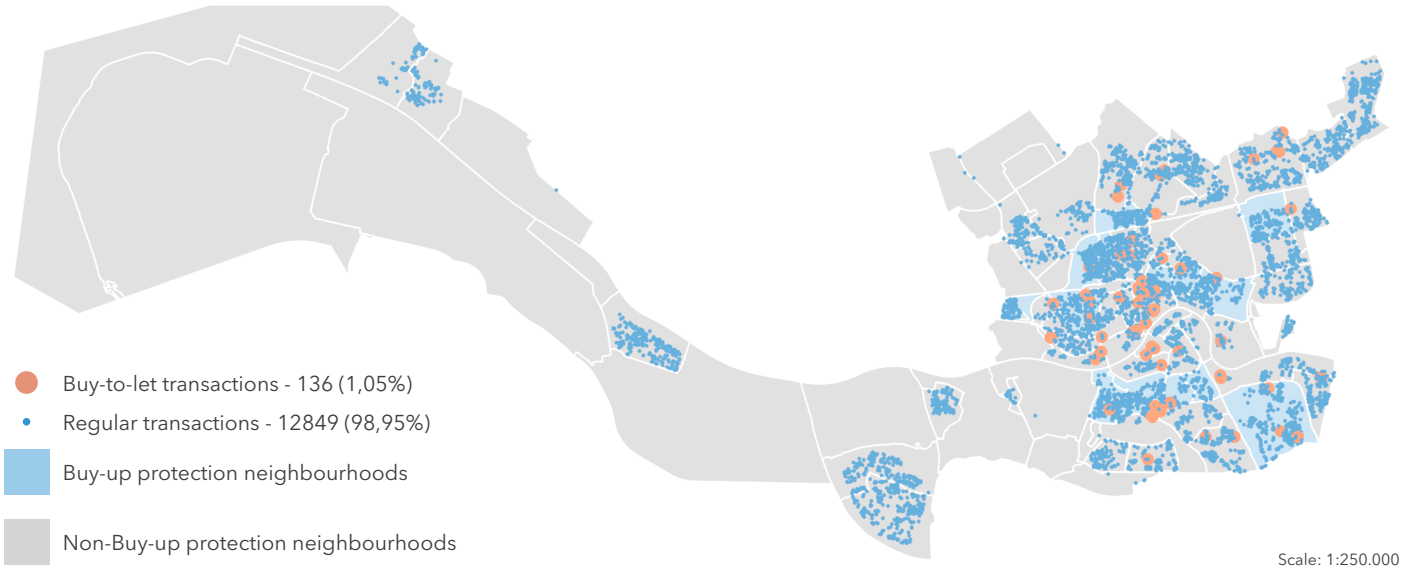
Source: paragraph 3.2 & 3.3

Figure 16: The average square meter rent in Rotterdam, split out over time (corrected for outliers (>3 st.d. deviations)



Source: paragraph 3.2 & 3.3

Figure 14: All housing transactions between the 14th of April 2021 and the 17th of March 2023 in the municipality of Rotterdam, with buy-to-let transactions highlighted



Source: Paragraph 3.2; BZK, n.d.

Figure 17 illustrates the percentage of buy-to-let transactions relative to the total of transactions in buy-up protection [BUP] and non-buy-up protection neighbourhoods, generalized per month. What becomes visible is that the percentage of buy-to-let transactions becomes 0% in buy- up protection neighbourhoods after the implementation of the buy-up protection, but after several months some buy-to-let transactions become apparent again. This can be explained by the fact that, as mentioned in paragraph 2.3, the buy-up protection does not completely prohibit buy-to-let, but features certain exemptions. However, what is noticeable is that the percentage of buy-to-let transactions in buy-up protection neighbourhoods did decrease in a steeper manner than in non-buy-up protection neighbourhoods.

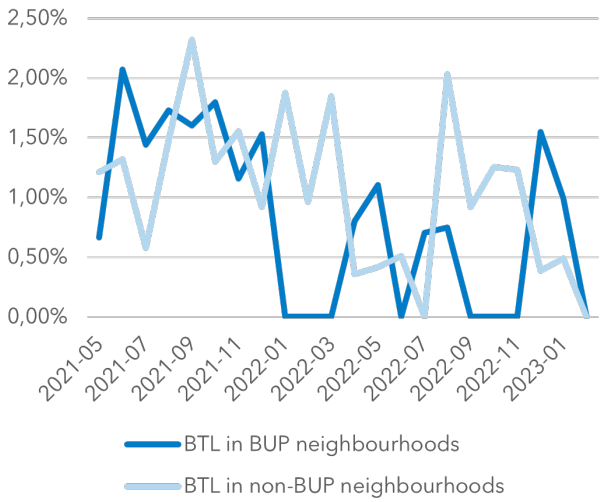
Generalizing the number of buy-to-let transactions in two timestamps, (1) before the implementation of the buy-up protection and (2) after the implementation of the buy-up protection, results in the product illustrated in figure 18. In this figure, the extent to which the buy-up protection has decreased buy-to-let in buy-up protection neighbourhoods becomes clear. However, it also becomes clear that the amount of buy-to-let has decreased in non-buy-up protection neighbourhoods after the implementation of the buy-up protection. This leads to the suggestion that the other factors at play (inflation, middle-expensive rental regulations, transfer taxes, etc. (paragraph 3.3.2) also have limited the amount of buy-to-let purchases in general. In other words, the 1,08% decrease of buy-to-let in buy-up protection neighbourhoods cannot be fully attributed to the buy-up protection.

Furthermore, a sidenote is to be placed surrounding the height of the amount of buy-to-let transactions. With the methods applied in this research, a regular purchase-transactions becomes a buy-to-let transaction when after the purchase-transaction has taken place, also a rental-transaction has taken place (paragraph 3.3). Therefore, if for example a dwelling is bought in November 2022 and rented out in November 2023 (beyond the temporal limits of this research), it still shows up as a regular transaction in this dataset. In other words, the number of buy-to-let purchases illustrated in figure 17 and figure 18 are the lower limit of the bandwidth of possible buy-to-let purchases.

Figure 18: he amount of buy-to-let [BTL] purchases in buy-up protection [BUP] and non-BUP neighbourhoods, split out between before- and after implementation

Neigh-bourhoods	Implemen-tation	Buy-to-let transac-tions	Total transac-tions	Percentual
Non-BUP	Before	43	3351	1,28%
	After	48	5192	0,92%
	Difference	**+5**	**+1841**	**-0,36%**
BUP	Before	23	1505	1,53%
	After	10	2213	0,45%
	Difference	**-13**	**+708**	**-1,08%**

Figure 17: The amount of buy-to-let [BTL] purchases in buy-up protection [BUP] and non-BUP neighbourhoods, split out over time



Source: paragraph 3.2 & 3.3

4.2 DiD analysis

The following paragraphs feature the results of the DiD analysis conducted. Figure 19 and figure 20 illustrate the square meter price/rents in Rotterdam at the defined timestamps (paragraph 3.3). These are, t1: the average square meter price before the implementation of the buy-up protection, t2: the average square meter price at the implementation of the buy-up protection, and t3: the average square meter price after the implementation of the buy-up protection.

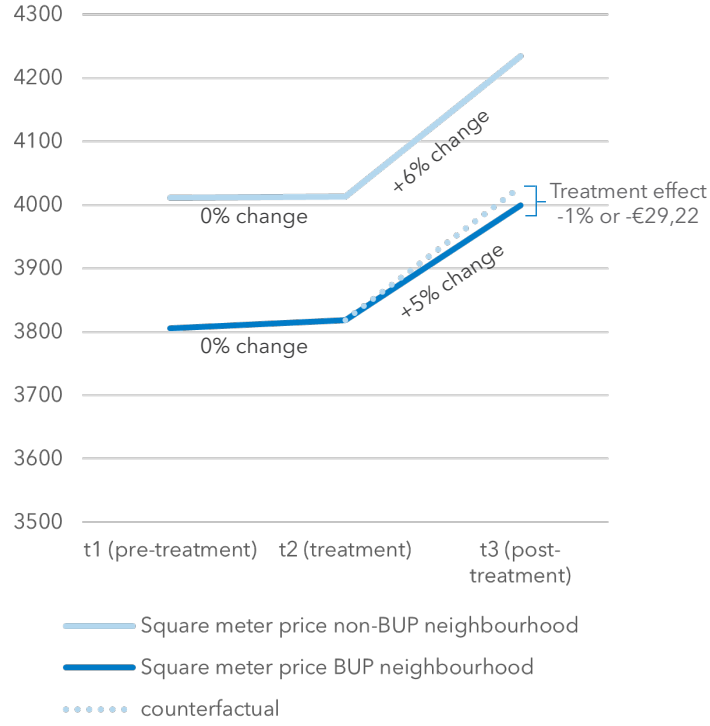
Firstly, it is worth noting the parallel trends assumption. Before the implementation of the buy-up protection, the square meter price/rent developed relatively similarly in both the buy-up protection neighbourhoods and the non-buy- up protection neighbourhoods. Furthermore, while there have been an abundance of national/municipality wide policies implemented that could affect this square meter price/rent (paragraph 3.3), there have been – next to the buy- up protection – no policies implemented in Rotterdam that exclusively affect the 16 neighbourhoods included in the buy-up protection. In other words, it can be assumed that if the buy-up protection was not implemented, the buy-up protection neighbourhoods would develop along the same trend as the non-buy-up protection neighbourhoods.

Regarding the effect of the buy-up protection on square meter *prices,* figure 19 illustrates the counterfactual (the percentual increase noticed in the control group) relative to the observed increase between t3 and t2 in the treatment group. From the difference between the counterfactual and the observed increase, the treatment effect can be derived. This treatment effect is -1% or a square meter price decrease of €29,22. In other words, abiding by the methods and results described in this research, it can be said that the buy-up protection is responsible for stagnating the increase in square meter prices in buy-up protection neighbourhoods with €29,22.

Regarding the effect of the buy-up protection on square meter *rents,* figure 20 illustrates the counterfactual relative

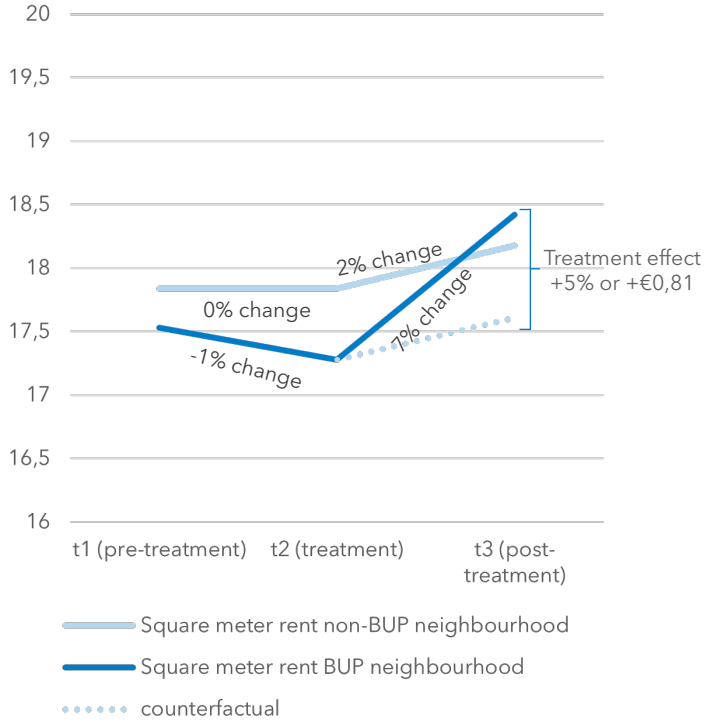
to the observed increase between t3 and t2 in the treatment group. The treatment effect is +5% or a square meter rent *increase* of € 0,81. In other words, abiding by the methods and results described in this research, it can be said that the buy-up protection is responsible for increasing square meter monthly rents in buy-up protection neighbourhoods with € 0,81.

Figure 19: DiD analysis of the average square meter price in Rotterdam



Source: paragraph 3.2 & 3.3

Figure 20: DiD analysis of the aaverage square meter rent in Rotterdam



Source: paragraph 3.2 & 3.3

5. Conclusion and discussion

In this research, two Difference-in-Difference [DiD] analyses were executed to analyse the effect of the implementation of the buy-up protection on the affordability of housing in neighbourhoods of Rotterdam. This analysis was executed to provide an answer on the research question: *"To what extent has the buy-up protection resulted in a reduction of housing unaffordability in Rotterdam?"*. The results of the preceding chapter produce a double-sided answer to this research question, as the buy-up protection was able to slightly flatten the increase of square meter prices of owner occupier housing but on the other hand can be attributed to *increasing* square meter rents in buy-up protection neighbourhoods. Concretely, within the timeframe of this research (up to March 2023), the implementation of the buy-up protection was able to prevent the average square meter price in buy-up protection neighbourhoods from being € 29,22 or 1,01% higher than if the buy-up protection was not implemented. On the other hand, the buy-up protection also resulted in a € 0,81 or 4,67% *increase* in square meter monthly rents in buy-up protection neighbourhoods.

The observed slight effect of the buy-up protection on square meter prices is in line with the theoretic exploration of housing market forces along the 4Q-model (Geltner et al., 2014). As buy-to-let decreased in the buy-up protection neighbourhoods, the demand for housing slightly decreased causing a slight decrease in square meter prices (Bosma et al., 2018). However, the hypothesis that the buy-up protection would have a negative (rent-increasing) effect on the housing market is also correct. Therefore, the effect of the buy-up protection on housing affordability is inconclusive. On the one hand, housing is becoming more affordable because house prices for owner-occupied housing are enduring a less steep increase, but on the other hand the average square meter rent in buy-up protection neighbourhoods did increase, making housing *less* affordable.

Furthermore, it is worth noting that, as suggested in paragraph 2.1, the buy-up protection does not 'solve' the issue of housing unaffordability. If buy-to-let was the sole cause of housing unaffordability, this research would have proven that the buy-up protection would have been able to **decrease** square meter prices, rather than just slightly flattening the increase. Rather, this research validates the complexity of the housing market (Hayek, 1989; Wyman et al., 2013), by illustrating that there are other factors present that share the cause of housing unaffordability. Adhering to this theory of complexity, it is impossible to give an hermetically sealed list of these factors, but in the following paragraphs some examples are discussed.

Firstly, the buy-up protection exclusively prohibits buy-to-let practices and does not prohibit investors from functioning within the neighbourhoods. The existence of other methods of investing in the housing market not prohibited by the buy-up protection could also attribute to housing unaffordability. For example, the method of keep-to-let – purchasing a new dwelling and renting out the old dwelling instead of selling it – has been estimated to contribute to a substantial number of conversions from owner-occupied units into rental units (Hochstenbach & Aalbers, 2023). Secondly, the wide array of possible influences outside of the domain of investor-attention could also potentially attribute to housing unaffordability. Some examples named in this research are the PFAS-crisis (Companen, 2021), household-size reductions (Groenemeijer et al., 2021), inflation (van Oirschot, 2023), but, again adhering to theories of complexity (Hayek, 1989), these possible influences on housing unaffordability are innumerable. Thirdly, the wide possibility of influences within an infinitely connected network also implies that even though this research has proven that the buy-up protection was able to slightly flatten the increase in square meter prices, the possibility of the buy-up protection negatively influencing housing unaffordability cannot be excluded. For example, investors are a substantial client of new construction projects and can be an assurance for housing developers that their constructed dwellings will be sold (Michielsen et al., 2019). If this assurance is omitted for housing developers the possibility for delays increases as generally housing developers will not start construction before around 70% of dwellings are sold (Borovitskaya, 2023). In the long-term, this can result in further shortages on the housing market, and a steeper increase in square meter prices. In other words, while this research has proven a short-term flattening of the increase in square meter prices due to the buy-up protection, it cannot be ruled out that this trend will be inverted in the long-term.

In summary, to reflect on the stated hypotheses in paragraph 2.5, the first hypothesis that the buy-up protection has a positive effect on the owner-occupier housing market is correct, but the hypothesis that the buy-up protection has a negative effect on the rental market is also correct. Furthermore regarding the last hypothesis, this research can neither prove or disprove that the buy-up protection has a negative effect on both markets in the long term. Confirming or disproving this hypothesis would require research with a longer timeframe. Therefore, exclusively anecdotal evidence from project developers regarding the incentive to develop housing can be used (NEPROM, 2023; Borovitskaya, 2023).

The main normative question following this conclusion is therefore; is the observed slight positive effect on owner-occupier house prices proportional relative to the negative effects of the policy? These negative effects include the in this research observed negative effect on the rental market, the in this research theorized effects on construction rates and demographic/social problems of reducing the share of the liberalized rental market, but also a more ideological problem regarding the justification of infringing on property rights for the 'public interest'. With the number of negative sides to the buy-up protection, is it still possible to argue that the buy-up protection functions in the public interest?

Providing an integral answer to this question is unattainable as it is not a matter of simply subtracting different variables to provide a numerical conclusion, but it is about weighing up different variables that are either not quantifiable or quantified in a different manner. In other words, it is impossible to subtract the quantifiable effect of the buy-up protection on square meter prices from the qualitative effect the buy-up protection has on the infringement of property rights.

However, a key normative interpretation of the conclusions of this research is that implementing the buy-up protection should be done with proper caution and research, instead of an 'as fast as possible' approach to exercise symbol politics (Hanff, 2022). The contemporary ethos of the general public regarding the housing market in the sense that every investor in the housing market is 'bad' should not be adopted by policy makers without any further consideration. This research has shown that while limiting the abilities of investors in the housing market has certain positive elements to it, the limitation of investors in the housing market also has negative effects on society. The job of the policymaker is to rationalize the public prejudice against investors and develop well-advised policies that also take into account the negative side of implementing policies, rather than implementing anything that the general public desires. While this paragraph does not necessarily argue that the buy-up protection is 'symbol politics', policymakers do need to properly consider all aspects of the policy to not reduce themselves to exercising symbol politics.

5.1 Limitations

However, the above presented conclusions endure certain limitations that merit further elucidations. Firstly, the source holder of the data – Funda – is not an 'official' source of transaction data. Funda is a collaboration effort of a substantial group of real-estate brokers which are estimated to contain 95% of all transactions in the housing market (Imperva, 2019). Therefore, the limitation is found in this missing 5% of transactions that could potentially influence the analyses conducted in this research. Furthermore, another limitation of using Funda for transaction data is that Funda exclusively provides the listed price of transactions instead of the actual transaction value. An argument could be made that the lack of actual transaction values influences the analysis as the Netherlands has endured a turbulent period with substantial differences between the listed- and actual transaction price. However, these differences have shown that, while turbulent, they have remained relatively consistent within the borders of a municipality (CBS, 2022d). In other words, if this difference increased in one neighbourhood, this also increased in another neighbourhood within the same municipality. Therefore, while the square meter prices observable in the results of this research might be slightly different than the actual transaction square meter prices, it is a valid assumption that this variance of the square meter prices between neighbourhoods is negligible, and thus does not heavily influence the results of the analysis itself.

To solve the above-mentioned limitation regarding the usage of Funda as a data source is to use an 'official' governmental source of transactions (Kadaster, n.d.). The usage of this data source was not feasible for this research as, contemporarily, it is found behind a substantial paywall. However, as EU-incentives such as the INSPIRE-movement are pushing for governments to fully open up their data (van Loenen et al., 2018), this data might become open-source in the future allowing for the application of this research with official data.

A further limitation is found in the temporal aspect of this research. If data was collected for a longer period before the implementation of the buy-up protection, the assumption of parallel trends for the DiD analysis could have been proven in a more robust manner. Furthermore, all non-buy-to-let transactions featured in this research still have the possibility to become buy-to-let transactions, as this is defined as a dwelling being rented out after the transaction of the dwelling. For example, if a dwelling bought in January 2023 (within the temporal limits of this research) is rented out in July 2023 (outside the temporal limits of this research), the original sale was a buy-to-let transaction, but could not be identified as such in this research. A recommendation to solve this limitation is to execute this research again in four years, as this is the temporal limit for the buy-up protection prohibiting an individual property from being rented out. Four years from the publication of this research, all transactions featured in this research are free from the buy- up protection, and could possibly be rented out again.

5.2 Policy recommendations

Lastly, the following paragraphs feature a policy recommendation based on the results of this research. This research has proven that the buy-up protection was effective in flattening the increase in square meter prices by a certain extent, but has also *increased* the square meter rents. Therefore, it should not be assumed that the buy-up protection deterministically works 'in favour of' housing affordability. If a municipality can argue for a slight flattening of the increase of square meter prices at the cost of an increase in square meter rents, it can still be recommended to apply the buy-up protection policy. However, if a municipality encounters problems in affordability in both the owner-occupier housing market and the rental market the justification for implementing the buy-up protection becomes questionable.

Furthermore, it is worth noting that the scope of this research is exclusively based around the effect of the buy-up protection on square meter prices/rents, not on a general 'effect' on society. Therefore, the results of this research cannot function as an integral justification for the continuation of the buy-up protection in Rotterdam. In other words, while this research has proven a positive

effect of the buy-up protection on square meter prices and a negative effect on square meter rents, this does not imply that there are no other effects of the buy-up protection. For example, the long-term economic effects or the general social/demographic effects of reducing the liberalized rental supply of housing have been theorized to be a potential issue in this research, and would require further research.

The key policy recommendation is therefore to apply the results of this research within a larger framework of buy-up protection related research. As the housing market consists of a complex interplay between innumerable factors (Wyman et al., 2013; Hayek, 1989), the scientific evaluation of policies is never 'finished'. The existence of yet another possible influence of the policy can never be ruled out.

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Appendix

Municipality	Municipal code	Implementation date	Up to WOZ	Areas	Municipal specific regulations	Fines
Haarlem	GM0392	01/01/2022	389000	all	Housing corporation	1st offence: 12500, 2nd offence: 20500
Rotterdam	GM0599	01/01/2022	405000 (NHG)	0531 Bergpolder, 0532 Blijdorp, 1081 Bloemhof, 1572 Carnisse, 1289 Ijsselmonde, 1449 Het Lage Land, 0661 Hillegersberg-Zuid, 1082 Hillesluis, 0842 Kralingen-Oost, 0841 Kralingen-West, 0325 Middelland, 0324 Nieuwe Westen, 0327 Oud Mathenesse, 1574 Oud-Charlois, 0814 Rubroek, T1571 Tarwewijk	Housing corporation, municipal-bought, bought commissioned by the municipality, Health-care specific rental	1st offence 8000, 2nd offence 12000, 3rd offence 18500, 4th offence 21750
Den Helder	GM0400	28/01/2022	250000	Centrum, Visbuurt, Van Galenbuurt, Oostsloot	Vacancy law, housing corporations	1st offence 21750, 2nd offence 87000
Wageningen	GM0289	17/02/2022	405000 (NHG)	28909 Binnenstad/Centrum, 028907 Boven- en benedenbuurt, 02890603 de Buurt-West, Nude 28908	bought (commissioned) by the municipality, bought by corporation, bought by health care provider	
Arnhem	GM0202	26/02/2022	325000	Arnhemse Broek, Centrum,De Laar, Elderveld, Elden, Geitenkamp, Heijenoord/Lombok, Klarendal, Malburgen-Oost (Noord), Malburgen-Oost (Zuid), Malburgen-West, Monnikenhuizen, Presikhaaf-Oost, Presikhaaf-West, Rijkerswoerd, Schuytgraaf, Spijkerkwartier, St. Marten/Sonsbeek-Zuid, Velperweg e.o., Vredenburg/Kronenburg,	Owned by municipality or bought by a company commissioned by the municipality	1st offence 21750, 2nd offence 87000
Groningen	GM0014	01/03/2022	305500	all except housing on the 2019 municipal organisation municipality 'Ten Boer'		??
's-Gravenhage	GM0518	01/03/2022	405000 (NHG)	all	Transformed housing	??
Dordrecht	GM0505	11/03/2022	405000 (NHG)	all	Not for: housing corporations, municipality-owned, health-related companies	
Utrecht	GM0344	18/03/2022	440000 (60%)	all	Buy-up protection not for: 1) housing corporations & 2) new construction	1st offence (particular): 7500, 1st offence (company): 12500, 2nd offence (both): 18500
Amersfoort	GM0307	24/03/2022	343000	all	Not for: bought in assignment of municipality or by health-care provider	??
Amsterdam	GM0363	01/04/2022	533000 (60%)	all	partial rent (living somewhere and renting out part of your house)	1st offence 21750, 2nd offence 50000
Eindhoven	GM0772	01/04/2022	405000 (NHG)	Almost everything, see: https://lokaleregelgeving.overheid.nl/CVDR631293/2	Not for: Housing corporations, new (rental) construction	1st offence 21750, 2nd offence 87000
Nieuwegein	GM0356	04/05/2022	440000 (Utrecht 60%)	Batau-noord, Batau-zuid, Blokhoeve, Doorslag, Fokkesteeg, Galecop, Hoogzandveld, Huis de Geer, Jutphaas Wijkersloot, Lekboulevard, Merwestein, Rijnhuizen, Stadscentrum, Vreeswijk, Zandveld, Zuilenstijn	New construction projects where owner & municipality have a different agreement, exemption when argued necessary by the lawmakers.	1st offence (particular): 7500, 1st offence (company): 12500, 2nd offence (both): 18500
Lopik	GM0331	18/05/2022	521000	all	municipality or 'toegelaten instelling'	1st offence (particular): 7500, 1st offence (company): 12500, 2nd offence (both): 18500
Sliedrecht	GM0610	19/05/2022	405000 (NHG)	all	Housing corporation or municipality owned	??
Almere	GM0034	24/05/2022	405000 (NHG)	all		22500, 90000
Bloemendaal	GM0377	01/06/2022	600000 (index)	all		12500, 20500

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Zeist	GM0355	01/06/2022	521000 (indexed)	Zeist-Oost, Zeist-west, Zeist-centrum, Zeist-Noord, Austerlitz, Bosch en duin, Den dolder, Huis ter heide	municipality or 'toegelat-en instelling'	??
Diemen	GM0384	22/06/2022	512000	all	municiipality or housing coroporation	8000, 21750
's-Hertogen-bosch	GM0796	01/07/2022	260000	all	Not for: housing corporations, municipal-ity, municipality-associated companies, health care providers	
Gouda	GM0513	01/07/2022	405000 (NHG)	all	housing corporations municipality	??
Amstelveen	GM0362	01/07/2022	440000	all	municipality or housing corporation	22500, 90000
Bunnik	GM0312	01/07/2022	487000 (60% meth-od)	all		??
Waalwijk	GM0867	01/07/2022	344500	Centrum, Besoyen, Antoniusparochie, landgoed Driessen		??
Tilburg	GM0855	01/09/2022	NHG	all	municipality or housing corporation	4000, 8000, 12000, 22500
Zwijndrecht	GM0642	21/09/2022	NHG	all	municipality or housing corporation	??
Maastricht	GM0935	01/10/2022	405000 (NHG)	all		22500, 45000
Zandvoort	GM0473	08/10/2022	438000	all	municipality or 'toegelat-en instelling'	??
Alblasser-dam	GM0482	13/10/2022	NHG	all	Housing corporation or municipality owned	??
Deventer	GM0150	26/10/2022	355000	binnenstad, voorstad, rivierenwijk, keizerslanden, zandweerd, colmschate-Noord, Colmschate-Zuid	Housing corporations, municipality owned, new construction	??
De Bilt	GM0310	26/10/2022	487000 (60% meth-od)	all	municipality or 'toegelaten instelling'	
Oss	GM0828	02/11/2022	405000 (NHG)	Schadewijk, Ruwaard, Oss zuid, Knikkelhoek & Ussen	housing corporations, municipality owned,	?
Nijmegen	GM0268	16/11/2022	350000	all	housing corporations, municipality owned,	all 22500
Hengelo	GM0164	01/01/2023	405000 (NHG)	Binnenstad, Woolde & Groot Driene)	Municipality-owned, housing corporation or health-care provider & new-housing excluded	??
Enschede	GM0153	01/01/2023	288000	Binnensingelgebied, Hogeland, Boswinkel-Stads-veld, Twekkelerveld, Enschede-noord, En-schede-Zuid	municipality or housing corporation	1st: 12000, 2nd: 22500, 3rd: 90000
Capelle aan den Ijssel	GM0502	02/Jan	405000 (NHG)	Middelwatering Oost, Oostgaarde Noord, Schenkel, Middelwatering West, Schollevaar Zuid		1st: 21750, 2nd: 87000
Lopik	GM0331	18/01/2023	440000	all	municipality or allowed organisation	1st: 7500, 2nd: 18500
Venlo	GM0983	01/02/2023	306000	18 neighbourhoods, see source	municipality, health-care provider	1st: 21750, 2nd: 87000
Schiedam	GM0606	15/02/2023	355000	Wijk Oost, Wijk Nieuwland		
Woudenberg	GM0351	01/03/2023	405000 (NHG)	De grift, Het groene woud, Het Zeeland, Laanzicht, Nico Bergstijn, Nieuwoord	Municipality, housing corporation, in asssign-ment of municipality, etc.	1st: 22500, 2nd: 90000
Schouw-en-Duiven-land	GM1676	07/03/2023	355000	Bruinisse, Ouwekerk, Scharendijke, Zierikzee, Burgh-Haamstede & Renesse	municipality or housing corporation	1st: 22500, 2nd: 90000
Vlaardingen	GM0622	23/03/2023	300000	Centrum, Westwijk, Oostwijk, Vlaardinger Am-bacht, Holy zuid, Holy Noord	new construction	1st: 15000, 2nd: 30000
Utrechtse heuvelrug	GM1581	11/04/2023	487000 (60% meth-od)	Amerongen, Doorn, Driebergen-Rijsenburg, Leer-sum, Maarn, Maarsbergen, Overberg	municipality or health-care provider	

Appendix 2: Full code of web scraper application

```
from bs4 import BeautifulSoup
import requests
import pandas as pd
import time
import datetime
import re

def scraper(city, type):
  # Functions to help clean data
  def replace_months(i):
    i = i.replace(‘ januari ‘, ‘/01/’)
    i = i.replace(‘ februari ‘, ‘/02/’)
    i = i.replace(‘ maart ‘, ‘/03/’)
    i = i.replace(‘ april ‘, ‘/04/’)
    i = i.replace(‘ mei ‘, ‘/05/’)
    i = i.replace(‘ juni ‘, ‘/06/’)
    i = i.replace(‘ juli ‘, ‘/07/’)
    i = i.replace(‘ augustus ‘, ‘/08/’)
    i = i.replace(‘ september ‘, ‘/09/’)
    i = i.replace(‘ oktober ‘, ‘/10/’)
    i = i.replace(‘ november ‘, ‘/11/’)
    i = i.replace(‘ december ‘, ‘/12/’)
    return i

  def contains_number(string):
    return any(char.isdigit() for char in string)

  # Functions that gather specifc data from housing page
  def get_scraped_on():
    return datetime.datetime.now().strftime(“%d/%m/%Y”)
  def get_postcode(woning_pagina):
    locatie_ruw = woning_pagina.find(‘span’, class_=’object-header__subtitle fd-color-dark-3’)
    if len(locatie_ruw.find_all(‘a’, class_=’fd-m-left-2xs--bp-m fd-display-block fd-display-inline--bp-m’)) == 1:
      locatie_ruw.find(‘a’, class_=’fd-m-left-2xs--bp-m fd-display-block fd-display-inline--bp-m’).extract()
    postcode = locatie_ruw.text[:8].strip()
    postcode = postcode.replace(‘ ‘, ‘’)
    return postcode

  def get_oppervlakte(woning_pagina):
    oppervlakte_ruw = woning_pagina.find(string=’Wonen’)
    if oppervlakte_ruw != None:
      oppervlakte_ruw2 = oppervlakte_ruw.find_next(‘span’).text
      oppervlakte = int(‘’.join(re.findall(r’\b\d+\b’, oppervlakte_ruw2)))
    else:
      oppervlakte_ruw = woning_pagina.find(string=’Oppervlakte’)
      if oppervlakte_ruw != None:
        oppervlakte_ruw2 = oppervlakte_ruw.find_next(‘span’).text
        if ‘/’ in oppervlakte_ruw2:
          oppervlakte_ruw2 = oppervlakte_ruw2.split(‘/’)[0]
        oppervlakte = int(‘’.join(re.findall(r’\b\d+\b’, oppervlakte_ruw2)))
      else:
        oppervlakte = ‘??’
    return oppervlakte

  def get_woningtype(woning_pagina):
    woning_type_ruw = woning_pagina.find(string=’Soort woonhuis’)
    if woning_type_ruw != None:
      woning_type = woning_type_ruw.find_next(‘span’).text
      return woning_type
    else:
      woning_type_ruw = woning_pagina.find(string=’Soort appartement’)
      if woning_type_ruw != None:
        woning_type = woning_type_ruw.find_next(‘span’).text
```

```
      return woning_type
    else:
      woning_type = '??'
      return woning_type

def get_prijs(woning_pagina, type):
  if type == 'verkocht':
    prijs_ruw = woning_pagina.find(string='Laatste vraagprijs')
    if prijs_ruw != None:
      prijs = prijs_ruw.find_next('span').text
    else:
      prijs = '??'
  elif type == 'koop':
    prijs_ruw = woning_pagina.find(string='Vraagprijs')
    prijs = prijs_ruw.find_next('span').text
  elif type == 'verhuurd':
    prijs_ruw = woning_pagina.find(string='Laatste huurprijs ')
    if prijs_ruw != None:
      prijs = prijs_ruw.find_next('dd').text
    else:
      prijs = '??'
  elif type == 'huur':
    prijs_ruw = woning_pagina.find(string='Huurprijs ')
    prijs = prijs_ruw.find_next('dd').text
  else:
    prijs = '??'
  if 'servicekosten' in prijs:
    prijs = prijs[:-30]
  if contains_number(prijs):
    prijs = int(''.join(re.findall(r'\b\d+\b', prijs)))
  else:
    prijs = 'Prijs op aanvraag / bij inschrijving'
  return prijs

def get_adres(woning_pagina):
  adres = woning_pagina.find('span', class_='object-header__title').text.strip()
  return adres

def get_aangeboden_sinds(woning_pagina, type):
  if type == 'koop' or type == 'huur':
    locatie_informatie = 'span'
  else:
    locatie_informatie = 'dd'
  aangeboden_sinds_ruw = woning_pagina.find(string='Aangeboden sinds')
  aangeboden_sinds = aangeboden_sinds_ruw.find_next(locatie_informatie).text
  if aangeboden_sinds != None:
    aangeboden_sinds = replace_months(aangeboden_sinds)
  else:
    aangeboden_sinds = '??'
  return aangeboden_sinds

def get_verkoopdatum(woning_pagina, type):
  if type == 'koop' or type == 'huur':
    return 'Nog niet verkocht/verhuurd'
  else:
    verkoopdatum_ruw = woning_pagina.find(string='Verkoopdatum')
    if verkoopdatum_ruw != None:
      verkoopdatum_ruw = verkoopdatum_ruw
    else:
      verkoopdatum_ruw = woning_pagina.find(string='Verhuurdatum')
      if verkoopdatum_ruw == None:
        return '??'
```

```
    verkoopdatum = verkoopdatum_ruw.find_next('dd').text
    if verkoopdatum != None:
      verkoopdatum = replace_months(verkoopdatum)
    else:
      verkoopdatum = '??'
    return verkoopdatum

  def get_perceel(woning_pagina):
    perceel_ruw = woning_pagina.find(string='Perceel')
    if perceel_ruw != None:
      perceel = perceel_ruw.find_next('span').text
      perceel = int(''.join(re.findall(r'\b\d+\b', perceel)))
    else:
      perceel = '??'
    return perceel

  def get_label(woning_pagina):
    label_ruw = woning_pagina.find(string='Energielabel')
    if label_ruw != None:
      label = label_ruw.find_next('dd').text
      if label == 'Niet beschikbaar':
        cleaned_label = 'Label not available'
      else:
        # Remove the "Wat betekent dit?" prefix, numbers, spaces, commas, and any leading or trailing whitespace from
the label
        cleaned_label = re.sub(r'Wat betekent dit\?|\d| |,', '', label).strip()
    else:
      cleaned_label = '??'
    return cleaned_label

  def get_bouwsoort(woning_pagina):
    bouwsoort_ruw = woning_pagina.find(string='Soort bouw')
    if bouwsoort_ruw != None:
      bouwsoort = bouwsoort_ruw.find_next('dd').text
    else:
      bouwsoort = '??'
    return bouwsoort.strip()

  def get_bouwjaar(woning_pagina):
    bouwjaar_ruw = woning_pagina.find(string='Bouwjaar')
    if bouwjaar_ruw != None:
      bouwjaar = bouwjaar_ruw.find_next('dd').text
    else:
      bouwjaar = '??'
    return bouwjaar.strip()

  def get_kamers(woning_pagina):
    kamers_ruw = woning_pagina.find(string='Aantal kamers')
    if kamers_ruw != None:
      kamers = kamers_ruw.find_next('dd').text
      if kamers[2] == ' ':
        kamers = kamers[1]
      elif kamers[3] == ' ':
        kamers = kamers[1:2]
      else:
        kamers = '??'
    else:
      kamers = '??'
    return kamers.strip()

  def get_badkamers(woning_pagina):
    badkamers_ruw = woning_pagina.find(string='Aantal badkamers')
```

```
    if badkamers_ruw != None:
      badkamers = badkamers_ruw.find_next('dd').text
      if badkamers[2] == ' ':
        badkamers = badkamers[1]
      elif badkamers[3] == ' ':
        badkamers = badkamers[1:2]
      else:
        badkamers = '??'
    else:
      badkamers = '??'
    return badkamers.strip()

  def get_woonlagen(woning_pagina):
    woonlagen_ruw = woning_pagina.find(string='Aantal woonlagen')
    if woonlagen_ruw != None:
      woonlagen = woonlagen_ruw.find_next('dd').text
      if contains_number(woonlagen):
        woonlagen = int(''.join(re.findall(r'\b\d+\b', woonlagen)))
      else:
        woonlagen = '??'
    else:
      woonlagen = '??'
    return woonlagen

  # The construction of an url based on the input
  if type == "verkocht":
    saleOrRental = "koop"
  if type == "verhuurd":
    saleOrRental = "huur"
  base_url = 'https://www.funda.nl'
  url = f'{base_url}/{saleOrRental}/{city}/{type}/sorteer_afmelddatum-af/'

  # Create empty dataframe where the scraped listings are added to
  housingAttributes = ['City', 'Type', 'PC6', 'adres', 'woningtype', 'label', 'bouwsoort', 'bouwjaar', 'woonlagen',
'kamers', 'badkamers',
      'perceel', 'oppervlakte', 'prijs', 'aangeboden_sinds', 'verkoopdatum', 'Scraped on']
  df = pd.DataFrame(columns=housingAttributes)

  # Establish baseline count
  countTotal = 0
  countTotalOnPage = 0
  countPages = 0

  # Establish total amount of listings within specified city/type
  firstPageHTML = requests.get(url, headers={"User-Agent": "Mozilla/5.0"}).text
  firstPageSoup = BeautifulSoup(firstPageHTML, 'lxml')
  amountOfListingsText = firstPageSoup.find('h1',
                  class_='search-output-result-count fd-m-none fd-m-bottom-s fd-flex fd-flex-column').text
  amountOfListings = int(''.join(re.findall(r'\b\d+\b', amountOfListingsText)))

  # While the amount of scraped listings is lower than the total amount of listings, run this loop
  while countTotal < amountOfListings:
    pageHTML = requests.get(url, headers={"User-Agent": "Mozilla/5.0"}).text
    pageSoup = BeautifulSoup(pageHTML, 'lxml')
    listingsOnPage = pageSoup.find_all('li', class_='search-result')

    # For every listing on this page (15), run this loop.
    for listing in listingsOnPage:
      listingUrl = base_url + listing.find('a')['href']
      listingHTML = requests.get(listingUrl, headers={"User-Agent": "Mozilla/5.0"}).text
      listingSoup = BeautifulSoup(listingHTML, 'lxml')

      # If an irrelevant or broken listing is encountered, stop trying to retrieve information.
```

```
    # Else, retrieve the information & add it to the df
    if 'parkeergelegenheid' in listingUrl or 'bouwgrond' in listingUrl or 'object' in listingUrl:
      print('irrelevant listing, skipped')
    elif len(listingSoup.find_all('p', class_='fd-m-none fd-color-dark-1 fd-text--emphasis')) == 1:
      print('Broken link, skipped')
    else:
      listingInformation = {
      'City': city,
      'Type': type,
      'PC6': get_postcode(listingSoup),
      'adres': get_adres(listingSoup),
      'woningtype': get_woningtype(listingSoup),
      'label': get_label(listingSoup),
      'bouwsoort': get_bouwsoort(listingSoup),
      'bouwjaar': get_bouwjaar(listingSoup),
      'woonlagen': get_woonlagen(listingSoup),
      'kamers': get_kamers(listingSoup),
      'badkamers': get_badkamers(listingSoup),
      'perceel': get_perceel(listingSoup),
      'oppervlakte': get_oppervlakte(listingSoup),
      'prijs': get_prijs(listingSoup, type),
      'aangeboden_sinds': get_aangeboden_sinds(listingSoup, type),
      'verkoopdatum': get_verkoopdatum(listingSoup, type),
      'Scraped on': get_scraped_on()
      }

      df.loc[len(df)] = listingInformation

    countTotal += 1
    countTotalOnPage += 1
    print(countTotal)

    # Check if page end is reached, if true, go to next page
    if countTotalOnPage == 15:
      countPages += 1
      print(f'All listings on page {countPages} have been scraped')
      countTotalOnPage = 0
      paginationList = pageSoup.find('nav', class_='pagination')
      nextPageText = paginationList.find_all('a')[-1]
      if nextPageText != url:
        url = base_url + nextPageText['href']

    #Time between every request to resemble human behaviour
    time.sleep(1)

return df
```