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Master Thesis

Msc. Spatial, Transport and Environmental Economics

Self-occupancy obligation and housing speculation: An empirical study in Rotterdam, the Netherlands

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Abstract

Using difference-in-differences and triple-differences models on transactions in Rotterdam between January 2013 and December 2022, this research finds that the self-occupancy obligation, which is an anti-speculative regulation designed to cease the activity of buy-to-let buyers, has succeeded to curb the housing speculation by cooling down the housing market in 16 regulated neighborhoods. However, when concentrating on the influence of the regulation on the low to medium-priced housing sector in treatment neighborhoods, there is a lack of effectiveness. Sensitivity analyses using sub-samples based on distance to the regulated neighborhoods' border and price ranges around the threshold value provide more insights. The results suggest that the policy's impact weakens closer to the border and varies over the price ranges. In general, this regulation has discouraged buy-to-let investors to join the market and given more opportunities for owner-occupied buyers. As a number of renters become buyers, it is possible that the rental market experiences a decrease in demand, hence, the yield for renting out and owning a house is no longer attractive to speculators. Taken together, the market is more accessible and affordable for owner-occupied buyers. These findings highlight the importance of taking spatial, time and price ranges heterogeneity into account when analyzing the impact of the regulation. Further research is needed to figure out the mechanisms and factors influencing the effectiveness of this regulation.

Keyword: housing speculation, self-occupancy obligation, housing price, housing sector

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1 Introduction

Housing speculation is a subject of growing concern around the world as it is considered as one of the primary causes of the housing cycles (Case, 1992; Malpezzi and Wachter, 2005; Gao et al., 2019). A speculative bubble can explain the up-phase in the housing cycle, for example in Sweden during the 1980s (Björklund and Söderberg, 1999), Japan in 1990s (Chung and Kim, 2004) or China during 2000s (Li, 2008). The increasing housing price surpasses household income increase, hence, the ratio of housing price to household annual income is relatively high, which makes housing unaffordable for low and middle-income households (Chung and Kim, 2004). When the bubble bursts, it severely harms the financial system and contributes to general economic instability (Case, 1992; Chung and Kim, 2004; Miralles i García, 2011). Due to its importance, several attempts to restrict land and real estate speculation have been made. The governments worldwide use different methods to curb the speculation. The popular regulations are taxation, e.g. property tax, transfer tax and capital gain tax; financial restriction, e.g. mortgage limit for speculative properties; or setting several criteria on the buyers, e.g. non-foreign buyers versus foreign buyers.

Scholars have used a variety of indicators and methods to evaluate the effect of anti-speculative policies on the housing market. However, most of them focus on the impact of taxations since this is the most commonly used method worldwide. While measures in some countries are ineffective (Agarwal et al., 2021; Chung and Kim, 2004; Li, 2008; Rauf and Weber, 2022), policies are proved to be effective in certain nations or areas in slowing down the housing market (Benjamin et al., 1993; Dachis et al., 2012; Oliviero et al., 2019). It appears that there is no one-size-fits-all policy for every country since the link between policies and socioeconomic position changes across geographic and demographic boundaries, as well as through time. Therefore, ex-ante research is crucial for selecting a possible regulation and ex-post research is important for assessing its efficacy in the short- and long-term following the implementation.

Speculators usually buy properties with the expectations of an increase in the price. For them, the properties are usually treated as an investment rather than an asset. They typically hold the properties for a short period of time or longer with little to no use with the purpose of selling them when the prices reach desirable profits. They might keep the condition of the properties the same for the whole holding period or do minor renovation to increase the value. It is not easy to identify whether a buyer has any speculative incentive since speculators can change their strategy from buy-to-let to speculation and vice versa depending on the market. Therefore, most of the anti-speculative regulations usually treat non-owner-occupied buyers as speculators, which means policy makers aim to adjust those buyers' behavior with the expectation of curbing the housing speculation phenomena.

In the Netherlands, buy-to-let buyers are being blamed for the rising house prices in recent years. The government and municipalities have passed several anti-speculative regulations to address the problem. For instance, high transfer tax

for buy-to-let investors, self-occupancy obligation, purchase protection or mortgage limit. However, the efficacy of these policies is being questioned. This research will look at the effect of the self-occupancy obligation in Rotterdam, which applies to 16 out of 92 neighborhoods, on the housing market in this municipality. This obligation came into force from 1st January 2022 (NOS Nieuws, 2021b). According to the law, at the time of registration in the public registers of the deed of transfer to the new owner, if the residential property has a WOZ value of less than €355,000, the homeowner is not allowed to rent it out within 4 years. This WOZ value threshold was raised to €405,000 in 2023. With this regulation, the policy makers anticipate that this restriction will reduce the potential for speculators to participate in the low to medium-priced housing sector, resulting in lower house prices.

Using a quasi-experimental approach on panel data between 2013 and 2022, the goal of this study is to examine the effects of the obligation in Rotterdam on the housing speculation phenomenon, to be more specific, whether it is effective in cooling down the housing market. The research question is as follow: *"Is the self-occupancy obligation in Rotterdam effective in curbing the housing speculation?"*. The study is significant for a number of reasons. To begin, the findings of this study may serve to determine how the market responds to anti-speculative regulation. Because there is no one-size-fits-all policy, policy efficacy varies across space, time and sector, it is necessary to assess its impact using multiple samples. Secondly, because this regulation is not as common worldwide as taxation, the research addresses an issue that has gotten less attention from the research community.

This research begins with an event study analysis to detect the anticipation effect in the housing market. The findings reveal that the market's behavior did not change considerably throughout the pre-treatment period. After this, the difference-in-differences model is used to find the average treatment effect of the regulation on the 16 treated neighborhoods relative to untreated neighborhoods. It is found that the housing market in regulated neighborhoods experienced a decline after the policy implementation. Since the regulation specifically targets the low to middle-priced housing sector in these 16 neighborhoods, the triple-differences (DDD) model is used to further investigate the effect. The model points out that there is a lack of policy impact on the low to middle-priced housing sector relative to the high-priced housing sector within the treatment neighborhoods.

In short, the self-occupancy obligation in Rotterdam is proved to be effective. Similar to most of the anti-speculative regulations, this obligation demotivates buyers with speculative motives to join the housing market by restraining buying opportunities and increasing the expenses for buying and owning properties. This makes the market become less competitive for owner-occupied buyers. Since more and more people have an option to buy the property rather than renting, the rental market can experience a decrease in demand, as a result, the expected yield to own a house is less attractive to speculators. In turn, the housing market becomes more affordable for owner-occupiers.

The remainder of this research will be as follows. Section 2 covers the concept of housing speculation, anti-speculative regulations and related literature about

analyzing the impact of the regulations on the housing market. Section 3 is the methodology with background about the self-occupancy obligation in the Netherlands, study area, data descriptives and the empirical models with three propositions. Section 4 shows the empirical results using graphs and tables. Section 5 analyzes the sensitivity of the results while the limitations of this research are mentioned in Section 6. Finally, a conclusion will be given.

2 Related literature

2.1 What is housing speculation?

Prior to anything else, it's critical to understand what housing speculation is and the causes of this situation in order to comprehend the issue that policymakers are attempting to address. Different terminologies have been used by academics to characterize housing speculation.

In general, housing speculation refers to the practice of speculators purchasing a property at a low price with the intention of subsequently reselling it later for a profit. In terms of strategy, they are different from other traditional buy-to-let investors. Lerner (1946) first categorized competitive speculation and monopolistic speculation. Competitive speculation, in which the speculators make their choices on their predictions of the future prices and market conditions, or in other words, the future equilibrium house prices (Kohn, 1978). Competitive speculators believe the market price will increase or decrease completely independent of their own activities. It differs from monopolistic speculation in which a speculator tries to acquire or maintain control over a sizable share of the existing good in order to affect the market price. There are different strategies that can be identified as competitive speculation.

To begin with, speculators can function as middlemen, purchasing from sellers who have high holding costs and cannot afford to wait for the right buyer, in other words, "flippers" have lower holding costs than the initial sellers (Bayer et al., 2020). By this mean, it reduces market price volatility and speeds up the market price's adjustment to its equilibrium or actual level. This is in fact a source for the capital formation, hence, is commonly seen stabilizing. As a result, speculation can bring benefit by improving the market's efficiency and the liquidity of the heterogeneous market. In such instances, speculators will only have a short-term impact on the market until the price returns to its "true value" (Smith, 1976). For middlemen, the timing of the market is unimportant, they may purchase the property regardless of the condition of the market, as long as they can find sellers who are willing to sell.

Secondly, speculators can also engage in the market activity as long-term holders who aim to profit from arbitrage opportunities resulting from either superior information about market fundamentals, or deviations from the fundamentals brought on by naive decision-making of other market participants (Bayer et al., 2020). This can be due to the diverse nature of real estate and the slow pace of market changes,

speculators' activity in real estate markets can lead to destabilizing expectations and actions from non-speculators. The "hot market" which is made by speculators causes distorted information and creates uncertainty regarding equilibrium market pricing (Bayer et al., 2020; Chinco and Mayer, 2016; Smith, 1976). Thus, naive buyers may be persuaded to make future purchases sooner to chase the market trends, resulting in an excess demand and a price increase over the equilibrium level. In addition to competitive speculation, monopolistic speculation reduces the amount of the good that is available and raises the price above the long-run equilibrium. Speculators using this strategy often enter the market while it is rising. Rational speculators take advantage of the naïve purchasers by strategically selling out the property before they see any indicators implying the bubble is about to burst (Bayer et al., 2020). This form of speculation is significant in particular market segments and can be both short-term holding and long-term holding for future development.

Smith (1976) also pointed out that the speculative cycle may be relatively longer in the real estate market than other markets where the speculative activity is normally assumed short-lived, and speculation is frequently mixed with development activity in that speculative acquisitions are undertaken to acquire real estate at a discount for future development. In general, the holding period of housing speculators is longer than that of other commodity speculators but still shorter than that of pure housing investors (Malpezzi and Wachter, 2005).
Gao et al. (2019) defined that housing speculation is considered as the purchases of non-owner-occupied homes, including second and investment homes, i.e. buy-to-let houses. Despite the fact that there may be some differences in investing strategy, it is significant that buy-to-let is commonly seen as a vehicle for speculative investment. Whereas the buy-to-let investors are driven by rental return whereas speculators are motivated by yield when reselling the property. However, investors might adjust their strategy in response to the market conditions. This makes it difficult to distinguish between buy-to-let investors and speculators. Moreover, speculators can profit from the property by renting it out to maximize the yield during the whole holding period. Rehm and Yang (2021) pointed out that speculators who rent out their properties are likely to have negative yields due to rental losses or positive yields but below the fair rate of return. However, given that they are more likely to concern about the profit when they sell the house, the low rental returns do not seem to be a risk. Chung and Kim (2004) assumed that there are two types of home demand: "regular" demand and "speculative" demand. The normal buyer avoids risk and would purchase a home based on factors like income growth and bond yield. The speculative buyer, on the other hand, is thought to be a risk-taker whose choices to purchase a home on such a high-risk factor are based on an unanticipated increase in housing price. In short, speculators' purchase decisions are based on their strong expectations of future increasing house prices (Malpezzi and Wachter, 2005; Li, 2008). They normally purchase real estate at a discount in comparison with the fundamental value with the intention of selling it for the highest possible profit.

In terms of the market, the housing speculation is known to happen in urban areas where the housing supply is inelastic and cannot meet the excess demand

(Benjamin et al., 1993; Gao et al., 2019; Malpezzi and Wachter, 2005). In those areas, the factors that contribute to housing speculation include five widely accepted theories: a low rate of interest on savings; an increase in money supply or liquidity; the availability of funds for home mortgage loans; an increase in housing demand and a supply-demand imbalance; and government initiatives to boost the economy (Chung and Kim, 2004; Gao et al., 2019).

In addition to that, some research has shown that housing speculation can happen in developing areas as well (Case, 1992; Var et al., 2017; Wells, 2015). Due to gentrification or urbanization, natural areas, coastlines, and agricultural land in cities and nearby areas are rapidly becoming accessible for development zoning. Speculative urban development results from the rise of real estate together with spatial investment tactics that stimulate (re-)valuation of real estate. Investors tend to have higher expectations for housing price rise than other areas. Therefore, in developing areas, transactions are usually made by investors with more speculative incentive than final users (Var et al., 2017).

From the aforementioned definitions, it can be concluded that housing speculation is a phenomenon in the residential real estate market which is caused by non-owner-occupied buyers with the expectations of an increase in the price of their properties. The properties are usually treated as an investment rather than a long term asset, typically held for a short period of time or longer with little to no use with the purpose of selling them when the prices reach desirable profits. Three potential ways that speculators earn high returns are taking advantage of market information, renovating to improve the quality of existing properties, and purchasing underpriced properties.

2.2 An overview about anti-speculative regulations

According to Case (1992), housing price volatility is not always a concern. As in an efficient asset market, land price would represent the marginal product of land in alternative uses. High productivity would simply lead to high land prices. However, Case had already conducted several studies and discovered some proof that the increasing volatility is at least partially the outcome of speculative activity. To be more specific, he found evidence that investors' predictions for future prices have a positive impact on the price of housing.

Housing speculation results in both short- and long-term negative externalities. The short-term consequence of housing speculation is distorted market information which possibly makes owner-occupied buyers decide to purchase the properties sooner (Smith, 1976). This makes the excess demand more severe, thus, causes property prices to rise above the fundamental value, possibly faster than increases in household income. When the ratio of housing price to yearly household income is relatively high, housing becomes unaffordable for low and middle-income people (Chung and Kim, 2004). Furthermore, as mentioned above, the housing speculation is one of the reasons causing the bust and boom in the real estate cycle. The booming phases cause significant unequal income distribution (Case and Cook, 1989). In

other words, speculative volatility can result in long-term income inequality. Speculators tend to reduce welfare and market efficiency to the degree that their actions cause bubbles and enhance market volatility (Bayer et al., 2020). Therefore, it is demanded for public policy response to address this market failure.

Housing speculation can stem from the supply side, for example due to the supply constraints. Therefore, it is well recognized that urban regulations might be feasible to avoid land speculation. However, demand-side is usually viewed as the reason for housing speculation (Malpezzi and Wachter, 2005). Because of which, most of the anti-speculative regulations are designed to impact buyer behaviors. Many regulations have been applied and can be categorized into policies that decrease speculators' yields, restrain the speculative opportunities or combine both.

The most powerful regulation is decreasing yields from property by increasing the holding costs, or the cost of capital which will lead to a fall in expected price. The most frequently suggested solution is taxation. The literature on real estate and property taxes examines tax policies from two main viewpoints: policies impacting the cost of holding the property and policies impacting the cost of ownership transfer. The former measures which are designed to increase the cost of home ownership normally impact property tax, interest rate or mortgage tax deduction. Whereas, the latter measures are taxes that must be paid when property ownership is transferred, which can include transfer tax and capital gain tax. It is worth noting that because taxes are levied on the property value or price, different tax treatment might be used for different price ranges in order to levy the targeted market participants. Moreover, as mentioned in subsection (2.1), non-owner-occupied buyers can always bear some degree of speculative activity in their investment strategy, therefore, some regulations are tailored for non-occupied buyers, short-term property holders, non-resident buyers or new infrastructure investment owners rather than every market participant. While home-occupied owners take house prices into account when it comes to buying a house rather than homeownership costs, second home and buy-to-let investors' decision is under the influence of these taxes (Ricks, 2021). Therefore, those regulations are expected to have a faster impact on housing markets where speculative demand is more severe than normal housing demand.

The mechanism of these anti-speculative regulations is influencing speculators' expectations of the property price or transaction expenses. Firstly, property tax is a component of user costs (Poterba, 1984), which are partly foreseeable expenses that people have to pay during the holding period. The housing price is determined by buyers' willingness to pay depending on the potential cash flow during the holding time including the user costs. The change in property tax directly impacts on the user costs, hence, causes a property's value to rise or fall. Besides, speculators' revenues heavily depend on the property price. Therefore, the tax change increases the risk for speculators. Secondly, transfer tax and capital gains tax, on the other hand, are one-time expenses. This can be a significant deterrent for non-occupancy market players because the tax makes it more expensive for both buyers and sellers to trade a property. Purchasers may avoid specific markets owing to uncertainties about how taxes would affect them, particularly if property prices unexpectedly increase or decrease at the time of reselling. Therefore, due to the costly purchase

expenses, the regulations can decrease the buying demand. Besides, even if the buyers are responsible for transfer tax, due to bargaining, sellers bear the tax burden (Benjamin et al., 1993). Hence, they result in decreased transaction prices and revenues for real estate speculators, which lessens speculators' incentives to buy a property in the first place.

In short, by levying taxes on real estate, governments have been attempting to stop the nation's housing speculation which generates the housing boom and bust. The primary mechanisms are influencing investors' expectations and increasing transaction expenses. After the tax becomes effective, in the short term, investor's expectations will be adjusted due to the tax reform (Li, 2008). Taxes limit the utility of selling a home since lower prices might be obtained but more expenditures must be incurred (Fritzsche and Vandrei, 2019). As a result, in the long term, these regulations reduce speculators' incentives.

In addition to taxation, some governments have enacted other policies to limit the speculative opportunities. For instance, speculators may have outright completely banned financing for houses sold within 90 days of purchase [1] or limited mortgage loan if a property is sold within 90 days of purchase and the new sales price exceeds the previous sales price by more than 10% [2]. Furthermore, in some countries, foreigners purchase a considerable proportion of real estate both in terms of quantity and value. Apparently, these out-ot-town buyers do not appear to dwell in those properties. One key assumption is that foreign owners also do not rent out their properties to locals. This not only reduces the housing availability for local buyers but also local tenants, which drives up prices and rent (Favilukis and Van Nieuwerburgh, 2021). Therefore, foreign ownership restrictions are also used to limit the activity of non-resident buyers in which foreigners not only have to pay higher taxes but also are only permitted to purchase new, off-the-plan properties, and the proportion of a new development that can be sold to foreign buyers is also restricted. However, the number of research on these regulations is quite limited.

In conclusion, taxation is a strong tool to impact the market, thus, the most popular method to curb housing speculation. Besides, policy makers also combine taxation with other restrictions to minimize the activity of speculators.

2.3 How to measure the effectiveness of anti-speculative regulations?

According to Smith (1976), the effectiveness of anti-speculative regulation is measured ultimately depending on how much it manages to slow down land and housing price increase, how much speculative activity it manages to reduce and how much it manages to alter non-speculative activity. The first criterion is total market level, whereas the latter two criteria are market participants level. From Smith's theory,

[1] The US Department of Housing and Urban Development (HUD) regulation (Federal Register, 2006, volume 71). HUD waived this restriction in 2010 (Federal Register, 2010, volume 75).

[2] HUD regulation (Federal register, 2013, Volume 78.

scholars used several indicators to measure the housing speculation phenomenon. Since taxation is the most common policy, the relationship between taxes and housing market indicators has recently received a lot of attention from scholars.

Firstly, market-level indicators are usually used to assess the effectiveness of taxes on market fluctuation i.e. how the market reacts to the change in regulations. The market's response can be measured by housing price or the change in housing price by household (Agarwal et al., 2021; Benjamin et al., 1993), in neighborhood or state level (Dachis et al., 2012; Rauf and Weber, 2022), in national level (Besley et al., 2014; Chung and Kim, 2004; Oliviero et al., 2019); housing price index i.e. Case and Shiller repeat sales index (Case, 1992; Li, 2008); the transaction volume (Besley et al., 2014; Best and Kleven, 2017; Dachis et al., 2012; Fritzsche and Vandrei, 2019). They focused on these indicators with a rule of thumb that the regulation is concerned as successful if it has a negative correlation with housing price (Chung and Kim, 2004; Rauf and Weber, 2022), that is if the taxes increase, the housing price will decrease. The number of transactions should also be decreased following the tax gain (Fritzsche and Vandrei, 2019).

Secondly, participant-level indicators, such as indicators for non-owner-occupied segment, speculative activity or non-speculative activity, are not frequently used. Gao et al. (2019) uses the fraction of non-owner-occupied home purchases in ZIP code level to indicate the housing speculation. Meanwhile Rehm and Yang (2021) used the rental yields to identify whether the rental properties are speculative demand.

2.4 Studies on the impact of anti-speculative regulations

The most basic model that has been used to investigate the effect of regulations is hedonic regression with neighborhood or state-specific and time fixed effect variables included to avoid omitted variable bias (Benjamin et al., 1993; Fritzsche and Vandrei, 2019; Rauf and Weber, 2022). Other model variations are also used. Firstly, many scholars take advantage of natural experiments with panel data for treatment and control groups before and after the tax reform which is are only applied to specific price notches (e.g. Stamp Duty Land Tax in the UK); holding durations (e.g. Hong Kong's Tobin transaction tax); or areas of study (e.g. transfer tax for foreign buyers within the Greater Golden Hourseshoe Area in Ontario). Hence, they used the difference-in-difference (DID) model for the study. Secondly, the ARIMA model (autoregressive integrated moving average model) is usually used to forecast the (change of) housing price following transfer tax reform (Chung and Kim, 2004; Li, 2008). Thirdly, from Tiebout's theory of tax-competition that people prefer non-taxed or lower tax areas, Dachis et al. (2012) used Poisson regressions on a regression discontinuity design to examine the change in transaction volume in postal code areas located at various distance from Toronto border inside which the Land Transfer Tax was in force whereas none of the surrounding municipalities had transfer tax at the time of study. They also used the same model to study the number of transactions which varied over time before and after the law was effective.

Researchers have shown that there are mixed conclusions of the effectiveness of taxes on the housing market over time and area of study. Firstly, it is well known that taxes have varied long- and short-term effects on the real estate market. While some studies (Besley et al., 2014; Benjamin et al., 1993; Dachis et al., 2012) only collected and examined short-term data for 20 to 30 months, other studies have longer time-series data, which allows them to examine both short-term and long-term effects of taxes on the housing market (Agarwal et al., 2021; Best and Kleven, 2017; Chung and Kim, 2004; Fritzsche and Vandrei, 2019; Li, 2008; Oliviero et al., 2019; Rauf and Weber, 2022). Secondly, the impact of taxes varies geographically due to the regional and demographic differences in the link between governance policies, market behavior and socio-economic results. It is also suggested that the overall impact of policies would depend on the combination of taxing measures (Rauf and Weber, 2022). As a result, it is important to study the impact of taxes in both short and long term and on each state or country.

Despite the economic relevance, there is only a small body of literature that studies the market anticipation. However, it is getting more attention in recent years. Dachis et al. (2012) looked for the anticipation effect before running the regression discontinuity design model to analyze the effect of the land transfer tax on the volume of real estate transactions. They found that the real estate market did not anticipate the tax. Best and Kleven (2017) and Fritzsche and Vandrei (2019) found evidence that the tax increase is anticipated and there are more real estate transactions taking place just before the tax is adopted. This can be explained by buyers and speculators trying to avoid higher expenses due to tax reform in the foreseeable future.

More evidence about the lock-in effect is focused. Firstly, in some countries or areas of study, the taxes seem effective in curbing housing speculation both in terms of transaction volume and the house prices (Benjamin et al., 1993; Dachis et al., 2012; Fritzsche and Vandrei, 2019; Oliviero et al., 2019). It is noteworthy that the effect of regulation depends on the inelasticity of the housing supply. While Dachis et al. (2012) found that there was a decline in house prices in Toronto, Canada early 2008 that was about equivalent to the tax increase, Benjamin et al. (1993)'s study in Philadelphia, USA discovered that the tax rate (5.07%) was lower than the decline in home prices (8%) however. The findings demonstrate that the perfect capital market does not appear to have ever existed.

Secondly, some researchers found out that anti-speculative regulations are not effective in solving housing speculation. Agarwal et al. (2021) discovered that the Tobin tax, which is a specific transfer tax on short-term property holders, increases selling costs and is therefore beneficial in reducing speculators' activity but ineffective in cooling down markets in Hong Kong. Since the tax increases the selling costs and lengthen sellers' holding periods, therefore, the housing makret has lower liquidity and higher prices. Their findings imply that limiting speculators alone is not enough to address the housing affordability issue. They demonstrate that the secondary market's transaction volume considerably decreases, suggesting that the Tobin tax depletes the market's liquidity, limiting supply and driving up prices.

The speculative taxes in Ontario, Canada was studied by Rauf and Weber (2022). The study examined the various effects of federal, state, and municipal policies in relation to regional and local supply and demand. In the presence of high market demand, property tax appears to be ineffectual in lowering house prices in both short and long terms. The speculation taxes contribute to rising home values both inside and outside tax administration jurisdiction. This suggests a spillover effect brought on by a shift in investment preferences to areas with lower taxes.
Last but not least, in some countries, the effects of taxes are found to be mixed. Li (2008) makes the argument that the introduction of the property tax in China does not result in any change in the housing market in the short term. However, a property tax rise of one percentage point will result in a 0.456 percent fall in dwelling prices over the long run. The reason behind this was due to the market elasticity. In the short term, the regulation tends to make an adjustment on the market expectations. But in the long run, it will adjust the user cost of property owners, hence, change the fundamental price of housing. Because of this reason, obtaining long-term statistics appears preferable so that we can better understand the actual impact of the tax.

It is found that in the UK, the housing market reacts to transaction taxes very fast and strongly. Besley et al. (2014) found that there was an average decrease in sale price of about $900 after the tax went into action. However, the rise in real estate transactions affected by the stamp duty holiday was roughly 8%. It is unable to determine if the tax was successful in cooling the market when it did contribute to a decline in house prices, but on the other hand, it resulted in an increase in transaction volume. However, whether owner-occupied purchasers or speculators made the transactions needs to be investigated further.

In order to partially explain the policy failure in Ontario, Smith (1976) pointed out that although the regulations were intended to eradicate all speculative behavior, it is possible that only part of it will be prohibited. The tax clearly has the greatest impact on short-term competitive speculators and investors who have less capacity to participate in long-term holdings and development. The short-term speculator is likely to participate in competitive speculation while the large speculator and developer may be involved in monopolistic speculation. Thus, the tax will decrease liquidity in many real estate markets and disrupt market efficiency. Moreover, the effectiveness of regulation regimes relies on the combination of real estate and housing policies. In addition, geographical variation of tax instruments, qualification and spillover effect will alter the aggregate outcome.

In conclusion, these aforementioned studies provide a solid foundation for future research on the impact of anti-speculative regulations. Firstly, the regulations usually target certain areas, price ranges or buyer groups, one may benefit from this setting and utilize a quasi-experimental approach to assess the effectiveness. Secondly, it is important to analyze the heterogeneity over space and time by using different spatial windows and time windows. Thirdly, these studies propose several mechanisms through which the regulations influence the housing market and the factors that determine whether the regulations are successful or not.

3 Methodology

3.1 Background: Self-occupancy obligation in the Netherlands

In the Netherlands, several studies have shown that market participants' expectations have a positive correlation with house prices during the 1990s (Eichholtz et al., 2015; Golland and Boelhouwer, 2002; Rouwendal and Longhi, 2008) and during the 2000s (Bolt et al., 2014). It is also noticeable that their expectations are based on the market trend rather than fundamental value of the properties. Therefore, it is predictable that some speculative motive has contributed to the current surge in house prices. 34 percent of the residences in four biggest cities in the Netherlands, namely Amsterdam, The Hague, Utrecht, and Rotterdam were sold to buy-to-let investors in 2020 (NOS Nieuws, 2021a). Buy-to-let investors are blamed for the housing availability shortage and the skyrocketing housing price. According to Conijn et al. (2019), the main reason is that buy-to-let buyers are willing to outbid owner-occupied buyers. Firstly, owner-occupied buyers, especially first-time buyers are limited when purchasing a new house by the maximum mortgage they can get. Secondly, due to the sharply increasing rent in big cities, the investment value for the buy-to-let investors is higher, hence, the expected yields also increase. This creates the opportunity for speculators to exploit properties by holding it for a short term to sell it for profit during this hot market or owning it in a longer run and renting them out during the holding term to maximize the yield. In short, speculators expect that their property value will increase due to the limited supply of rental housing.

Therefore, the government and municipalities have passed a number of regulations to tackle this problem. For instance, the self-occupancy obligation which ensures that those who buy a home cannot rent it out for a number of years, e.g. four to five years, or in other words, home-owners are the only individuals permitted to live there. Since 2020, Amsterdam was the first municipality to enact the self-occupancy obligation with newly-built buildings. There are some exceptions, for example the owners may rent to first-degree relatives, such as spouse or children; or rent it to third parties for a temporary stay abroad; or rent out the house if the total rent does not exceed the limit for medium-priced rent. Home-owners can apply for a permit to rent out the property if they are in exempted situations. From April 2022, the scope of the regulation was expanded to every property, including existing properties, that has WOZ value below 512,000 euro. The WOZ value is determined by each municipality through appraisal (WOZ-waarde, 2023). Due to the large volume of data at the same time, they use valuation models to utilize the data. The WOZ value is determined by examining the market value of homes sold in the municipality around the value reference date (around 1 January of the preceding year). For example, the WOZ value 2023 is the appraisal value of the house on 1 January 2022. These valuation models take into account all house market values. By comparing all properties with each other using these valuation models, appraisal values for each property are obtained even if they are not sold in

that year. In fact, due to bargaining and computational errors, the WOZ value can be different from transaction price. However, the WOZ value is maintained up to current and re-established every year, therefore, it is in line with housing market sales prices, but with a lag of approximately 1 to 2 years.

Since then, many municipalities have been adopting the same policy. In 2022, approximately 127 out of 352 municipalities in the Netherlands have introduced similar self-occupancy obligations (Trompert, 2022). In addition to the self-occupancy obligation, buy-to-let investors in residential real estate are subject to an increase in the national transfer tax from 2% to 8% (van de Steenoven and Wijngaard, 2020). The high transfer tax for non-occupied owners is a common method to curb housing speculation. Strengthening the position of owner-occupiers in the housing market relative to investors is one of the main goals of this policy change. It is predicted that the rate hike will make it less appealing for investors to buy houses, which leads to an increase in the quantity of housing stock that is available for owner-occupied buyers.

All regulations are imposed on the date they sign the transfer deed, which is also that the property is registered with the Land Registry and the new ownership becomes official. There are two important stages in a transaction: signing the purchase agreement and signing the transfer deed. Meanwhile the purchase agreement forms the basis of the transfer deed, the transfer is not yet final even if the purchase agreement is registered at the notary. There is a three-day cooling off period after signing the purchase agreement in which buyers can decide to pull out. If the purchasers are unable to get a mortgage within the agreed-upon time frame under some financial clauses, the transaction might also be canceled. Therefore, the date of transfer deed is the official date on which ownership, rights and obligations are officially transferred and is also the date on which the self-occupancy obligation starts to apply.

3.2 Study area

This research focuses on Rotterdam, where the self-occupancy obligation went into force on 1 January 2022. Before that, from October 2020, Rotterdam introduced a similar regulation but it only applied for newly-built housing which accounted for a very small proportion in the housing market. Therefore, this study will focus on the impact of the regulation introduced on 1 January 2022 on existing housing. Rotterdam, one of the four biggest cities in the Netherlands, is chosen to be studied due to the fact that the regulation applies for both new constructions and existing housing rather than only newly-built properties like several municipalities, which potentially makes a stronger influence on the housing market. Furthermore, Rotterdam has fewer exemptions; for example, they do not rule out houses that are already rented out 6 months before the transfer date. Last but not least, it came into effect quite early in comparison with the surrounding municipalities. The regulation applies to 16 out of 92 neighborhoods in Rotterdam. A map of the study area with 16 neighborhoods that are under the policy is provided in Figure 1. The

self-occupancy obligation applied to all real estate transactions with a WOZ value up to €355,000. This threshold is set based on the maximum mortgage amount under the Dutch National Mortgage Guarantee (NHG) in 2022. This limit is adjusted every year. Among the four biggest municipalities in the Netherlands, the WOZ value threshold of Rotterdam is equal to that of The Hague and lower than that of Utrecht (€440,000) and Amsterdam (€512,000). According to the website of Rotterdam municipality (Gemeente Rotterdam, 2023), these neighborhoods are chosen because of the following reasons: (1) The total number of low-cost and medium-priced owner-occupied homes that are rented out in the neighborhood is more than the average (=1,000) in Rotterdam; (2) the percentage of cheap and medium-priced owner-occupied homes that are rented out in the neighborhood is more than the average (= 24%) in Rotterdam and (3) The growth in the number of cheap and medium-priced owner-occupied homes that are rented out in the neighborhood is more than 20% (calculated from 2015).

Figure 1: Study area

3.3 Data descriptives

The research is based upon NVM (Dutch Association of Real Estate Agents) micro-data on house transactions, which provides information on around 80 percent of transactions in the Netherlands. Data for each transaction includes the transaction price, the exact location, and a wide variety of house characteristics such as size, number of rooms, construction year, type of house, date of listing, date of signing purchase agreement and date of transfer deed, etc. A few outlier observations are excluded [3]. The newly-built properties (294 observations) are also excluded from

[3]Transactions with prices that are above €10 million or below €10,000 or a square meter price below €100 or above €100,000 are excluded. Properties that are larger than 2,500 square meters or smaller than 25 square meters or have more than 25 rooms are also removed.

the dataset as this research only focuses on existing housing. As a result, 40,786 transactions in Rotterdam from January 2013 to December 2022 were used for this research.

The WOZ value data is obtained from the website of Kadaster (Netherlands' Cadastre, Land Registry and Mapping Agency). The webpage provides the reference WOZ values from 2014 to 2022, which are equivalent to the WOZ values from 2015 to 2023. Among the NVM data, 30,610 transactions can be recognized to have the WOZ value at the time of transfer.

Finally, the geodata of neighborhoods and municipalities are publicly provided by Centraal Bureau voor de Statistiek (CBS). This geodata is used in QGIS for estimating the distance from observations to the neighborhood border. Using QGIS, the 16 regulated neighborhoods are dissolved to remove the common borders. Then the distance to the regulated neighborhood border is estimated.

Several dummy variables are also created manually in STATA17. Firstly, the dataset provided by NVM contains the information about the neighborhood, therefore, the properties are verified whether they are inside the 16 regulated neighborhoods. Secondly, the properties are verified whether they are within the regulated sector. Assuming that the WOZ value threshold for this regulation in Rotterdam is always based on the maximum guaranteed mortgage by the Dutch National Mortgage Guarantee (NHG). This maximum amount is re-evaluated on an annual basis. By this way, we have a distinct WOZ value threshold for each year. Therefore, the targeted sector is defined by comparing the WOZ value at the time of transfer with the threshold value of that year. Thirdly, the transactions are verified whether they are obligated to the policy. Recall that it concerns the date that the deed of transfer is registered in the Land Registry, which is the date of ownership transferring. Therefore, if the time of registration in the public registers of the deed of transfer to the new owner is before 1st January 2022, the house is not regulated, meanwhile transactions with date of transfer on 1st January 2022 or later, even if the sale agreement is registered in 2021, are regulated. Table 1 reports the main descriptive statistics for the dataset with 2 panels: (A) full sample and (B) treatment neighborhoods only.

In terms of transfer time, we have data of 24 months after the policy implementation and 108 months before the policy implementation. It appears that approximately 33.5% of the observations are within the treatment neighborhoods. There are not many differences in housing characteristics between two panels. The average sales price in treatment neighborhoods is 10.4% lower than that of the full sample. There is also more housing that falls under the treatment sector in regulated neighborhoods compared to the full sample. These differences are consistent with the fact that these neighborhoods are more appealing to buy-to-let investors than the other neighborhoods since they have more low to medium-priced properties which potentially generate higher yield.

Table 1: Descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Panel A: Full sample					
Sales price (in €)	40,786	296,848	234,309	20,000	6.600e + 06
The log of transaction price	40,786	12.39	0.630	9.903	15.70
WOZ value at transfer (in €)	30,610	262,609	202,151	20,000	3.674e + 06
Size of property (in m2)	40,786	106.1	49.04	26	1,171
Size of other space (in m2)	40,786	22.98	1,486	0	299,997
Number of rooms	40,786	4.011	1.524	1	23
Apartment	40,786	0.654	0.476	0	1
Terraced property	40,786	0.220	0.414	0	1
Semidetached property	40,786	0.107	0.309	0	1
Detached property	40,786	0.0196	0.139	0	1
Garden	40,786	0.740	0.439	0	1
Maintenance state is good	40,786	0.793	0.405	0	1
Construction year	39,138	1,963	32.82	1,299	2,019
Distance to border	40,786	1,125	2,374	$-1,170$	21,909
After the policy implementation	40,786	0.0956	0.294	0	1
Treatment neighborhood	40,786	0.335	0.472	0	1
Treatment sector	30,610	0.707	0.455	0	1
Year of ownership transfer	40,786	2,018	2.714	2,013	2,023
Year of observation	40,786	2,017	2.662	2,013	2,022
Panel B: Treatment neighborhoods					
Sales price (in €)	13,654	266,064	244,516	26,000	6.600e + 06
The log of transaction price	13,654	12.24	0.665	10.17	15.70
WOZ value at transfer (in €)	10,753	222,972	206,825	34,000	3.374e + 06
Size of property (in m2)	13,654	98.87	54.56	26	1,000
Size of other space (in m2)	13,654	14.68	38.82	0	3,200
Number of rooms	13,654	3.907	1.690	1	23
Apartment	13,654	0.832	0.374	0	1
Terraced property	13,654	0.117	0.322	0	1
Semidetached property	13,654	0.0441	0.205	0	1
Detached property	13,654	0.00710	0.0840	0	1
Garden	13,654	0.633	0.482	0	1
Maintenance state is good	13,654	0.768	0.422	0	1
Construction year	13,055	1,946	27.17	1,434	2,018
Distance to border	13,654	-260.3	185.8	$-1,170$	0
After the policy implementation	13,654	0.0814	0.274	0	1
Treatment sector	10,753	0.823	0.382	0	1
Year of ownership transfer	13,654	2,017	2.670	2,013	2,023
Year of observation	13,654	2,017	2.627	2,013	2,022

3.4 Empirical models

The purpose of this study is to examine whether the self-occupancy obligation is effective in curbing the housing speculation phenomenon. I assess its impact following one of the criteria proposed by Smith (1976), which is how much housing prices the regulation manages to slow down. This research focuses on the impact of the self-occupancy obligation for non-owner-occupied buyers, which are potentially considered as speculators, on the housing market in Rotterdam. One method for estimating this effect is to use a difference-in-differences model to compare the housing markets of regulated and unregulated neighborhoods. Prior to this, the event study analysis is used to examine the pre-treatment trend to identify anticipatory effect. The regulation has 3 effects on the housing market as summarized in the following propositions. Graphic as well as econometric analyses will be used to test these propositions.

Proposition 1: There is no significant market anticipation.

Rotterdam is the second municipality to implement the self-occupancy obligation. The first municipality to introduce the comparable regulation for newly-built properties was Amsterdam in July 2020. Rotterdam also implemented the same regulation for newly-built housing in October 2020. However, new constructions only account for a relatively small proportion in the housing market, this regulation started to apply for the whole market after that 1 year, including existing housing from January 2022. The information about this obligation was not published in the media until October 2021, only three months before it was officially implemented. The time gap seems to be minor so that there should not be a significant anticipatory effect on the market.

In order to analyze the anticipatory effect during the fourth quarter of 2021, I use the event study analysis, focusing on the 2-year pre-treatment period. In order to control for unobserved variables, postal code and time fixed effects are added into the model. In the Netherlands, 6-digit postal codes are small, typically one block along one side of a street. Therefore, housing within a 6-digit postal code tends to have some similar characteristics or (dis)advantages over other 6-digit postal codes. Furthermore, including location fixed effects can also control spillover effects to address any time-invariant unobserved heterogeneity. Monthly time fixed effect is used to control for unobserved time trend factors. Two different types of monthly time fixed effect will be used: the signing sale agreement month fixed effect and the ownership transfer month fixed effect. Hereby they are respectively mentioned as agreement month fixed effect and transfer month fixed effect. In the dataset, the average difference between day of purchase agreement and day of transfer is 67.7 days.

To proceed, let q denote the quarter to treatment (January 2022), with $q < 0$ being before the imposition of the regulation, and $q > 0$ being after. There are 36 quarters before the treatment and 7 quarters after the treatment. Let p_{ixt} denote the transaction price of observation i at a particular neighborhood x and month t, X_{itj} denote the housing characteristics j of house i at time t, N_x be the dummy

variable whether the property is inside the treatment neighborhood ($N_x = 1$ if the property is inside the treatment neighborhood and 0 if not), γ be the postal code fixed effects, δ_t be monthly time fixed effects and ϵ_{ixt} be the error. I first start with the following model using only transactions 2-year before the policy is adopted with the third quarter year 2021 as the reference group.

$$\log p_{ixt} = \alpha_0 + \sum_{j=1}^{J} \alpha_j X_{itj} + \sum_{q=-36}^{-28} \beta_q q N_x + \gamma_x + \delta_t + \epsilon_{ixt} \tag{1}$$

In this model, the interaction term qN_x is the treatment neighborhood dummy for the relative quarter q. The coefficient of interest β_q indicates the average treatment effect in a given relative quarter q.

Proposition 2: The regulation has impact on the regulated neighborhoods.

The main target of the self-occupancy obligation is cooling down the market in the chosen neighborhoods. It is believed that this regulation will demotivate buy-to-let buyers since they can only buy houses in the high-priced housing sector. As a result, both their holding costs and transaction expenses increase, hence, they have relatively lower yields from the property. By restraining the activity of buy-to-let buyers, who have been outbidding owner-occupied buyers in recent years, the market is expected to become less competitive. Therefore, we may find the effectiveness of the self-occupancy obligation on the housing market of 16 treatment neighborhoods.

The first step is to estimate the effect of the regulation on the housing market in general. In order to test this proposition, the difference-in-differences (DID) model is used to compare regulated and unregulated neighborhoods. There are 16 treated neighborhoods and 76 control neighborhoods. All 96 neighborhoods are within the Rotterdam municipality. The identifying assumption of this method is the parallel trends assumption which implies that, had the treatment not occurred, they likely would have continued having similar trends. Despite the fact that we cannot prove or truly test this trend, it is a frequent technique to employ pre-treatment event study data to support this assumption.

We now have the dummy variable A_t for whether the transaction happens after the policy implementation ($A_t = 1$ if the property is transferred after the policy implementation and 0 if not). In order to further eliminate the omitted variable bias which can be caused by the changes in the neighborhood level at the time of purchase, I include the linear neighborhood trend fixed effect variable "Neighborhood $\times$ Year of transfer" variable θ_{xt} in the model. I now analyze the impact of the regulation with the following baseline model:

$$\log p_{ixt} = \alpha_0 + \sum_{j=1}^{J} \alpha_i X_{ixtj} + \beta_1 A_t N_x + \gamma_x + \delta_t + \theta_{xt} + \epsilon_{ixt} \tag{2}$$

Let $\overline{\log p}$ be the average log of house prices. In this model, the parameter of interest β_1 of the DID model estimates the treatment effect of the regulation on

housing price in treated neighborhoods:

$$\widehat{\beta_1} = \left(\overline{\log p_{\text{after,treatment neighborhood}}} - \overline{\log p_{\text{before,treatment neighborhood}}}\right) - \left(\overline{\log p_{\text{after,control neighborhood}}} - \overline{\log p_{\text{before,control neighborhood}}}\right)$$

After the baseline model, I use 16 dummy variables for 16 treatment neighborhoods to analyze the impact of the regulation on each neighborhood. Model 2 becomes:

$$\log p_{ixt} = \alpha_0 + \sum_{j=1}^{J} \alpha_i X_{ixtj} + \sum_{x=1}^{16} \beta_x A_t N_x + \gamma_x + \delta_t + \theta_{xt} + \epsilon_{ixt} \tag{3}$$

The coefficient β_x captures the impact of the regulation on each neighborhood.

Proposition 3: The regulation has no significant impact on regulated housing sector (low to middle-priced housing sector) in the treatment neighborhoods.

Because of the regulation, buy-to-let investors are forced to participate in the high-priced sector instead of the low and middle-priced sector or leave the market as they do not have enough capital to join the high-priced sector. In either case, that buy-to-let investors leave the low to middle-priced housing sector makes the market less competitive, creating favorable conditions for owner-occupied buyers to join the market. Due to the fact that more people have the opportunity to own a property, the demand on the rental market diminishes, which in turn affects the potential yields for buy-to-let buyers. With a reduced yield, the profitability of buy-to-let investment or speculation declines. Given these dynamics, we expect to see a decrease in house prices in both housing sectors. Nevertheless, we might see small or insignificant difference in the changes of these two sectors. In other words, the regulation may make an insignificant impact on the low to middle-priced housing sector compared to the high-priced housing sector within regulated neighborhoods.

For this proposition, the dataset is divided into 2 sectors: the high-priced housing sector and the low to middle-priced housing sector. Let w denote the WOZ value of the property at the time of deed of transfer, with w under the threshold value of that year being low to middle-priced housing sector and w above the threshold value of that year being high-priced housing sector. Hence, we have the dummy variable $S = 1$ if the property belongs to the low and middle-priced housing sector and 0 if it belongs to the high-priced sector. Note that the WOZ value of the property and the threshold are changed every year, therefore, the property can be within the treated sector in one year but not in another year, therefore, this dummy variable depends on housing i with WOZ value w at time t. We now have two differences: treated and untreated neighborhood, treated and untreated sector. This is suitable for a triple differences (DDD) setting.

To test this proposition, firstly, I run the model 2 with 2 subsamples: under and above the threshold, i.e. within or without the treatment sector. After that, I focus on the housing market in regulated neighborhoods by using the triple differences

(DDD) once proposed by Wooldridge (2007). This method can potentially account for the unobserved trends in house prices of the low to medium-priced housing sector across neighborhoods and the house prices changes of both sectors in the treatment neighborhoods that have nothing to do with the policy, which can bias the results. When isolating the unobserved trend, the method can strengthen the parallel trend assumption to analyze the average treatment effect.

The following model is used to estimate this effect:

$$\begin{aligned}\log p_{iwxt} =&\alpha_0 + \sum_{j=1}^{J} \alpha_i X_{itj} + \beta_1 S_{iwt} + \beta_2 A_{it} N_{ix} + \beta_3 A_{it} S_{iwt} + \beta_4 S_{iwt} N_{ix} + \beta_5 A_{it} N_{ix} S_{iwt} \\ &+ \gamma_x + \delta_t + \theta_{xt} + \epsilon_{ixt}\end{aligned} \tag{4}$$

Let $\overline{\log p}$ be the average log of house prices. In this model, the parameter of interest β_5 of the DDD model will give:

$$\begin{aligned}\widehat{\beta_5} = &\left(\overline{\log p_{\text{after, treatment sector, treatment neighborhood}}} - \overline{\log p_{\text{before, treatment sector, treatment neighborhood}}}\right) \\ &- \left(\overline{\log p_{\text{after, treatment sector, control neighborhood}}} - \overline{\log p_{\text{before, treatment sector, control neighborhood}}}\right) \\ &- \left(\overline{\log p_{\text{after, control sector, control neighborhood}}} - \overline{\log p_{\text{before, control sector, control neighborhood}}}\right)\end{aligned}$$

This parameter measures the treatment effect of the regulation on the low to middle-priced housing sector relative to the high-priced housing sector in regulated neighborhoods.

4 Empirical results

4.1 Pre-treatment event study analysis

The pre-treatment trend is critical for understanding the anticipatory trend associated with the policy implementation. In this study, the pre-treatment period is examined in order to indicate the anticipatory trend. Postal code and monthly fixed effects are used to control for unobserved variables. The findings of the analysis are visually presented in Figure 2, which illustrates the coefficient β_q of model 1 with 95% confidence interval. The third quarter of 2021, which is 2 quarters before the policy implementation, is used as the reference group. The coefficient of one quarter before the policy implementation is close to 0, implying that there was no substantial difference between treated and untreated neighborhoods in comparison with the reference quarter. Therefore, we can conclude that there is no anticipatory effect on the housing market when the information was covered on the news from October 2021. It confirms that the observed changes in the housing market following the policy implementation are likely due to the policy itself rather than pre-existing differences between the treated and untreated neighborhoods.

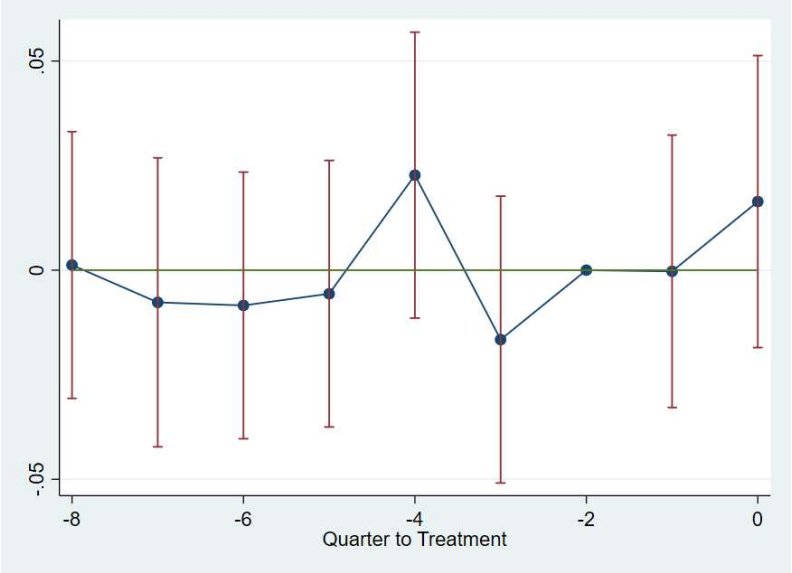

Figure 2: Price trend of real estate transactions in the pre-treatment period. Vertical axis demonstrates the change in the price of units transacted in treatment neighborhoods. Horizontal axis counts quarters to the imposition of the self-occupancy regulation. The dot gives the coefficients of the interaction term neighborhood treatment dummy and quarter. Red vertical lines are 95% and 5% confidence bounds.

4.2 Self-occupancy obligation and housing price in treatment neighborhoods

The price effect on the regulated neighborhoods in comparison to the non-treated neighborhoods is analyzed using the difference-in-differences model (model 2). Table 2 reports the regression results. The table provides an overview results with three columns, each column represents a different model specification, with different time windows to understand the price effect over different periods and fixed effect variables to control for unobserved variables. All specifications include 9 (dummy) variables for house characteristics, 6-digit postal code, agreement month and transfer month fixed effect variables. The coefficient of the interaction term "After the policy implementation × Treatment neighborhood" shows the estimated average treatment effect of the self-occupancy obligation on the housing price in regulated neighborhoods after it went into effect.

In response to the skyrocketing house prices in recent years, policy makers expected the self-occupancy obligation would tackle the problem. Therefore, to assess the effectiveness of this regulation, firstly I use [-2,+2] year time window. Column (1), (2) are the baseline models using only observations with time of transfer within January 2020 to December 2023. The coefficient in the first column is negative and close to zero, indicating insignificant impact. In column (2), the linear neighborhood trend fixed effect variable is included to control for unobserved trend. The result shows that there is a $e^{-0.0142} - 1 = 1.41\%$ decrease in housing prices in treatment neighborhoods compared to control neighborhoods after the policy implementation.

Table 2: Regression results - Difference-in-differences

	(1) [-2,+2] year	(2) [-2,+2] year	(3) All observations
Treatment neighborhood ×	-0.00728	-0.0142	-0.0363***
After the policy implementation	(0.00704)	(0.0126)	(0.00643)
Agreement month fixed effect	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes
Neighborhood × Year fixed effect	No	Yes	Yes
PC6 fixed effect	Yes	Yes	Yes
Observations	9304	9304	37652
R-squared	0.959	0.960	0.955

Note: The dependent variable is the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Bootstrap-robust standard errors with 20 replications in parentheses; *** p<0.01, ** p<0.05, * p<0.1

However, this coefficient is not statistically significant. The model specification in column (3) uses all observations from the dataset. When using the longer time window, the coefficient is -0.0363, indicating that the prices in treatment neighborhoods have decreased by 3.56% after the policy was adopted. The coefficient is statistically significant at a 99% confidence interval. This suggests that the policy was successful in cooling down the housing prices. It is also noteworthy that the longer time window, the stronger and more significant the impact.

To dig deeper into the analysis, I include 16 dummy variables for 16 treatment neighborhoods. By incorporating these dummy variables, I aim to capture the specific effects on each treatment neighborhood. The figure 3 illustrates the coefficients of the interaction term "Neighborhood dummy variable × After treatment" in model 3 using the full sample and bootstrap-robust standard errors with 20 replications, with 95% confidence interval.

Among the 16 neighborhoods, half of them experience a notable decrease in housing prices after the policy implementation within the observed time frame. The coefficient values of these neighborhoods vary from -0.47 to -0.14, suggesting a considerable impact of the regulation. For the other neighborhoods, the policy has no significant influence on the housing market. However, it is important to highlight that the housing market in the neighborhood "Groot Ijsselmonde" has an increase at 7.87% with a 95% confidence interval. These findings shed light on the heterogeneity among the treatment neighborhoods, showing that the housing market response to the policy varies across different neighborhoods. While individual neighborhoods exhibit varying responses to the policy, the average treatment effect is negative when considering the 16 neighborhoods as a whole. Therefore, policy makers can further analyze the specific neighborhoods that the regulation is proved to be ineffective or has the opposite impact.

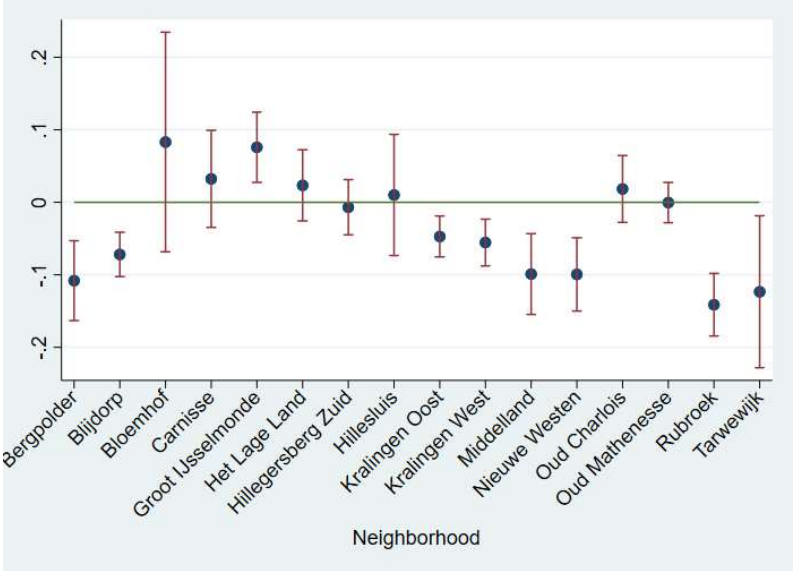

Figure 3: Impact on house prices in treated neighborhoods. Vertical axis demonstrates the change in price of units transacted in treatment neighborhoods. Horizontal axis is treatment neighborhood names. The dot gives the coefficients of the interaction term treatment neighborhood dummy and after the policy implementation. Red vertical lines are 95% and 5% confidence bounds.

4.3 Self-occupancy obligation and different housing sectors

I continue to explore the impact of the self-occupancy obligation on different housing sectors, namely the low to middle-priced sector with the WOZ value at the transfer date upto the threshold value of that year, and the high-priced sector with the WOZ value at the transfer date above the threshold value of that year. The regression results are presented in Table 3. The table includes three columns, each column represents a different model specification and sub-sample. Two types of time, the 6-digit postal code and the linear neighborhood trend "Neighborhood $\times$ Year of transfer" fixed effects are used in all models.

Firstly, in column (1) and (2), I focus on the policy impacts on different sectors based on the threshold values. Both model specifications include house characteristics. Model (1) uses the sub-sample of the low to medium-priced housing sector. The result shows a 3.59% decrease in this sector within treatment neighborhoods in relative to this sector in control neighborhoods. The coefficient is statistically significant at a 99% confidence interval. Model (2) examines the sub-sample of the high-priced housing sector. The coefficient reveals a 4.07% decrease in housing prices. However, the coefficient is only significant at a 90% confidence interval. These findings align with expectations that the policy declines the housing prices in both sectors within the treatment neighborhoods compared to control neighborhoods.

Table 3: Regression results - Triple differences

	(1) WOZ under threshold	(2) WOZ above threshold	(3) All observations
Treatment neighborhood ×	-0.0366***	-0.0416*	-0.0674***
After the policy implementation	(0.00812)	(0.0170)	(0.0139)
Treatment neighborhood ×			0.00147
Treatment sector			(0.00901)
After the policy implementation ×			0.0559***
Treatment sector			(0.00699)
Treatment neighborhood ×			0.0236
After the policy implementation ×			(0.0199)
Treatment sector			
Agreement month fixed effect	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes
Neighborhood × Year fixed effect	Yes	Yes	Yes
PC6 fixed effect	Yes	Yes	Yes
Observations	19703	7925	28369
R-squared	0.947	0.920	0.963

Note: The dependent variable the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Bootstrap-robust standard errors with 20 replications in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Column (3) is the regression results of the triple-differences (DDD) model (model 4)) which allows for the examination of the combined effects of both treatments: treatment neighborhood (inside 16 neighborhoods) and treatment sector (under a certain WOZ value). The coefficient of the interaction term "Treatment neighborhood × Under threshold × After the policy implementation" shows the combined treatment effect of both the treated neighborhood and the low to middle-priced housing sector. The result shows that there is a 2.39% increase in prices of the low to middle-priced housing sector relative to the high-priced housing sector within the treatment neighborhoods. The coefficient is not statistically significant, implying a lack of impact on the pricing dynamics between these two sectors within regulated neighborhoods.

4.4 Discussion

The regression results provide insights into the impact of the self-occupancy obligation on housing prices within 16 treatment neighborhoods. The findings suggest a heterogeneous effect of the policy across different time windows, neighborhoods and housing sectors. In general, the implementation of the self-occupancy obligation in Rotterdam has successfully decreased the property prices throughout the housing market in regulated neighborhoods. The impact is stronger when using the longer

time window. It is also noteworthy that the heterogeneity among neighborhoods are not uniform as most of the neighborhoods experience a downward trend, yet some do not have any change, or even have an upward trend in housing prices. As a whole, these results are consistent with the expectation and goal of the self-occupancy obligation. However, when focusing on the targeted sector in regulated neighborhoods, the obligation is found to be ineffective.

Firstly, the regulation discourages buy-to-let buyers to join the market. The mechanisms behind this effectiveness seem to be a combination of previous anti-speculative regulations that are mentioned in Subsection 2.2. On one hand, the regulation restrains buy-to-let buyers to participate in the low to middle-priced housing sector by prohibiting renting the property out within a certain time after the transfer. On the other hand, buyers that have enough resources to join the high-priced housing sector have to pay higher transaction expenses (e.g. transfer tax) and holding expenses (e.g. property tax). In short, it becomes more costly to own a property for investment purposes.

Secondly, the self-occupancy obligation makes the market more accessible for owner-occupiers. Due to the decrease in investor demand, the market becomes less competitive and owner-occupiers have more opportunities to purchase properties. As buy-to-let buyers have been outbidding for the recent years, after the policy implementation, prospective buyers can buy houses with more reasonable prices. Furthermore, the speculation phenomenon in the Netherlands in recent years is caused by the limited rental housing. When a number of renters become buyers, the demand for rental housing also decreases, in turn the yields from renting out or owning properties are lower. These all factors can contribute to a decline in housing prices.

Thirdly, for neighborhoods that experience no change or increase in housing prices, it may be the short-term effect of the regulation. It is crucial to consider the market elasticity in order to capture the dynamics of policy impact. It is proposed that some laws, including those restricting property rights, may not have the desired result immediately. While the impact may be small, insignificant or ineffective in the short term due to the lagged effect, policy can influence market behavior over time and lead to more significant outcomes when market participants have a clearer understanding about the regulation. Therefore, it is possible that the current study covers only short-term effects of the policy and requires a longer period for a thorough evaluation.

Future research could take into account using a long-term dataset to capture the likely lagged effects of this self-occupancy regulation in some neighborhoods. In addition, collecting information on distinguished buyer groups (owner-occupied buyers and buy-to-let buyers) will make it possible to conduct a more thorough analysis of how the policy will affect different groups on the housing market. These additional elements will improve the accuracy of the assessment and provide more insights into the overall effectiveness and implications of the policy.

5 Sensitivity analysis

To ensure the robustness of the analysis, a series of sensitivity analyses are performed by running the aforementioned models on different sub-samples.

Firstly, instead of using the linear neighborhood trends fixed effect variable, I use the non-linear neighborhood trends fixed effect variable for the models by including the quadratic term "Neighborhood × Year^2". Model 2 and 4 are analyzed again using this quadratic trends fixed effect variable. The sensitivity analysis results are shown in Table 4.

Table 4: Sensitivity analysis – Quadratic trends fixed effect

	(1) All observations	(2) WOZ under threshold	(3) WOZ above threshold	(4) All observations
Treatment neighborhood ×	-0.0363***	-0.0367***	-0.0416*	-0.0675***
After the policy implementation	(0.00738)	(0.00944)	(0.0169)	(0.0143)
Treatment neighborhood ×				0.00147
Treatment sector				(0.00925)
After the policy implementation				0.0559***
× Treatment sector				(0.00718)
Treatment neighborhood ×				0.0236
After the policy implementation				(0.0205)
× Treatment sector				
Agreement month fixed effect	Yes	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes	Yes
Neighborhood × Year fixed effect	Yes	Yes	Yes	Yes
Neighborhood × Year^2 fixed effect	Yes	Yes	Yes	Yes
PC6 fixed effect	Yes	Yes	Yes	Yes
Observations	37652	19703	7925	28369
R-squared	0.955	0.947	0.920	0.963

Note: The dependent variable is the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Bootstrap-robust standard errors with 20 replications in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The results of the sensitivity analysis are not significantly different from the baseline models. However, when considering the standard errors of both baseline results and sensitivity analysis results, it is noteworthy that the statistical significance levels of column (3) and the interaction term "Treatment neighborhood × After the policy implementation × Treatment sector" in column (4) are uncertain. There is a lack of strong evidence of the regulation impact on the high-priced housing sector, hence, the difference in change between the two housing sectors within treatment neighborhoods. It is possible that buy-to-let investors leave the market rather than shifting from the lower sector to the high-priced housing sector. Con-

sequently, the increasing demand by owner-occupied buyers to the targeted sector offset the decrease in investment demand, resulting in the increasing housing prices in the low to middle-priced sector relative to the high-priced sector in treatment neighborhoods. However, due to the lack of data about buyer groups, the question about the real mechanisms is left open.

Secondly, the difference-in-differences model (model 2) is assessed on several sub-samples with different distances to the regulated neighborhoods' border and different price ranges around the WOZ value threshold. Table 5 shows the results of the robustness checks of the difference-in-differences model.

In the first two columns, I use 2 different distances from the treatment neighborhoods' border. Given that the 16 regulated neighborhoods are relatively small and in close distance to the city center which primarily consists of residential properties rather than industrial properties like the outskirts, it is reasonable to examine sub-samples within a maximum distance of 5000 meters from the regulated neighborhood border. The result in column (1) shows that the policy makes negligible difference between the housing market in regulated and unregulated neighborhoods when taking into account housing within 500m from the border. In column (2), the impact is smaller in comparison with the baseline model where $\beta_1 = -0.0363$. However, it is still statistically significant. This suggests that the impact varies across various sub-samples based on the distance to the treatment neighborhoods' border.

Column (3) and (4) run the model with different WOZ value ranges, namely $\pm 20\%$ and $\pm 50\%$ around the threshold at time of transfer. The results show that the smaller the range around the threshold, the smaller the impact of the regulation. It is noteworthy that the coefficient in column (4) is consistent with the baseline model and statistically significant at a 99% confidence interval while the coefficient in column (3) is not significant.

Column (5) and (6) use more restrictive sub-samples based on not only the distance to the border but also price ranges around the WOZ value threshold. The coefficients in column (5) and (6) are consistent with those in column (3) and (4). In short, these results imply that the regulation impact varies over both distance to border and price ranges. However, it seems that housing within the $\pm 50\%$ WOZ value threshold is more sensitive with the policy than the rest and they nearly capture all effects of the regulation.

Thirdly, the triple-differences model (model 4) robustness is examined using the same sub-samples as the previous sensitivity test. The findings of this analysis are presented in Table 6. The coefficients of the interaction term "Treatment neighborhood $\times$ After the policy implementation $\times$ Treatment sector" have some changes in comparison to the baseline model where $\beta_5 = 0.0236$.

Table 5: Sensitivity analysis – Difference-in-differences

	(1) Distance to border ≤ 500m	(2) Distance to border ≤ 5000m	(3) ±20% around WOZ threshold	(4) ±50% around WOZ threshold	(5) Distance to border ≤ 5000m, ±20% around WOZ threshold	(6) Distance to border ≤ 5000m, ±50% around WOZ threshold
Treatment neighborhood ×	0.0124	-0.0271***	-0.0260	-0.0314***	-0.0254	-0.0314**
After the policy implementation	(0.0129)	(0.00642)	(0.0136)	(0.00942)	(0.0144)	(0.0108)
Agreement month fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Neighborhood × Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
PC6 fixed effect		Yes	Yes	Yes	Yes	Yes
Observations	18574	35013	7806	20231	7763	20186
R-squared	0.955	0.955	0.941	0.936	0.941	0.936

Note: The dependent variable the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Sensitivity analysis – Triple differences

	(1) Distance to border ≤ 500m	(2) Distance to border ≤ 5000m	(3) ±20% around WOZ threshold	(4) ±50% around WOZ threshold	(5) Distance to border ≤ 5000m, ±20% around WOZ threshold	(6) Distance to border ≤ 5000m, ±50% around WOZ threshold
Treatment neighborhood ×	-0.0200	-0.0665***	-0.0168	-0.0436***	-0.0167	-0.0436**
After the policy implementation	(0.0121)	(0.0140)	(0.0153)	(0.0124)	(0.0236)	(0.0149)
Treatment neighborhood ×	-0.0200	0.00167	-0.00254	-0.00593	-0.00253	-0.00593
Treatment sector	(0.0103)	(0.00884)	(0.0124)	(0.0113)	(0.0151)	(0.00875)
After the policy implementation ×	0.0567***	0.0570***	0.00561	0.0443***	0.00561	0.0443***
Treatment sector	(0.0111)	(0.00683)	(0.0109)	(0.00777)	(0.0102)	(0.00671)
Treatment neighborhood ×	0.0149	0.0227	0.0104	0.00935	0.0104	0.00935
After the policy implementation × Treatment sector	(0.0128)	(0.0178)	(0.0224)	(0.0149)	(0.0268)	(0.0167)
Agreement month fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Neighborhood × Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
PC6 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14745	28328	6299	18453	6299	18453
R-squared	0.965	0.963	0.895	0.935	0.895	0.935

Note: The dependent variable is the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Bootstrap-robust standard errors with 20 replications in parentheses; *** p<0.01, ** p<0.05, * p<0.1

When using the sub-samples based on the distance to the border in column (1) and (2), we can see that as the distance interval around the border decreases, the coefficient becomes lower. This implies a weakening impact of the regulation on properties closer to the border. However, those coefficients remain insignificant, the same as the baseline model result. Regarding the WOZ value ranges around the threshold in column (3) and (4), the coefficients become closer to zero when widening the price ranges, emphasizing the lack of effectiveness. The coefficients in column (5) and (6) have no difference from the results in column (3) and (4). As mentioned above, the housing with WOZ value within ±50% around the threshold may capture most of the regulation's impact, these findings strengthen the hypothesis that the policy makes no significant difference on the low to middle-priced housing sector compared to the high-priced housing sector.

Taken together, the results of these above sensitivity analyses indicate that the distance to border and the price ranges around the WOZ value threshold may play a role in moderating the effectiveness of the self-occupancy obligation. As the impact is weaker when getting closer to the border, and the impact level may vary over different price ranges. However, the overall conclusion remains unchanged, that the policy has succeeded in cooling down the housing market in 16 treatment neighborhoods in general. Nevertheless, within these neighborhoods, there is no significant difference in change of housing price between the low to middle-priced sector and the high-priced sector.

Last but not least, I test the robustness for models in proposition 3 by using an alternative way to categorize the low to medium-priced and the high-priced housing sectors. Since the criteria to categorize housing sectors can change from time to time, and it is unclear how the maximum mortgage of NHG is evaluated, therefore, the WOZ value in 2022 (which is the 2021 reference) of every observation can be used to define the housing sector. As mentioned above, most of the WOZ value of the properties is updated yearly and in line with the market. Hence, we can identify a low to middle-priced house by looking at the WOZ value in 2022 rather than comparing the past data. Assuming that all houses in the dataset were sold in 2022, if the 2022 WOZ value is under the threshold €355,000, the property is in the targeted sector. By using this threshold, approximately 63.4% of transactions in the dataset falls under the targeted sector instead of 70.7% like in the baseline model. The mean transaction price of the targeted sector in the baseline model and this robustness check model are 229,807.5 and 192,892.4 respectively. The models in proposition (3) for analyzing impact of the regulation on different sectors are run again with this alternative WOZ threshold. Table 6 reports the sensitivity analysis results.

Using the alternative way to categorize housing sectors, the sensitivity analysis results are not significantly different from the baseline results (Table 3). Column (1) and (2) find that the regulation makes a slightly stronger impact meanwhile, in column (3), the coefficient of the interaction term "Treatment neighborhood × Under threshold × After the policy implementation" is consistent with the baseline model and remains statistically insignificant. In conclusion, by either way we use to categorize different housing sectors, the regression results still show that this

Table 7: Sensitivity analysis - Alternative WOZ threshold

	(1) WOZ 2022 ≤ €355,000	(2) WOZ 2022 ≥ €355,000	(3) All observations
Treatment neighborhood × After the policy implementation	-0.0399*** (0.0103)	-0.0432* (0.0178)	-0.0549*** (0.00900)
Treatment neighborhood × (WOZ 2022)			-0.0186
Treatment sector			(0.0101)
Treatment sector (WOZ 2022) × After the policy implementation			0.0866*** (0.00714)
Treatment neighborhood × Treatment sector (WOZ 2022) × After the policy implementation			0.0219 (0.0131)
Agreement month fixed effect	Yes	Yes	Yes
Transfer month fixed effect	Yes	Yes	Yes
Neighborhood × Year fixed effect	Yes	Yes	Yes
PC6 fixed effect	Yes	Yes	Yes
Observations	22682	13003	36455
R-squared	0.943	0.934	0.960

Note: The dependent variable is the log of transaction price; Housing characteristics are included as explanatory variables in every model specification; Bootstrap-robust standard errors with 20 replications in parentheses; *** p<0.01, ** p<0.05, * p<0.1

regulation can decrease housing prices in the targeted sector when comparing treatment neighborhoods versus control neighborhoods. However, within the treatment neighborhoods themselves, there is a lack of impact on the low to middle-priced housing sector compared to the high-priced sector.

6 Limitations

This research has a number of limitations which mainly stem from the data availability that can be improved for further research. Firstly, the housing sectors (low to middle-priced and high-priced housing sectors) are not well defined. In the baseline models, the maximum mortgage amount of NHG is used as the annual threshold. However, it is unclear how this amount is evaluated in practice or whether it can be used to categorize housing sectors. In the sensitivity analysis, the WOZ value in 2022 is used to divide the housing market into two sectors, even for the transactions in the past. However, this assumption ignores potential changes in house characteristics over time, such as renovations or depreciation, that could affect how a property is classified. Future research could consider more comprehensive measures to define the housing sectors to overcome this constraint.

Secondly, this research makes an assumption that every house falling under the regulation does not get any exceptions for renting. For example, the house can be rented out to first-degree or second-degree relatives, or if the owner of the house is going on a longer trip, etc. In fact, speculators may take advantage of these loopholes and purchase regulated housing with the intention of renting it out while waiting for the market price to reach a desired level. This can bias the findings about the influence of policy. More data on the use of properties can be collected for further studies.

Thirdly, there is a lack of evidence about the mechanisms of the regulation effectiveness. The current explanation on mechanisms is based on previous studies. However, due to the potential external validity of those studies, these explanations might be irrelevant in this context. To gain a comprehensive understanding of the policy's effectiveness, future research can concentrate on examining its impact on distinct buyer groups, namely buy-to-let buyers and owner-occupied buyers, as they tend to have different expectations, behaviors and impact when participating in the market. By evaluating these buyer groups separately, we can gain insights into whether the policy is having varying effects on different buyers and better understand the overall results. Furthermore, as I expect a number of renters to become buyers that makes the yields from renting out and owning a property decrease, a data of the rental market might be helpful to understand the interaction between renting and owning market. Hence, we can gain more insight into the mechanisms of the regulation.

7 Conclusion

Even though housing speculation can assist the economy by enhancing the market's efficiency and liquidity, the negative impacts of it are undeniable. Housing speculation causes information distortion and uncertain equilibrium market pricing which makes the transaction housing price higher than the fundamental value. Due to its negative externality, several regulations have been passed to control the housing price, which is a growing concern for both policymakers and academics. In many countries, governments implement different anti-speculative regulations such as taxation, financial limitation, buyer limitation, etc. In the Netherlands, one of the current regulations is self-occupancy regulation which requires home-buyers to reside in the property within some certain years before being allowed to rent it out.

In this research, I aim to estimate the effects of the aforementioned regulation on the housing market in the municipality of Rotterdam. This regulation is applied for housing with WOZ value under a threshold within 16 neighborhoods in Rotterdam. A transaction dataset on house sales from January 2013 through December 2022 is used. I use the event study analysis to study the pre-treatment period trend before employing the difference-in-differences method to determine the average treatment effect between treated and untreated neighborhoods. The triple-differences model is then used to delve deeper into the impact of the regulation on the low to middle-priced housing sector within regulated neighborhoods. Based on

graphic demonstration and quantitative analysis, it can be concluded that in general, the regulation has decreased the housing prices in 16 treatment neighborhoods in the short term. The coefficients obtained from different model specifications with different time windows, distance to border windows and price ranges consistently indicate a significant negative price change in these neighborhoods. It is noteworthy that the impacts of this regulation on each neighborhood are different, some experience no impact meanwhile the others may have an increase in housing prices. However, when considering the treatment neighborhoods themselves, the regulation is proved to have no significant impact on the targeted housing sector, which is the low to middle-priced housing sector.

These findings contribute to the existing literature on anti-speculative regulations by highlighting the importance of taking spatial, time and price ranges heterogeneity into account when analyzing the effectiveness. This research clearly illustrates the impact of the regulation, but it also raises the question about the mechanisms through which the regulation influences the housing market, the factors that cause the heterogeneity among treatment neighborhoods and whether the results change in the long term. To better understand the implications of these results, future research is needed to investigate the impact of the regulation on buyer groups or the interaction between renting and owning market.

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