Analyzing Municipal Characteristics on Different Types of Vacancy Rates in the Netherlands

Lars van den Bogaert (0744670)

Utrecht University, l.p.vandenbogaert@students.uu.nl

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Dr. ing. Jaime Soza Parra (Thesis supervisor)

Dr. Irina van Aalst (Second assessor)

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FOREWORD

When I look back at my time at Utrecht University, I reflect on a great time. During this time, I developed scientific thinking skills and gained essential knowledge in the field of geography. Also, my interest in economic geography and real estate has been developed during my master's. Additionally, I built an extensive network of fellow students and teachers and I had the opportunity this year to work as an ambassador for the master program.

I would like to thank my internship address, Colliers, for allowing me to write my thesis there and for introducing me to the real estate world. Over the past few months, I have met many new people and gained a better understanding of how this field is structured.

I also would like to thank my direct internship supervisor at Colliers, Wouter Renardel de Lavalette, for his help and advice throughout the process. I was given a lot of freedom during my internship. Additionally, I would like to thank all the other colleagues involved for the enjoyable and educational time.

Finally, I would like to thank Jaime Soza Parra for his guidance as my thesis supervisor. Whenever I had a question or asked for feedback, he was always ready and provided a quick response even in the last weeks before the deadline. Sometimes, research does not always go as expected. In my case, there was a lot of incorrect data, which required making decisions later in the process. Despite this, Jaime supported and motivated me to keep going.

I hope you enjoy reading this thesis.

Lars van den Bogaert

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ABSTRACT

Over the last few years, the percentage of vacant shops has fluctuated significantly in the Netherlands. After COVID-19, the number of vacant shops seemed to decrease for an extended period, but since the first quarter of 2024, it has started to rise again. To gain a better understanding of how vacancy occurs, this thesis analyzes the association between municipal characteristics and retail vacancy rates in the Netherlands. Data from Colliers and the Central Bureau of Statistics (CBS) is used to obtain information on retail vacancies and municipal characteristics. A Panel Generalized Linear Model (PGLM) is conducted with information from 2015 to 2022, with frictional, long-term, and structural retail vacancy rates as the dependent variables. The results of the model show that higher incomes and urban areas are positively associated with frictional vacancy, while higher population density correlates positively with long-term vacancy. Structural vacancy is negatively associated with higher income and population density.

Keywords: *Retail Vacancy, Real estate, Frictional Vacancy, Long-term Vacancy, Structural Vacancy, Panel Generalized Data, Quantitative.*

SUMMARY COLLIERS

Colliers is a real estate consulting firm that is listed internationally. It has been providing professional real estate services throughout the Netherlands since 2000, with offices located in Eindhoven, Amsterdam, 's Hertogenbosch, Utrecht, and Rotterdam. Along with the Netherlands, the company operates in 65 other countries and has been in existence for over 100 years. In the Netherlands alone, Colliers employs about 380 people, out of which around 150 work in Amsterdam. Colliers offers advice to real estate users, investors, and owners. They offer their services in various sectors, including residential, healthcare, retail, sustainability, religious real estate, logistics, hotels, offices, and the hospitality industry. I have been part of the development & design department during my internship.

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INTRODUCTION AND RELEVANCE

1.1 Introduction

Retail vacancy have been an issue in several areas of the Netherlands. From 2008 to 2016, the percentage of vacant retail space increased a lot, reaching a 10% peak in 2016. This was primarily caused by a reduction in available retail space due to a high number of business closures (Netherlands Environmental Assessment Agency, 2016). As a result, over a tenth of all retail space is left unused, providing no value to retailers, consumers, and other stakeholders in the shopping areas.

After 2016, there is a period of decline until the COVID-19 crisis causes retail vacancy rates to rise again. The vacancy rate peaked at 7.5% in 2021. This number was even higher in the inner cities of the 40 largest cities, where almost one in ten shops were vacant, which resulted in a decline of 3,000 active retailers (Brinks, 2024).

In 2023, the vacancy rate then declined rapidly, reaching 6% for the whole of the Netherlands and around 8% for the bigger city centers. Towards the end of the COVID-19 crisis, retail vacancy rates start to show signs of recovery, with people returning to the shopping streets and new shops being added (Custers, 2023).

That positive trend seems to come to an end. More and more retail spaces are becoming vacant, and in the first quarter of 2024, this trend even accelerates (Kok, 2024). Of the 31,000 shops in city centers, more than 2,500 are now empty. These empty shops amount together for almost 433,000 square meters of unused property, an area equivalent to 60 football pitches (Colliers, 2023).

However, it is important to note that the vacancy rate alone does not explain the whole situation. It is crucial to make a difference between the different types of vacancies. Such as short-term vacancies of less than a year and long-term vacancies of more than a year. The longer a shop remains vacant, the more negative effects it has on the shopping street wich could lead to a downward spiral that results in fewer visitors and makes it more challenging for retailers to generate enough turnover (Colliers, 2024).

It is fair to say that retail vacancy is experiencing very chaotic times and currently seems to be rising again. Therefore, researching vacancy is important as it has a direct negative effect on surrounding shops (Buitelaar et al., 2013).

1.2 Problem definition

As discussed in the introduction, the Netherlands has been facing a issue of retail vacancy in various areas for many years. Vacancy rates have increased since 2008, reaching their peak in 2016 and again during the COVID-19 pandemic. This has had negative impacts on retailers, consumers, and the local economy (Verhoef, Noordhoff, & Sloot, 2023).

Although vacancy rates temporarily decreased after 2021, they have been on the rise again since early 2024. One of the main problems is that vacancy can lead to a negative spiral for surrounding stores, meaning that vacancy can create even more vacancy and lead to negative effects such as bankruptcies, mortgage and investment write-downs, job losses, and increased regional inequality (Huizinga & Ossokina, 2014).

Furthermore, retail vacancy is not just a problem for building owners; it affects society as a whole. When areas have many empty buildings, it can lead to an unattractive shopping environment, which eventually can cause a decline in the livability of the neighborhood, an increase in crime, and a lower standard of living. Empty retail spaces, for example, are ideal for illegal activities such as money laundering and illegal hemp plantations (RPC, 2020; Talen, 2022).

Another group affected by retail vacancy is institutional investors, such as pension funds and insurers. They are particularly impacted by the decline in value that occurs due to vacancy. This devaluation can also cause a localized domino effect, resulting in further losses in the real estate value of properties around the vacant building (Ouwehand, 2018). One consequence of this domino effect is that the livability of the city center comes under pressure. This is a serious concern for the government and private parties (Kaal, 2011) on both local, and national level, since on of their main goals is to create a livable city center (Baggerman, 2022).

1.3 Societal relevance

High retail vacancy rates in the Netherlands can cause serious social problems. Inner-city shopping areas are fundamental to the functioning of a city and play an important role in the urban structure due to the strong relationship between shops and the vibrancy and service level of a city (van der Wal et al., 2016).

The societal impact of retail vacancies extends to influencing local government policies and urban planning, which can play a crucial role in revitalizing neighborhoods and supporting local economies (Kickert & Talen, 2022). Hospers (2015) highlights that retail vacancy in city centers is a growing problem due to the rise of online shopping, changes in time use, and a decrease in population. In today's society, city centers are increasingly becoming meeting places and are thus vital to a community. A high vacancy rate in the city center is therefore detrimental to the livability of residents, retailers, and visitors. Hospers argues that urban redevelopment, investment in the atmosphere, and unique crowd pullers are essential to keeping city centers attractive and combating vacancy.

1.4 Academic relevance

In previous research, Mallach (2018) stated that vacant properties are a problem since they are a symptom of other issues such as concentrated poverty, economic decline, and market failure. Mallach's (2018) study examines the concept of vacancy in general but not specific on retail.

Park and Talen (2021) researched urban retail vacancy in Chicago and identified three main causes: structural changes in the retail industry, demographic shifts, and rising operational costs. Their findings suggest that both broad industry trends and specific local factors must be considered in addressing urban retail vacancies.

Benjamin et al. (1998) researched how retail space demand and supply react to changes in retail sales, rental prices, land-use regulations, land availability, and the cost of capital. They discovered that there are inelastic price elasticities for both the demand and supply of retail space, which indicates a mismatch in the quantity and location of retail space demanded and supplied. This difference leads according to Benjamin to retail vacancy.

Later, Benjamin et al. (2000) researched how local retail vacancy rates are influenced by national and local economic conditions. They discovered a significant spatial correlation in vacancy rates among neighboring metropolitan areas, indicating that local factors have a high influence on retail vacancy rates. Their study also showed that these local rates stay consistent over time. Although spatial factors are dominant, changes in the national vacancy rate also significantly impact local vacancy rates according to Benjamin. Their research suggests that to effectively deal with retail vacancy issues, we need to consider both local dynamics and broader economic trends.

Wurtzebach et al. (1991) mentioned that researching retail vacancy is crucial for various economic stakeholders, including property owners and investors. They mentioned that high vacancy rates can significantly impact the return on investment for commercial real estate, leading to decreased property values and increased financial risk for investors.

Zweeden (2009) investigated retail vacancy in Dutch city centers, exploring reasons for differences between cities. He concluded that key factors for retail vacancy are structural changes in the retail industry, demographic shifts, and rising costs for retailers.

Verwijs (2022) studied retail vacancy in Dutch neighborhoods. Verwijs found that vacancy rates are positively associated with population characteristics, urbanity, and property transformations from retail stores to housing. Verwijs also found that construction before 2000 and higher average housing values had a negative association with retail vacancy.

Already a lot of research has been conducted on the topic of retail vacancy and its influencing factors. However, all of these studies share a common characteristic, which is the lack of differentiation between types of vacancy and a specific focus on retail vacancy.

To fill in this lack of focus, this thesis will address the gap highlighted by Tool (2018) and Verwijs (2022) for further investigation. Verwijs and Tool both suggest in their research that it will be essential to research the differences between structural, frictional, and long-term vacancies in the future. By conducting this research, I aim to bridge this gap and gain a deeper understanding of the various municipality characteristics and their influence on these three types of vacancy.

1.5 Research objective

The primary objective of this study is to understand which municipal characteristics are associated with higher or lower retail vacancy rates. This study is unique because, for the first time, data on different types of vacancy—structural, frictional, and long-term—will be available and analyzed.

1.6 Research question and sub-questions

Based on the problem definition and the research gap, this research aims to answer the following research question: "What is the association between municipality's types of retail vacancy rates and specific municipality's characteristics in the Netherlands between 2015 – 2022?"

To answer this question, two sub-questions are established. The first sub-question is: *"What are the various types of retail vacancy according to the literature?"* It is important to understand the different types of vacancies because it is fundamental for our analysis.

After describing the different types of retail vacancies, the next step is to examine the factors contributing to these vacancies, as identified in academic literature. This leads to the research question*: "What are the determinants of retail vacancy identified in academic literature?"* Several studies already investigated the determinants of vacancy in various real estate sectors such as offices, houses, and retail. Their outcomes will be used for the selection of determinants to be examined in this research.

1.7 Thesis outline

The introduction chapter provides background information regarding the relevance, research question, and problem statement. Chapter 2 consists of scientifically relevant research. The chapter starts by explaining traditional location theories and how the real estate market works, followed by more detailed research about vacancy and the determinants of retail vacancy. Chapter 3 provides an overview of the data collection and the methods that have been used in this research. Chapter 4 presents the descriptive statistics and the results of the statistical analysis, followed by a conclusion in Chapter 5. In Chapter 6, the research findings will be discussed and interpreted, followed by the limitations of this study and recommendations for future research and policy.

LITERATURE REVIEW

This chapter will provide the theoretical background for this thesis. The literature review will start by explaining background information about traditional locational theories. Understanding these locational theories gives a better understanding of how our retail landscape was formed and why retailers choose certain locations to start a business. After the traditional theories, different forms of vacancy will be discussed. Next, the retail real estate market and its impact on a vacancy will be explained, followed by an explanation of several factors that influence vacancy. The theoretical background and literature review will then contribute to setting up several hypotheses for the analysis.

2.1 Location theories.

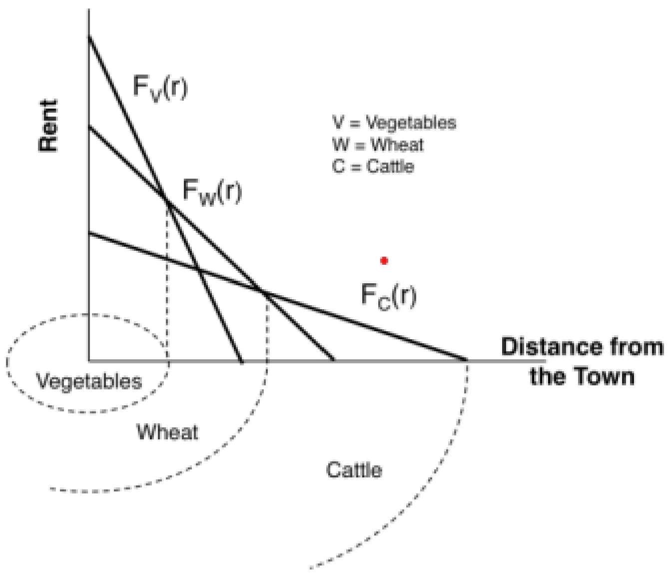
2.1.1 Von Thünen model

Johann Heinrich von Thünen was one of the first scientists to study company locations. He created the land use theory in his paper "Der isolierte Staat" (1826), which served as the foundation for classical location theories. Von Thünen attempts to explain land use by examining the distance from the central market (Figure 1). (Atzema et al., 2002; Harvey & Jowsey, 2004). Although the theory focuses on agricultural land use, it can also be useful in explaining the locations of retail businesses.

Von Thünen's model contains several assumptions: (1) The city is centrally located in an autarky, surrounded by an agricultural hinterland and untouched wilderness. (2) The terrain is flat with no rivers or mountains, and soil quality and climate are the same everywhere. (3) Farmers transport their goods by ox cart without roads and strive to maximize profits (Han et al., 2022).

When all assumptions are met, Von Thünen describes that around the city, four agricultural rings can be distinguished. The first ring contains intensive agriculture and dairy production, with products such as vegetables, fruit, and milk. These products spoil quickly and have high transport costs and therefore are close to the city. The second ring includes wood and building material production, which are expensive and difficult to transport because of their weight. The third ring produces large-scale crops such as grain, which are less perishable and lighter, allowing them to be grown further from the city. The fourth ring contains livestock, which can move itself to the city, lowering transport costs (Sinclair, 1967).

Figure 1: von Thunen's Distance-Rent Curve (Yandri et al, 2018)



Von Thünen's theory can be used to explain the structure of today's inner cities, where retail and especially the big chains have established their branches in the best locations with the highest customer flows. This is possible because these branches manage to realize high returns per square meter (Piovani et al., 2017). Peripheral retail locations are also explained using this model. These shops, which require a lot of floor space and yield relatively little per square meter, are only profitable in peripheral locations where land prices are lower (Nozeman, 2012).

Today, the model is no longer accepted. Von Thünen's model is a simplified representation of reality and does not align with the current economic situation due to several invalid assumptions, such as the use of modern transport and the assumption of a homogeneous landscape with uniform soil quality. In reality, flat terrain is uncommon and soil quality varies (Singh, 2022). Nevertheless, it serves as a basis for more recent location theories described later.

The Von Thünen model was later modified and reconstructed by Alonso (1960). He developed a new model that was applicable not only to agriculture but also to other sectors, allowing the theory to be considered a more general theory.

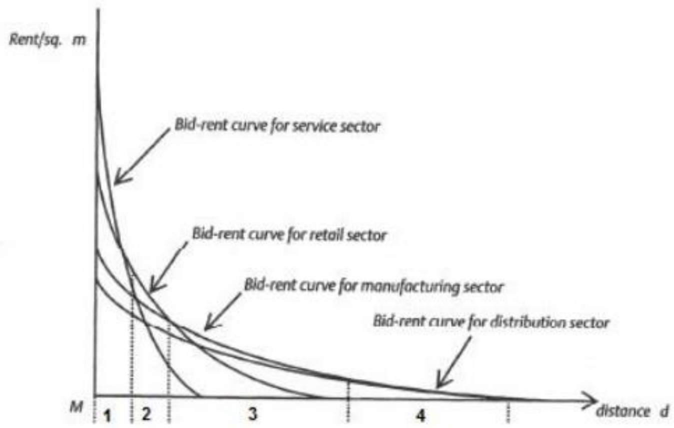
2.1.2 Bid Rent Theorie

In 1960, Alonso developed the Bid Rent model, which was based on Von Thünen's theory of agricultural land use. However, Alonso focused more on the urban level to create a general theory. One of the important assumptions Alonso stated in his research is that all amenities compete for the best accessible location (the center) in a region (Brown, 1987).

Alonso's (1960) model introduces the bid-rent curve, which indicates how much a company is willing to pay per square meter in a given location. A site close to the market is more attractive, so the curve is steep near the market (M). As you move further away from the market, the curve flattens, corresponding to the land-rent gradient in the Von Thünen model.

The model presents bid-rent curves for different sectors, including service, retail, factory, and distribution. The curve with the highest point in a given location determines which sector can generate the most profit there. In the diagram, the retail sector is positioned in Block 2, as it features the highest retail curve. In the context of the retail sector, this model indicates that shops with limited financial resources tend to be attracted to locations with lower rent levels, thus experiencing less foot traffic. This idea also explains why similar types of shops tend to be grouped in certain areas of the city, a also knowns as clustering. For example, big stores cluster in busy areas because they can afford the high rent and attract many customers, while smaller shops cluster in quieter areas where rent is lower, even though they get fewer customers (Van Dijk, 2009).

Figure 2 : Bid-rent curves for different sectors (McCann, 2021)



Bolt (2003) suggests that Alonso's model can also be applied to determine ideal retail locations. Instead of focusing on accessibility, Bolt focuses on pedestrian traffic. He posits that each retailer aims to have a spot in a high-foot-traffic area, which will drive up rental prices because of an increase in demand. Bolt (2003) categorizes retail locations as A, B, and C, with A1 having the highest foot traffic (index: 100) and C having the lowest (index: 5-10). A-locations attract the most attention from potential tenants, making vacancies less likely to occur in A areas compared to C locations, which means that investing in retail properties in A locations offers more certainty of stable income for the investor.

2.1.3 Christaller central place theory

Walter Christaller was a German researcher who studied the spatial patterns of cities. These patterns can be described using the "Central Place Theory" (Christaller, 1933). The Central Place Theory is also considered the best-developed normative theory regarding the location of businesses in the retail sector (Craig, Ghosh, & McLafferty, 1984). It provides a solid explanation for the spatial distribution of retail locations.

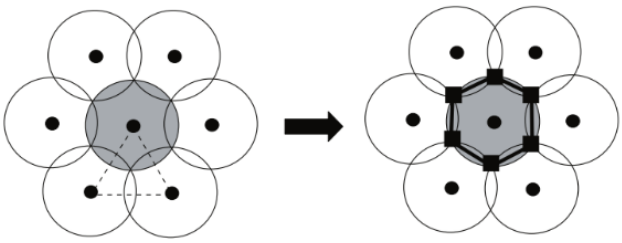
Christaller's theory explains the spatial patterns and sizes of places, as well as the relationship between market areas. The theory is build on two key concepts: range and threshold (Atzema et al., 2002). The range is the maximum distance a consumer is willing to travel for a service, under the assumption that the demand for a service decreases as the distance to it increases. It is also assumed that consumers will always choose the nearest available service.

The other key concept is the threshold, which is the minimum level of demand needed for a service to be economically viable. The range and threshold vary for different services, explaining why larger cities have more types of services than smaller towns. For example, an academic hospital requires a threshold that is not achievable in a small town (King, 2020).

Christaller's theory distinguishes different central places based on a rank orders. He assumes that a center of the highest order (e.g., a place with a university) offers all goods and services of lower-order centers, but not the other way around (Agarwal, 2001).

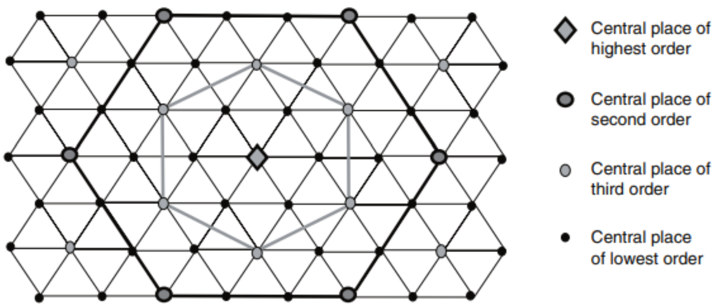
To visualize his theory, Christaller used polygons, because using circles would result in overlaps, causing monopoly positions to be lost. Polygons, on the other hand, fit together perfectly (Getis, 1966).

Figure 3: From circle to hexagon (Eiselt, h. a., & Marianov, v, 2011).



In Figure 4, the distribution of retail centers is illustrated using hexagons. The central place of the highest order, like a big shopping mall, is represented at the center. This mall has everything, from big department stores to luxury shops. The central place of the second order includes smaller shopping centers with useful places like supermarkets and specialty stores. The central place of the third order might consist of even smaller shopping areas with local grocery stores and a few shops. Finally, the lowest order represents tiny convenience stores in villages that only have basic items (Geurts, 2012).

Figure 4: Hierarchical structure of central places theory (Eiselt, h. a., & Marianov, v, 2011).



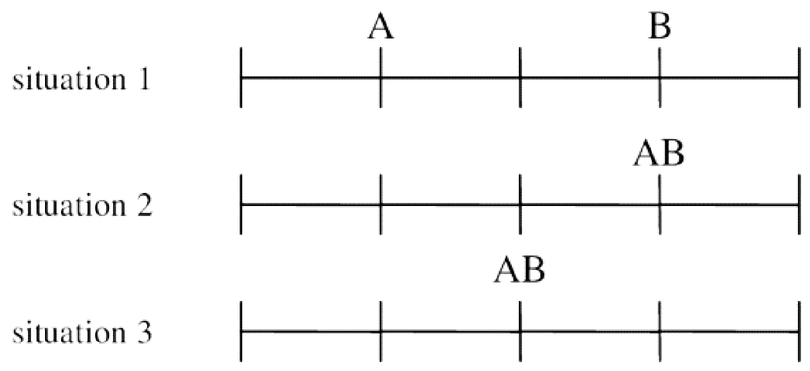
2.1.4 Hotelling's law

In 1929, US mathematician Harold Hotelling came with an important theory about the behavior of comapany’s in choosing a location.. In his article "Stability in Competition" in the Economic Journal (1929), Hotelling explains that businesses are influenced in their spatial behavior by the actions of competing firms. This behavior causes similar firms to cluster together, which is the opposite of the theory proposed by Christaller. Hotelling's theory focuses on finding the optimal location in the market, rather than minimizing costs or distance (Hotelling, 1929).

Hotelling (1929) described multiple examples about political parties, religious denominations, and cider dealers to explain his theory. However, the most used explanation comes from Lösch's book "The Economics of Location" (1954), where Lösch's explains the law based on two ice cream sellers on a beach.

In phase 1, (figure 5) there are two ice cream sellers operating on a beach. According to Christaller's theory, both are in the middle of their market area, each holding 50% of the total market. In phase 2, ice cream vendor A decides to place his shop next to his competitor, ice cream vendor B, to gain an advantage. As a result, ice cream vendor A now holds 75% of the market share, while ice cream vendor B holds only 25%. According to Hotelling (1929), the reaction is that ice cream seller B will 'jump' over ice cream seller A to regain his market share. This process will continue to repeat itself until, in phase 3, both companies are located side by side in the middle of the market. At this point, both parties again have a 50% market share. Since there is no incentive to change locations (as the process would repeat itself), this situation will be considered a retail equilibrium (Brown, 1989). Applying Hotelling's theory to this study of vacancy, it can be argued that when businesses are concentrated in the center, the old locations in situation 2 become less attractive for other businesses to settle, potentially leading to vacancies in these areas.

Figure 5 : Hotelling's law (De Bok, 2006)



2.1.5 Alfred Weber

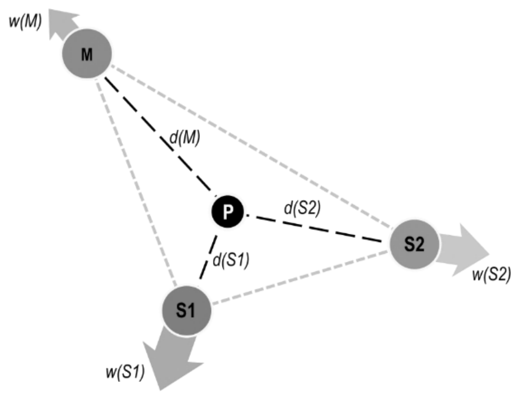
Alfred Weber was a German economist and is considered a pioneer in location theories within urban and regional economics. In his book "Über den Standort der Industrien" (1909), he introduced a model for the optimal location of industrial companies, aiming to minimize transportation costs (Church, 2023). Even though the theory focuses on industrial companies, it still provides a good foundation for the logic behind making decisions about retail locations.

Weber's model is based on several assumptions. These are: the company operates from a fixed location with a profit-maximizing goal; relocation costs are low; the final product uses a fixed ratio of raw materials; all actors have complete information; and transport cost functions are linear (McCann, 2001).

According to Weber's model, represented by the Weber-Moses triangle, a profit-maximizing company (P) will locate itself where transportation costs of raw materials and finished products are minimized. Figure 6, shows that the industrial company P is located at a cost-minimizing point between locations M, S1, and S2. S1 and S2 are suppliers that provide raw materials to P, while M is the market where P sells its final products. The distances between P and these points are represented by d(S1), d(S2), and d(M), showing the transportation costs.

In the scenario in figure 6, P is situated closer to S1 than to S2, because the transportation costs per unit of product from S1 are higher than those from S2. This causes the optimal point for P to be nearer to S1 to minimize total transportation costs. The total transportation costs, D, are minimized at point P, where D = d(S1) + d(S2) + d(M).

Figure 6 : Weber Triangle. (Van Dijk, M, 2009)



2.2 Real estate market theories

Real estate theories aim to answer why and how a particular property is developed and how and for what reasons the stock of a specific type of property changes over time (Ploeger, 2004). Over the past years, multiple models have been developed to explain the real estate market. These models share a central assumption: a real estate project is realized only if it generates a profit. This is because real estate is viewed either as an investment object or as a source of income.

2.2.1 Real estate market overview

Geltner et al. (2007) wrote in their book "Commercial Real Estate Analysis and Investments" about the basis of the real estate system. According to Geltner et al. (2007), this system consists of three components: the space market, the development market, and the asset market. Together, these components form the foundation responsible for changes in the built real estate stock. Figure 7 provides a visual representation of this system and shows the interconnected main elements of each component.

Figure 7 : The real estate system. (Geltner et al., 2006)

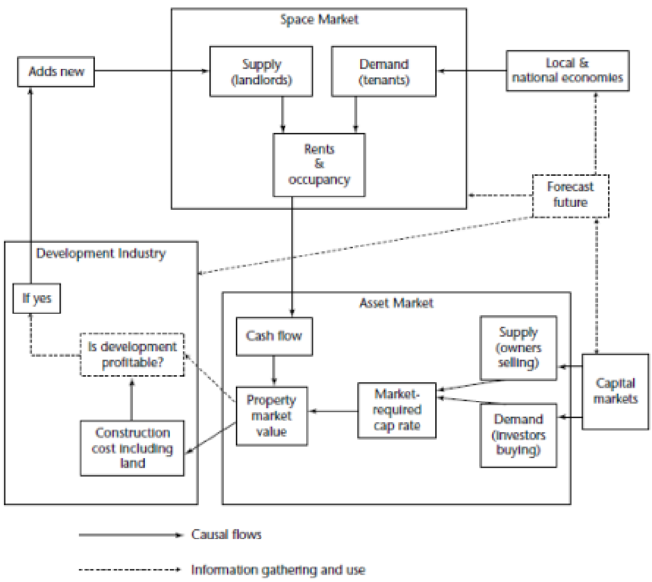


Figure 7 also illustrates the link between the different markets and their connections to national and international economies and capital markets. In the space market, there is an interaction with user demand for physical space, which determines rents and occupancy rates. The amount of physical space in the real estate stock is the responsibility of the development market (Geltner et al., 2007).

At the bottom of the figure, we see that the asset market is influenced by the space market. Operating cash flows in the form of rental income are a fundamental feature of the asset market. These rental flows, combined with the capitalization factor or return requirement of investors, determine the market values in the asset market. The market values created in the asset market are an important driver of the development market. When market values exceed development costs, new construction projects will take place, leading to an increase in supply (Geltner et al., 2007).

Connecting Geltner's findings with the real estate market, the PBL Netherlands Environmental Assessment Agency reports that an excessive increase in supply is one of the causes that lead to higher vacancy rates, especially in the years leading up to the crisis (PBL, 2014).

2.2.2 DiPasquale-Wheaton model

The four-quadrant model, developed by DiPasquale and Wheaton (1992), is used to explain the real estate market. Their model shows how supply and demand in the market are balanced, providing an overview of how the real estate market functions. It's important to note that DiPasquale and Wheaton's model was originally designed for the housing market; however, it can also be applied to the retail property market.

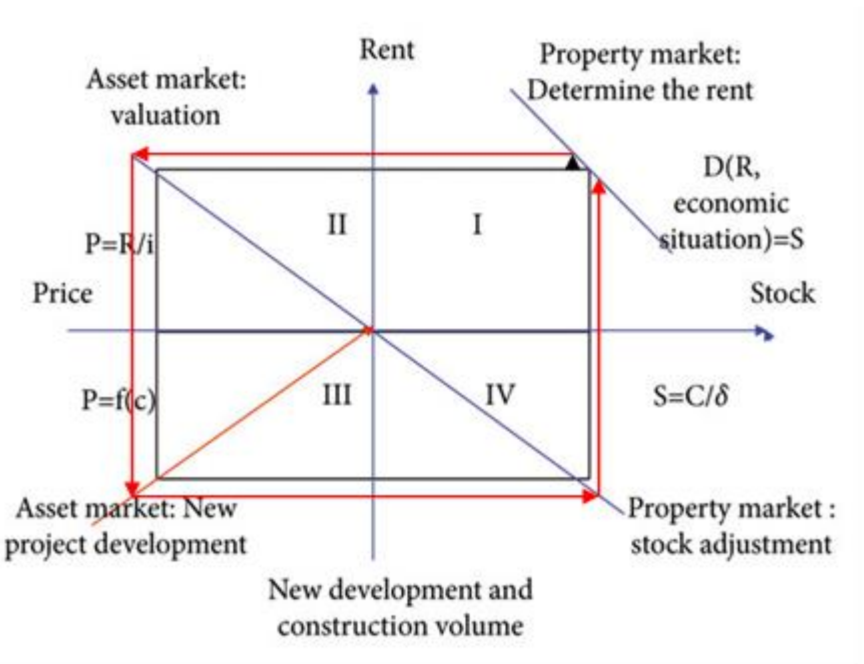
The model is divided into four quadrants. The two left quadrants (II & III) belong to the asset market and are split into valuations and development. The two right quadrants (I & IV) represent the property market and are divided into demand and stock adjustment. These markets have also been described earlier in Geltner's (2007) real estate market model.

To understand the model, it is important to notice that one of the characteristics of the real estate market is that the current supply of real estate cannot quickly adjust to changes in demand (Lentz & Tse, 1999). This is because it takes multiple years to develop and construct a building. As a result, rental prices are pushed up when there is a sudden increase in demand, as shown in figure 8. The black line in the figure represents the initial situation, while the red line shows a new situation with higher demand but the same supply. In quadrant I, the rent price is determined by the demand from the economy relative to the existing supply, causing rent prices to rise when demand is higher than supply, and to fall when supply exceeds demand (Garay, 2016).

The rent level has a direct effect on the investment value, which is determined in quadrant II. The value of real estate is calculated based on the rent level and the capitalization rate (Geltner et al., 2007). When rents increase and the capitalization rate remains constant (based on the market), the value of real estate goes up. The capitalization rate is a market-derived figure that is mainly influenced by the opportunity cost of capital, growth expectations, and risk. It represents the relationship between investment and income.

In quadrant III, the costs of new developments are determined by replacement value. The value from quadrant II and the costs in quadrant III determine whether the market can start new developments. A developer will develop this new construction if the returns exceed the costs and he expects to make profit (Lisi, 2015).

Figure 8 : Four-quadrant equilibrium diagram of the real estate (Li, 2022)

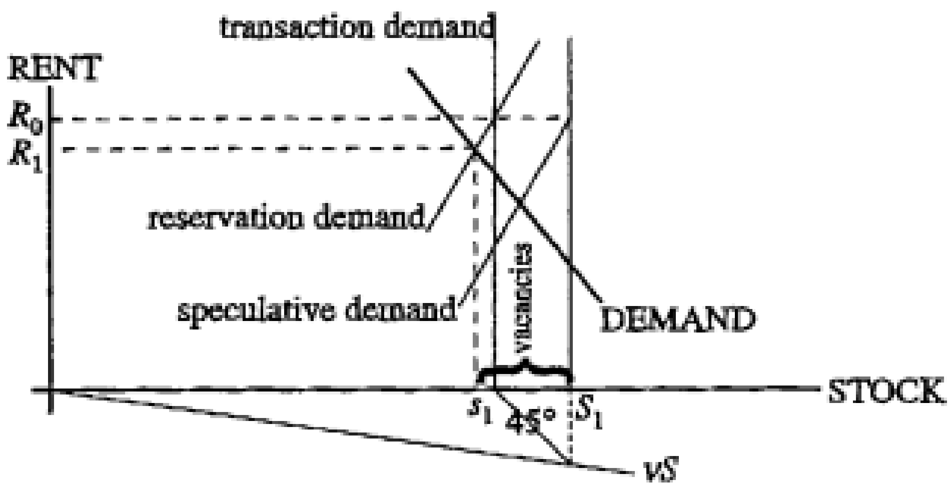


2.2.3 DiPasquale-Wheaton model and vacancy

DiPasquale-Wheton did not specifically describe retail vacancy in their model. This is because they assumed that the market always ends up with an equilibrium. Collwell (2002), however did described vacancy for the fisr time in his paper *Tweaking the DiPasquale-Wheton model*, he explained how vacancy can also be included in the model.

Colwell's model explains the demand for vacant units by landlords in two parts: natural vacancy and speculative demand. Natural (frictional) vacancy happens because tenants move out, and it takes time to find new tenants. This is a normal part of the rental process. Speculative demand occurs when landlords make decisions based on their expectations about future rent prices. If they think rents will go up, they might keep units vacant to rent them out later at higher prices. If they think rents are too high, they might rent out more units to take advantage of the current rates. Figure 9 shows how these two types of demand work together. The total demand for vacant units is where the speculative and transaction demand intersect, and this intersection helps determine the rent price.

Figure 9 : Determining vacancies in the four quadrant model (Colwell, 2022)



2.2.4 Vacancy

Dolega (2015) mentioned that the way retail vacancy is measured is very important.. The most obvious indicator, and probably the easiest to apply as done by research from (Verwijs, 2022) , is to use the total change in vacancy rate (Wrigley and Dolega, 2011; Balsas, 2014). Wrigley and Lambiri (2014) however, point out, that not all vacancy rates are the same. Long-term structural vacancy is probably a far better indicator than the general rate, as a short-term friction or churn-related vacancy is a natural phenomenon and is an important element of a center dynamic and adjustment. On the other hand, long-term vacancy might be a result of local factors, such as the low quality of physical fabric (not renovated buildings or streets) or poor location in terms of visibility for pedestrians (Dolega 2015).

The term "vacancy" is used in many different contexts, but a precise scientific definition is difficult to find. Researchers such as Benjamin et al. (2000), Keeris (2005), and Weimar and Koppels (2006) have studied its causes but did not provide a general scientific definition. Van der Voordt (2006) defines vacancy as "the non-let situation of an available property." A clear definition for retail vacancy is difficult to establish, but in his book "Transformation of Office Buildings" (2007), Van der Voordt presents a detailed classification of office space vacancies, grouping them into four categories with a total of thirteen types.

2.2.5 Types of vacancy

The first category is known as "Accepted Vacancy,”. Accepted vacancy covers types of vacancy that are expected during normal real estate operations. This includes "Initial Vacancy," which occurs after a property is developed or renovated; "Natural Vacancy," which is the standard vacancy level for a particular property type in a specific market; "Turnover Vacancy," which happens when tenants are changing; and ***"Frictional Vacancy,"*** which is a short-term vacancy lasting no more than a year, where delays in tenant replacement are not viewed as problematic. Geltner et al (2007) indicates that a certain level of frictional vacancy is necessary for the retail market to function properly. This is because vacancy allows existing shops to relocate directly to a new (higher) property for example.

The second category is called "Problematic Vacancy,". Problematic vacancy identifies situations where finding new tenants becomes challenging. This includes ***"Long-Term***

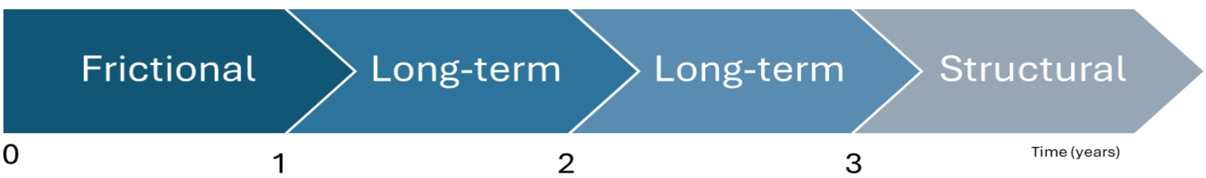
Vacancy," where properties remain unoccupied for up to two years after a frictional vacancy; and "Operational Vacancy," which occurs due to the property's bad performance. This can happen because the building has a old construction for example.

The third category is "Dramatic Vacancy,". Dramatic Vacancy describes problematic situations where the vacancy becomes, problematic. One of the types of dramatic vacancy is: **"Structural Vacancy",** which refers to properties that are vacant after 3 years of friction and long-term vacancy and have no prospect of finding a new tenant in the short term. Then there is "Structural Vacancy – Hopeless," where properties have been vacant for two years without future rental prospects, often failing to meet market demands. "Location Vacancy" involves properties in undesirable locations, making tenancy even more challenging.

The last category, "Administrative Vacancy," focuses on the financial implications of vacant properties. This includes "Economic Vacancy," which is related to revenue loss due to below-market demand; "Excess Vacancy," which is the difference between actual and natural vacancies when returns are compromised; "Financial Vacancy," marking financial losses due to unoccupied space; and "Pure Vacancy," which tracks the financial impact of vacancies, excluding those caused by ongoing construction.

Locatus (n.d) also categorizes vacancy into three types: frictional vacancy, lasting up to one year; long-term vacancy, lasting between one and three years; and structural vacancy, defined as three or more consecutive years. This is in line with the definition from Van der Voorts (2007).

Figure 10 : Duration of different types of vacancy



2.3 Determinants of Vacancy

Multiple studies have already been conducted on the determinants of vacancy. Groen (2015) conducted a study on retail vacancy rates in Dutch city centers and identified several significant determinants. Economic factors, such as Gross Regional Product (GRP), were found to play an important role, with an increase in GRP leading to a decrease in retail vacancy rates, particularly in A-locations (the most attractive retail locations). In contrast, spatial aspects, such as scale economies, had a negative impact on retail vacancy rates. This was especially visible in the C-segment of cities. Also characteristics of shops, such as the degree of branching, showed that higher levels of branching led to higher vacancy rates, with significant effects in the A segment. He also found that location-related factors played a role, such as the walking distance from the station to the city center, where shorter travel times were associated with lower retail vacancy rates.

2.3.1 Crime rates

Park and Talen (2021) conclude that multiple factors influence vacancy in the real estate retail market. These include the structural transformation of the industry, demographic changes, and increased costs for retailers. Structural transformation refers to long-term changes in the retail industry that are beyond anyone's control. These changes are related to consumer behavior, government actions, and technological innovations such as the rise of online shopping.

Park and Talen (2021) also found that crime rates can impact retail vacancy due to their influence on both consumer behavior and business operations. High-crime areas tend to shock customers, reducing foot traffic and sales, which can make it difficult for retailers to sustain their businesses.

These shocks can also cause a shopping area to enter a downhill spiral, as mentioned in the introduction (Ouwehand, 2018). This downward spiral occurs because vacant stores impact shopping areas, symbolizing business failure and economic decline for both individual businesses and the area as a whole (Teller and Elms, 2012).

Another consequence is that vacant buildings can become abandoned and reduce the sense of place in local communities (Coca Stefaniak et al., 2005; Katyoka and Wyatt, 2008; Wrigley and Dolega, 2011), leading eventually to the downfall of whole shopping areas (Grimmer, 2021).

2.3.2 Income

Ruiz-Rivera et al. (2016) conducted research on urban segregation in Mexico City, focusing on the availability of everyday consumer goods and services by examining the number of stores of a certain type. Their research compared segregated low-income, high-income, and non-segregated areas and found that low-income areas have the lowest retail density and less access to quality public services like education and healthcare. They concluded that income segregation creates unequal access to goods and services, excluding urban populations from collective benefits. Even though Ruiz-Rivera et al. (2016) do not specifically address retail vacancy in their paper, their research is a valuable reference for analyzing the average income in our model and exploring whether this factor influences retail vacancy in the Netherlands.

2.3.3 Urbanization

Hazelaar (2019) conducted research on different demographic factors influencing office vacancy in the Netherlands. Hazelaar concluded that the more addresses there are in the area around a property, the less potential there is for vacancy. Hollander et al. (2018) support this finding, stating in their paper that an increase in retail properties in an area is associated with a decline in retail vacancy. The Netherlands Bureau for Economic Policy Analysis (2016) also supports the statement that population density in the surrounding area is important. They state that “Retail locations in regions with rising populations will benefit at the expense of retail locations in areas with declining populations, where vacancy can become a structural phenomenon." Oskam (2021), however, disproves this outcome. He found that retail vacancies are less common in areas with lower urbanity (Level 5) compared to those with higher urbanity (Level 1).

2.3.4 Grey pressure

Figure 11: Eldery people per municipality 2024 (CBS, 2024)

One of the demographic trends that play in regions is aging. The population is getting older and, as a result, the population composition is changing. Figure 11 shows the grey pressure per municipality for 2024. What is srtands out is that there is primarily ageing in non-urban areas.

According to the PBL, one of the consequences of ageing is that the potential labour force is decreasing, and the share of pensioners is increasing (PBL, 2010). This shrinkage, can also affect consumers' buying behaviour, and as a result, the support base for facilities in a region with more elderly people can decrease (HBD, 2011). Mostert (2011) supports this by stating that the purchasing power of people over 65 is 20% lower than the average. He also states that this group spends less on items such as shoes and fashion which could reduce demand for stores in this industry.

Hanff (2020) supports this by arguing that consumers who are less mobile are also less able to shop. Ageing is, therefore, a negative factor for city centers and other shopping destinations that are at a greater average distance from consumers. This can lead to fewer store visits, which might contribute to a higher vacancy rate.

2.4 Research hypothesis

Based on the literature discussed above the following hypotheses will be taken into account during this research. The hypothesis have also been visualized in figure 12. :

Population Density

*H_0: Higher population density is **not** associated with lower retail vacancy rates.*

H_1: Higher population density is associated with lower retail vacancy rates.

Income

*H_0: Higher income is **not** associated with lower retail vacancy rates.*

H_1: Higher income is associated with lower retail vacancy rates.

Urban Classification

*H_0: Urban municipalities are **not** associated with lower retail vacancy rates compared to rural municipalities.*

H_1: Urban municipalities are associated with lower retail vacancy rates compared to rural municipalities.

Grey pressure

*H_0: Higher grey pressure is **not** associated with lower retail vacancy rates.*

H_1: Higher grey pressure is associated with lower retail vacancy rates.

Crime Rates

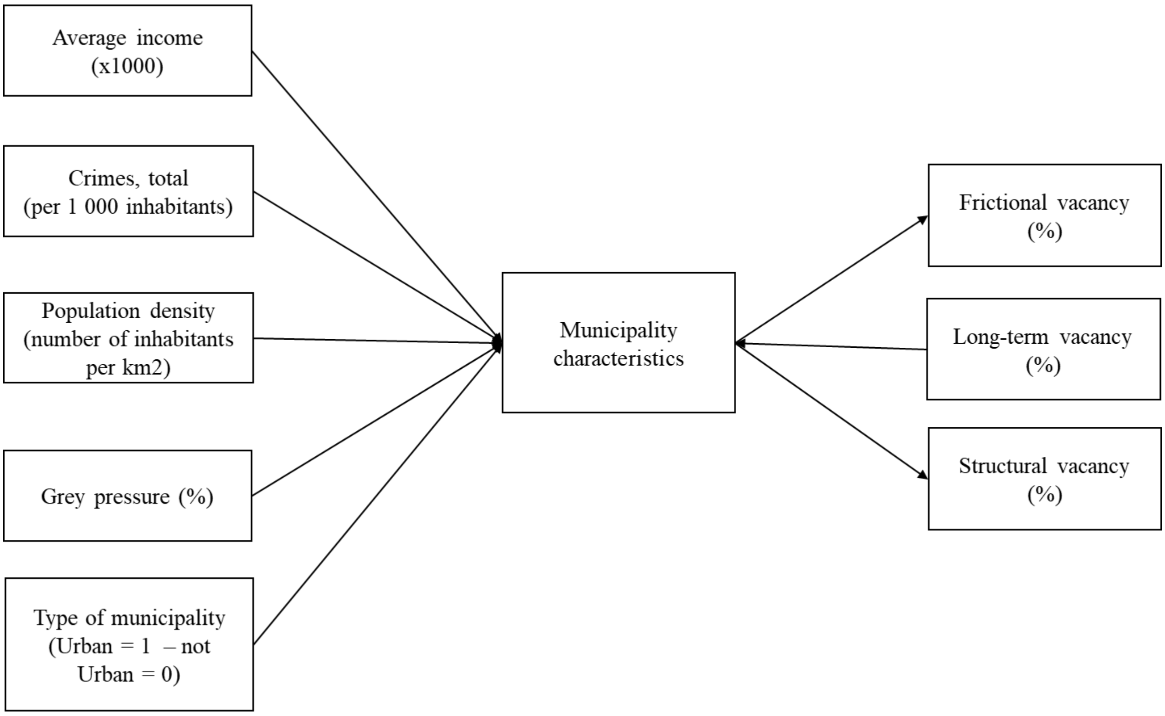
*H_0: Higher crime rates **are** not associated with higher retail vacancy rates.*

H_1:: Higher crime rates are associated with higher retail vacancy rates.

Note that for each variable (friction,structural,long-term) the same hypothesis will be tested.

2.4.1 Conceptual model

Figure 12 : Conceptual model



RESEARCH METHODOLOGY

This chapter will discuss the research methodology for this thesis. It discusses the research questions, the research approach, and the methods of data collection and analysis. In addition, the reliability and validity of the study will be discussed.

3.1 Methodological approach

3.1.1 Research philosophy

This thesis adopts a positivist approach, using objective and systematic analysis of measurable data to gain insight into the vacancy rates of retail spaces in Dutch municipalities. This involves the use of deduction, as various hypotheses are drawn up based on scientific literature (Saunders et al.). To investigate which determinants influence types of vacancy, quantitative research will be conducted. Ahmad et al (2019) define quantitative research as follows "*Quantitative research is a form of research that relies on the methods of natural sciences, which produces numerical data and hard facts. It aims at establishing cause and effect relationship between two variables by using mathematical, computational, and statistical methods. The research is also known as empirical research as it can be accurately and precisely measured.*". In addition, according to the literature, we also speak of secondary research. This is a form of research in which data is collected from existing sources, such as publications, reports, statistics, and internet sources.

3.2 Data Collection

The data used for this study came from several external sources. The first dataset analyzed was obtained through my internship at Colliers. Every year, Colliers receives the current vacancy figures on 1 January for all retail properties in the Netherlands from Locatus. This dataset contains data for every shop in the Netherlands. Each shop is assigned a classification, including whether the shop was vacant or not on 1 January. The dataset then distinguishes between the three types of vacancy discussed earlier: Frictional, Long-Term, and Structural.

All shops that were vacant were then calculated as a percentage per municipality and vacancy type. All these vacancy figures were put into a new file that shows the percentage vacancy rate per municipality and vacancy type.

The second dataset used is from the Central Bureau of Statistics (CBS). This is the dataset "Core Figures Neighborhoods and Districts 2004-2023." It contains key figures on all neighborhoods and districts in the Netherlands per year and also includes data at the municipal level. From this dataset, the following data have been extracted: Grey Pressure (the ratio between the number of people aged 65 or over and the number of people aged 20 to 65), Average WOZ (€ × 1,000) (average WOZ value of homes), Average Income (average disposable income of private households, excluding students (× 1,000)), and Population Density (number of citizens per km^2). Population Density was chosen over Total Population because an increase of 1 citizen in a municipality will most likely not have any significant effect on the retail vacancy in the municipality. However, an increase of 1,000 citizens will most likely have a more significant effect on retail vacancy.

The dataset also contains information about the degree of urbanization. The Central Bureau of Statistics distinguishes this degree into five different levels: (1) extremely urbanized, (2) strongly urbanized, (3) moderately urbanized, (4) hardly urbanized, and (5) not urbanized. Further details are explained in Appendix 1. In this study, it was decided to merge levels 1 and 2 into "Urban" and levels 3, 4, and 5 into "Not-Urban." This was done to reduce the number of parameters to estimate, making the model easier to interpret and improving the robustness of the estimates. Furthermore, it provides a clear insight into the differences between Urban and Non-Urban areas (Beer & Deerenberg, 2005).

The last dataset used is the "Recorded Crime; Type of Crime" dataset from the CBS (n.d.). From this dataset, the recorded crimes per 1,000 inhabitants have been used, which is defined by the CBS as: crimes recorded by the police in an official report. An average of the crime figures was chosen because it provides an overall picture of a municipality's crime rate.

3.2.1 Inclusion and exclusion criteria

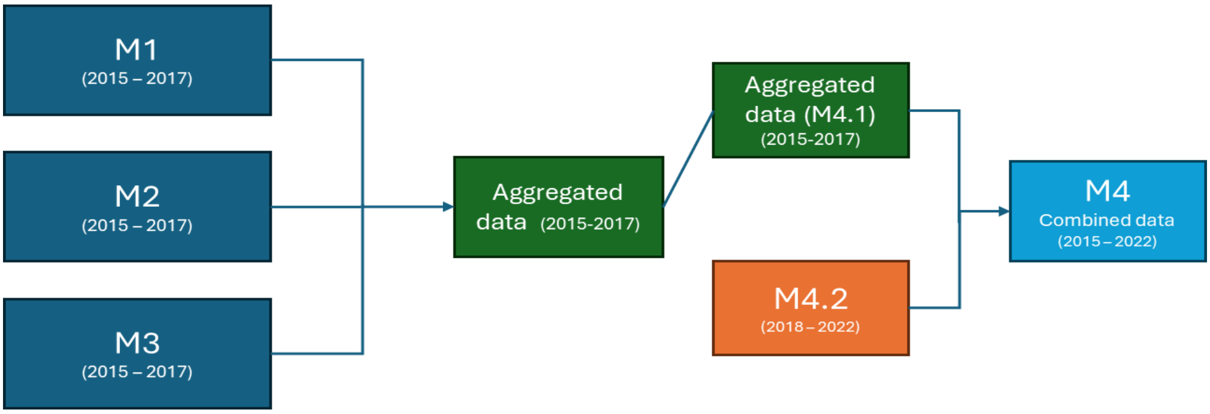
A research period from 2015 to 2022 was chosen because, during this period, all data is available from different municipalities in the Netherlands, both in the CBS dataset and the Locatus dataset. Geographically, the data was examined at the municipality level. This was selected because the data about different types of vacancy from Locatus is only available at the municipality level. The dataset contains information on all 345 municipalities as of January 1, 2022.

3.2.2 Data aggregation

An important factor taken into account was that between 2015 and 2022, several municipalities merged into new municipalities. To address this issue, an overview of all changes within municipalities was created (Appendix 2). After the overview was created, the decision was made to aggregate this data to create a complete dataset.

Figure 13 shows an example of how the municipality of Midden-Groningen was aggregated. In 2018, the municipalities of Hoogezand-Sappemeer (M1), Menterwolde (M2), and Slochteren (M3) merged into the municipality of Midden-Groningen. As the data for Midden-Groningen is only available from 2018 onward, it was decided to merge the data of the merged municipalities using aggregation. This resulted in the creation of dataset M4.1 with data from 2015-2017. M4.1 was then linked to Midden-Groningen (M4.2) with existing data from 2018-2022. This creates a complete dataset for Midden-Groningen with data from 2015-2022. The exact aggregation method per variable can be seen in appendix 3.

Figure 13 : Data aggregation method used



3.3 Data preparation

After the data vacancy data and the data from CBS had been aggregated and merged some steps have been taken for the data preparation. First each municipality was assigned a unique "Municipality_ID". Then the years have been transformed to (Years_ID) using $\text{Year\_relative} = \text{Year} - 2015$. Then the dependent variables were normalized (Friction, Long-Term, and Structural) from percentages to a range between 0 and 1.

3.4 Descriptive statistics

3.4.1 Multicollinearity Analysis

As outlined in the research question in Chapter 1, this study examines the relationship between the three different dependent variables (Structural, Long-Term, and Frictional vacancy) and the independent variables that represent municipality characteristics. After all the data preparation was completed, a multicollinearity analysis was conducted using a correlation matrix and a VIF test to check for multicollinearity (Daoud, 2017).

The correlation matrix (Appendix 4) was created using the Pearson correlation, a statistical technique used to measure the degree of relationship between two variables. The values range between -1 and 1, with 1 indicating a perfect positive correlation, 0 indicating no correlation, and -1 indicating a perfect negative correlation (Ersin Karaman et al., 2011)

The results of the correlation matrix showed that there was a strong positive correlation between average income and average WOZ value *r*=(0,92). This indicates that higher incomes are associated with higher property values. Haffner and Boumeester (2010) support this outcome in their paper. Also, some correlation was observed between crime and urban dummy, *r*=(0,60), suggesting that crime rates are higher in urban areas. Grey pressure was negatively correlated with crime, r=(0,40) and the urban dummy was positively correlated with population density *r*=(0,70).

The correlation matrix is visualized in a heatmap, as suggested by Friendly and Kwan (2003). The heatmap uses color and intensity of shading to represent the strength and direction of correlations between variables. Positive correlations are shown in red shades, while negative correlations are in blue. The heatmap can be found in Appendix 5.

3.4.2 VIF Test

The next method that has been used is the Variance inflation factor. The variance of regression coefficients can be calculated by $\frac{1}{1-R^2}$ which is called the VIF. If the variance inflation factor and tolerance are greater than 5 to 10 and lower than 0.1 to 0.2, respectively (R^2 = 0.8 to 0.9), multicollinearity exists (Kim, 2019). The result of the VIF test showed high values for the variables Average income (R^2 = 9,79) and the Average WOZ value (R^2 = 7,85). This can be explained by the fact that households with a higher income can generally spend more on housing expenses. This is especially true for homeowners who benefit from increases in the value of their property (Haffner and Boumeester, 2010). Due to the high VIF score of income and WOZ values, it was decided to leave the variable average house value out of the model. As a result, all variables except Population_density (2.64) and Urban_dummy (2.53) have an (R^2 of less than 2). According to Kim (2019), this suggests that the multicollinearity in the model is acceptable. In Appendix 6 an overview of all VIF scores can be found.

3.4.3 Descriptive data

The descriptive dataset in table 1, provides a detailed overview of the different variables that will be used in the analyses. These independent variables are: Grey Pressure, Population Density, Average Income, Crime Rates & level of urbanity.

Tabel 1 : Descriptive data

Variable	mean	sd	median	min	max	skew	kurtosis	se
Friction	0,38	0,14	0,38	0,03	0,88	0,28	-0,16	0,00
Long_Term	0,36	0,13	0,35	0,04	0,78	0,31	0,23	0,00
Structural	0,26	0,12	0,25	0,02	0,75	0,53	0,03	0,00
Grey_pressure	0,37	0,07	0,37	0,15	0,68	0,09	0,76	0,00
Population_density	949	1094	486	68	6712	2,20	5,31	22,50
Average_income (*1000)	47,00	6,97	46,30	31,60	95,80	1,24	4,89	0,14
Crimes (per 1000 inhabitants).	38,15	13,57	35,10	14,30	117,10	1,32	2,45	0,28
Urban_dummy	0,31	0,46	0,00	0,00	1,00	0,85	-1,29	0,01

Note: N = 2365. Long-term, Structural and Friction are the dependent variable.

Grey Pressure has an average of about 0.37 with a standard deviation of 0.07, suggesting minimal variation across municipalities. Therefore, most municipalities have a similar proportion of elderly residents, with the distribution being mostly normal but slightly skewed. The outliers can be found in the municipalities of Bergen, Laren, and Rozendaal. Municipalities with very low grey pressure include Utrecht, Groningen, and Amsterdam, which is common for cities with a large student population (Oudshoorn, 2011).

Population density varies with an average of 949 people per square kilometer, ranging from 54 to 6,712. The areas with the highest population density are Then Hague, Leiden, and Haarlem.

The Average Income variable has a mean of 47.00 and a standard deviation of 6.97, indicating some variation across municipalities. The median value is 46.30, with a minimum of 31.60 and a maximum of 95.80. The distribution is positively skewed (1.24), suggesting that most municipalities have average incomes below the mean, with a few municipalities having significantly higher incomes.

Municipalities with the highest average income include Bloemendaal, Laren, and Blaricum, which are known for being high income areas. Municipalities with the lowest average income include Delfzijl, Pekela, and Stadskanaal. This pattern reflects the socio-economic disparities across different municipalities in the Netherlands.

The Friction variable, reflecting consistency across cities, averages around 0.38 with a normal distribution, suggesting that friction levels are similar in most municipalities. The highest friction rates can be found in: Bergen, Wassenaar and Culemborg.

The Structural variable has an average of 0.26 with a normal distribution, suggesting that structural vacancy is relatively consistent across different municipalities. Municipalities with the highest structural vacancy are Zoeterwoude, Beesel and Leusden.

Longterm vacancy has an average of 0.36 and a slightly skewed but nearly normal distribution. Municipalities with the highest long-term vacancy are : Neder-betwue, Bergen(l.) & Sliedrecht.

3.5 Statistical Analysis.

This section describes the steps I followed to estimate a Panel Generalised Linear Model (PGLM) with individual random effects, using panel data over the period 2015-2022. The chosen specifications are: family = Gaussian, effect = individual, and model = random. This means we use a PGLM with a normal distribution for the dependent variable and account for individual random effects. Panel data was chosen because it completes the same units, in this case, municipalities, over multiple time periods, allowing us to analyze both cross-sectional and temporal variation

A standard general linear regression model can be described as:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + u_i + \epsilon_{it}$$

Where (Y_{it}) is the dependent variable and $(\mathrm{X}_{1\mathrm{it}}, \mathrm{X}_{2\mathrm{it}}, \ldots)$ the independent variable. This model assumes a linear relationship between the dependent variable and the independent variables.

A Generalised Linear Model (GLM) extends this linear regression by assuming that the dependent variable (Y_{it}) follows a particular distribution derived from the exponential family GLM consists of three components (Turner et al, 2008):

1) Linear predicter

$$\eta = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_p X_{pi}$$

2) Link funcion

$$g(E[Y]) = \eta i$$

3 Variance function

$$\mathrm{var}(Y_i) = \phi V(\mu)$$

The distribution of the errors of our model have been set to 'gaussian'. The Gaussian family is used for continuous response variables and assumes a normal distribution. The link function for this family is typically the identity function. (Baltagi. 2013).

In the model the *individual effect* has been chosen, because this accounts for unique, unobserved characteristics of each city that might influence retail vacancy rates (Croissant, 2019). This choice allows the model to control for stable, city-specific factors, such as local economic policies or historical development patterns, that are not directly measured but still impact the vacancy rates.

If the three components are applied to our model, the Generalized linear model will look like this:

The linear predictors : (η_{it}) are defined as:

$$\text{Friction}_{it} = \beta_0 + \beta_1 \cdot \text{Log\_Average\_income}_{it} + \beta_2 \cdot \text{Urban\_dummy}_{it} + \beta_3 \cdot \text{Year\_ID}_{it} + \beta_4 \cdot \log(\text{Population\_density}_{it}) + \beta_5 \cdot \text{Grey\_pressure}_{it} + \beta_6 \cdot \log(\text{Crime}_{it}) + u_i + \epsilon_{it}$$

$$\text{Long-term}_{it} = \beta_0 + \beta_1 \cdot \text{Log\_Average\_income}_{it} + \beta_2 \cdot \text{Urban\_dummy}_{it} + \beta_3 \cdot \text{Year\_ID}_{it} + \beta_4 \cdot \log(\text{Population\_density}_{it}) + \beta_5 \cdot \text{Grey\_pressure}_{it} + \beta_6 \cdot \log(\text{Crime}_{it}) + u_i + \epsilon_{it}$$

$$\text{Structural}_{it} = \beta_0 + \beta_1 \cdot \text{Log\_Average\_income}_{it} + \beta_2 \cdot \text{Urban\_dummy}_{it} + \beta_3 \cdot \text{Year\_ID}_{it} + \beta_4 \cdot \log(\text{Population\_density}_{it}) + \beta_5 \cdot \text{Grey\_pressure}_{it} + \beta_6 \cdot \log(\text{Crime}_{it}) + u_i + \epsilon_{it}$$

The identity link function equates the expected value Friction_{it} to the linear predictor:

$$g(\mu_{it}) = \mu_{it} = \eta_{it}$$

We assume the dependent variable follows a normal distribution (Gaussian):

$$Y_{it} \sim \mathcal{N}(\mu_{it}, \sigma^2)$$

The variance of $\text{var}(Y_{it})$ is constant and independent of the expected value

$$[\text{var}(Y_{it}) = \phi]$$

The PGLM model, developed by Croissant (2021), extends the Generalized Linear Model by including panel data. The panel data in this research was collected from several municipalities for the period from 2015 to 2022. However, after analyzing the data, it was found that data were missing for some municipalities in certain years. This means that we do not have data available for every municipality, which is reflected in the strict inequality $n < N \times T$, where n is the number of observations, N is the number of municipalities, and T is the number of years. This results in an unbalanced panel dataset (Baltagi, 2021). An example of a panel generalized model (Appendix 7) with unbalanced data is discussed in Croissant (2021) and have been used as a framework for our model

3.5.1. Assumption

The PGLM assumes a linear relationship between the transformed expected response and the explanatory variables through the link function. Residual plots indicate that this assumption is reasonably met in appendix 8

While GLMs do not require normally distributed residuals, we examined the residuals for any extreme deviations. Q-Q plots and histograms in the Appendix 9 indicated that the residuals were approximately normally distributed, with minor issues of kurtosis and slight skewness.

The Durbin-Watson test were used to check for autocorrelation. When the DW value is between a range of 1.5 to 2.5 the level of autocorrelation is acceptable (Turner, 2019). The results of the Durbin-Watson test for the three models showed different levels of autocorrelation (Appendix 10)The Friction Model has a Durbin-Watson statistic of DW = 2.015, suggesting no autocorrelation. The Long-term Model shows a Durbin-Watson statistic of DW = 1.9708, also indicating no autocorrelation. The Long Term Model has a DW = 1.3782 indicating that there is slightly autocorrelation in the model. (Turner, 2019)

The tests suggest that while the Friction and Long Term models generally meet the independence assumption, the Structural model shows however positive autocorrelation, making the model for structural less valid .

RESULTS

4.1 Panel Generalized Linear Models (PGLM)

This chapter presents the results of the Panel Generalized Linear Models (PGLM) that has been applied to the data. The analysis focused on three dependent variables: Friction, Structural, and Long Term. Since each type of vacancy will be analyzed. Three different panel generalized models have been conducted.

4.2 Panel Generalized Linear Models (Friction)

The first model shows the results of multiple independent variables on the Friction variable. The results are summarized in table 2 .

Tabel 2 : Results for the Generalized Linear Model Predicting Friction

	Estimate	Std. Error	t value	p value
(Intercept)	-0.837	0.151	-5.533	< .001 ***
Log_Average_income	0.264	0.035	7.440	< .001 ***
Urban_dummy	0.033	0.013	2.551	.011 *
Year_ID1	-0.016	0.011	-1.473	.141
Year_ID2	-0.059	0.011	-5.384	< .001 ***
Year_ID3	-0.072	0.011	-6.299	< .001 ***
Year_ID4	-0.046	0.012	-3.784	< .001 ***
Year_ID5	-0.033	0.012	-2.708	.007 **
Year_ID6	-0.083	0.013	-6.356	< .001 ***
Year_ID7	-0.115	0.014	-8.146	< .001 ***
Log_Population_density	0.015	0.006	2.593	.010 **
Grey_pressure	-0.030	0.060	-0.503	.615
Log_Crime	0.046	0.015	2.954	.003 **

Significance codes: *** p < .001, ** p < .01, * p < .05. N=2365. *The model was estimated using Maximum Likelihood Estimation. The Newton-Raphson maximisation algorithm was used, requiring 5 iterations to converge. Convergence was achieved with a return code of 8, indicating that successive function values were within the relative tolerance limit. The log-likelihood value at convergence was 1429.198 with 15 free parameters estimated.*

The model for Friction indicates that several factors are significantly associated with friction vacancy. These factors are Average Income, Urban Dummy, Log Population Density, and Log Crime. This means that higher average incomes, urban settings, greater population density, and higher crime rates correspond with increased frictional retail vacancy. Specifically, Average Income ($b = 0.264$, $p < .001$), Urban ($b = 0.033$, $p = .011$), Log Population Density ($b = 0.015$, $p = .010$), and Log Crime ($b = 0.046$, $p = .003$) all show positive associations. These results support the hypothesis H1 for population density, income, urban classification, and crime rates, indicating that higher population density, higher income, urban municipalities, and higher crime rates are associated with higher frictional retail vacancy rates.

All years, except for ID1, however, show a significant negative coefficient, indicating a decrease in friction vacancy over time. The years with the highest effects include Year ID3 ($b = -0.072$, $p < .001$), Year ID6 ($b = -0.083$, $p < .001$), and Year ID7 ($b = -0.115$, $p < .001$). These results suggest a general trend of decreasing friction between 2015-2022.

Grey Pressure ($b = -0.030$, $p = .615$) did not have a significant effect, indicating that this variable does not impact friction vacancy in this model. Therefore, hypothesis H0 for Grey Pressure is accepted, indicating no association between Grey Pressure and higher frictional retail vacancy rates.

4.3 Panel Generalized Linear Models (Long_term)

The second model shows the results of multiple independent variables on the Long_term variable. The results are summarized in table 3.

Tabel 3 : Results for the Generalized Linear Model Predicting Long-term

	Estimate	**Std. Error**	**t value**	**p value**
(Intercept)	0.407	0.108	3.777	< .001 ***
Log_Average_income	0.002	0.025	0.078	.938
Urban_dummy	-0.006	0.009	-0.639	.523
Year_ID1	-0.001	0.010	-0.140	.889
Year_ID2	0.014	0.010	1.298	.194
Year_ID3	0.001	0.011	0.058	.954
Year_ID4	-0.048	0.011	-4.334	< .001 ***
Year_ID5	-0.046	0.011	-4.181	< .001 ***
Year_ID6	-0.014	0.012	-1.195	.232
Year_ID7	-0.027	0.012	-2.255	.024 *
Log_Population_density	0.014	0.004	3.524	< .001 ***
Grey_pressure	-0.023	0.041	-0.551	.582
Log_Crime	-0.034	0.011	-3.074	.002 **

Significance codes: *** p < .001, ** p < .01, * p < .05. N=2365. *The model was estimated using Maximum Likelihood Estimation. The Newton-Raphson maximisation algorithm was used, requiring 81 iterations to converge. Convergence was achieved with a return code of 8, indicating that successive function values were within the relative tolerance limit. The log-likelihood value at convergence was 1601.35 with 15 free parameters estimated.*

The model for Long-term cacancy indicates that several factors are significantly associated with long-term vacancy. These factors are Log Population Density and Log Crime. This means that greater population density corresponds with increased long-term retail vacancy, while higher crime rates correspond with decreased long-term retail vacancy. Specifically, Log Population Density (b = 0.014, p < .001) shows a positive association, while Log Crime (b = -0.034, p = .002) shows a negative association.

These outcomes support the hypothesis H1 for population density, indicating that higher population density is associated with higher long-term retail vacancy rates. It also supports the hypothesis H1 for crime, indicating that higher crime rates are associated with higher long-term vacancy rates in this model.

All years, however, show a mix of significant and non-significant coefficients, indicating varying effects on long-term vacancy over time. The years with the highest effects include Year ID4 ($b = -0.048$, $p < .001$), Year ID5 ($b = -0.046$, $p < .001$), and Year ID7 ($b = -0.027$, $p = .022$). These results suggest a trend of decreasing long-term vacancy for these specific years.

Average Income ($b = 0.002$, $p = .938$), Urban Dummy ($b = -0.006$, $p = .522$), Grey Pressure ($b = -0.023$, $p = .581$), Year ID1 ($b = -0.001$, $p = .889$), Year ID2 ($b = 0.014$, $p = .194$), Year ID3 ($b = 0.001$, $p = .954$), and Year ID6 ($b = -0.014$, $p = .232$) did not have significant effects on explaining long-term retail vacancy.

4.4 Panel Generalized Linear Models (Structural)

The third model shows the results of multiple independent variables on the Structural variable. The results are summarized in table 4.

Tabel 4 : Results for the Generalized Linear Model Predicting Structural

	Estimate	Std. Error	t value	p value
(Intercept)	1.285	0.165	8.068	< .001 ***
Log_Average_income	-0.235	0.039	-6.094	< .001 ***
Urban_dummy	-0.031	0.015	-2.048	.041 *
Year_ID1	0.018	0.007	2.422	.015 *
Year_ID2	0.046	0.008	5.733	< .001 ***
Year_ID3	0.073	0.009	8.528	< .001 ***
Year_ID4	0.092	0.010	9.511	< .001 ***
Year_ID5	0.077	0.010	7.717	< .001 ***
Year_ID6	0.095	0.011	8.486	< .001 ***
Year_ID7	0.138	0.013	10.927	< .001 ***
Log_Population_density	-0.031	0.007	-4.554	< .001 ***
Grey_pressure	0.028	0.067	0.426	.671
Log_Crime	0.001	0.015	0.088	.930

Significance codes: *** p < .001, ** p < .01, * p < .05 . N=2365. *The model was estimated using Maximum Likelihood Estimation. The Newton-Raphson maximisation algorithm was used, requiring 4 iterations to converge. Convergence was achieved with a return code of 8, indicating that successive function values were within the relative tolerance limit. The log-likelihood value at convergence was 2179,.498, with 15 free parameters estimated.*

The model for Structural Vacancy indicates that several factors are significantly associated with structural retail vacancy. These factors are Average Income, certain Year IDs, and Population Density. Specifically, Average Income (b = -0.235, p < .001) and Population Density (b = -0.031, p < .001) show a negative association. Urban Dummy (b = -0.031, p = .041) indicated that non-urban areas (urban dummy = 0) are associated with higher structural vacancy compared to urban areas (urban dummy = 1).

These findings support the hypothesis H1 for income, indicating that higher income is associated with lower structural retail vacancy rates. The hypothesis H1 for population density is also supported, showing higher population density is associated with lower structural retail vacancy rates.

The coefficients for years show all significant positive effects, indicating an increase in structural vacancy over time. The years with the highest effects include Year ID7 ($b = 0.138$, $p < .001$), Year ID4 ($b = 0.092$, $p < .001$), and Year ID6 ($b = 0.095$, $p < .001$). These results suggest a trend of increasing structural vacancy for these specific years.

Grey Pressure ($b = 0.028$, $p = .671$) and Log Crime ($b = 0.001$, $p = .930$) did not have significant effects. Therefore, the hypotheses H0 for urban classification, and H0 for crime rates are accepted, indicating no association between these variables structural retail vacancy rates.

4.5 Overal results

Table 5, gives a overview of all variables potentially influencing the types of vacancy. In chapter 5 the results will be further discussed.

Tabel 5 : Summary of Variable Effects on Friction, Long-term, and Structural Models

Variabele	Friction	Long-term	Structural
Average_income	+	*	-
Urban_dummy	+	*	-
Year_ID1	*	*	+
Year_ID2	-	*	+
Year_ID3	-	*	+
Year_ID4	-	-	+
Year_ID5	-	-	+
Year_ID6	-	*	+
Year_ID7	-	-	+
Log_Population_density	+	+	-
Grey_pressure	*	*	*
Log_crime	+	-	*

Note : (+) = positive correlation, (-) = negative correlation, (*) = no significance

CONCLUSION

For this study, data was collected to analyze the influence of various municipal characteristics on vacancy rates of retail properties in the Netherlands using a Panel Generalized Linear Model. The data was obtained from multiple sources, including Colliers and CBS, and covers the period from 2015 to 2022. The results of this study give an overview of the factors that contribute to frictional, long-term and structural vacancy rates and answer the research question: *"What is the association between municipality's types of retail vacancy rates and specific municipality's characteristics in the Netherlands between 2015 - 2022?"*

The results of the PGLM show that higher incomes and an urban environment are associated with higher friction vacancy rates. Population density is positively associated with structural and friction vacancy rates, meaning that more densely populated areas are more likely to experience friction and long-term vacancy of retail premises. A negative relationship was also found between crime and long-term vacancy rates, implying that higher crime rates are associated with lower long-term vacancy rates.

Structural vacancy rates is also influenced by average income, and non-urban municipalities. Municipalities with higher incomes and higher population density show lower rates of structural vacancy.

The results also show that friction vacancy rates have decreased over the years which can be seen as a positive effect. In contrast, long-term vacancy rates have increased which can be seen as a negative effect. Regarding long-term vacancy, it is difficult to make statements, as much of the model's data is not reliable due to autocorrelation, this will be further discussed in the discussion.

These results gives an answer to the research question *"What is the association between municipality's types of retail vacancy rates and specific municipality's characteristics in the Netherlands between 2015 - 2022?"* by showing which municipal characteristics are related to the different types of vacancy.

DISCUSSION

Higher incomes are associated with an increase in frictional vacancy rates. This means that municipalities with higher average incomes have higher tenant turnover or more removals and conversions. This could possibly be explained by the fact that affluent areas have a higher turnover rate of retail premises, which is caused by higher rents and competitive market dynamics (Benjamin et al., 1998). However, for long-term vacancy rates, average income has no significant influence, suggesting that income is not a decisive factor in determining long-term vacancy rates. Municipalities with higher average income are associated with a decrease in structural vacancy rates. This suggests that municipalities with a higher average income are less likely to have structural vacancy rates. One possible explanation is that, according to Ruiz-Rivera et al. (2016), higher-income areas experience greater economic stability and purchasing power and have better access to commercial facilities. This is supported by the fact that lower-income people tend to have less purchasing power, resulting in less demand for retail products and services (Baren, 2020). This can cause retailers to struggle to remain profitable, which can lead to higher structural vacancy rates.

Furthermore, the study found that urban areas have higher frictional vacancy rates. This could possibly also be explained by the higher turnover rate of shops big shopping areas, which are generally located in more urban environments (Benjamin et al., 1998). Additionally, structural shop declines are less common in more urban areas. This is supported by Hazelaar (2019) and Hollander (2018), who confirm that the more addresses there are around shops, the less likely vacancy is present. However, for long-term vacancy, urbanisation has no significant impact.

Furthermore, structural vacancy rates have been found to decrease with an increase in population density. One explanation may be that large shopping areas in densely populated cities remain popular because, besides shopping, they are also used as meeting and recreational areas (Weltevreden, 2006). The positive correlation between population density and long-term vacancy rates can be explained by the overload of retail spaces in densely populated areas, which leads to structural vacancy rates (Verhoef, Noordhoff, & Sloot, 2023). Another explanation is that in areas where fewer people live, or in regions where there is shrinkage, the supply of shops decreases because there is less support (HBD, 2010). This may explain higher structural vacancy rates. Gray pressure shows no significant effect on any of the three types of vacancy. We can therefore conclude that gray pressure is not a determinant.

Mainly for long-term and Structural vacancy, a positive effect was expected based on the negative spiral into which shopping areas can enter (Ouwehand, 2018; Grummer, 2021). However, this does not appear to be the case. Unexpected was the association between higher crime rates and lower long-term vacancy rates. An explanation for this is difficult to give.

Looking at the years, we see that From 2016 to 2022, there are clear trends in retail vacancy rates. Frictional vacancy rates decrease significantly over this period, with rates ranging from 3.3% to 11.5%, especially in the years 2020 to 2022. Long-term vacancy shows a mixed picture, with significant decreases in 2019 (-4.8%), 2020 (-4.6%) and 2022 (-2.7%). Still, it is difficult to make a statement on this, given the non-signifacts of the other years. In contrast, structural vacancy shows a sustained increase from 2016 to 2022, with the largest increases in the pandemic years and in 2022 (+13.8%). One possible explanation is that between 2015 and 2022, online purchases increased from 53% to 78%. (CBS, n.d) which affects the structural vacancy rate.

It is important to note that this study has several limitations. First, the data is limited to the period between 2015 and 2022. A longer period may give a better picture of certain patterns. In addition, the study was conducted at municipal scale level because only data on vacancy type was available at this scale. Municipal level is a relatively large study area within which demographic factors can vary. Within municipalities, for instance, there are large differences between districts and villages. Finally, municipal mergers between 2015-2022 were taken into account as best as possible. However, this aggregation may involve a possible margin of error.

Furthermore, only 4 municipal characteristics are included in the model. This is because there is no further complete data available for the period 2015-2022 with other relevant characteristics.

The error analysis of the PGLM model used shows that the variable 'friction' performs well without significant problems. However, the variable 'structural' shows clear signs of autocorrelation, which reduces the reliability of the results. The 'long-term' variable shows few significant outcomes, which complicates the interpretation and applicability of these results.

Bases on the limitations in the thesis, I recommend the following steps for follow-up research. Future research could focus on extending the period studied to gain a better understanding of the trends in retail vacancy over a longer period. In addition, applying spatial panel data methods can be a good method for future research, as this approach takes into account spatial dependency. This is particularly relevant because vacancy rates in one area can have a strong influence on surrounding municipalities as described in the literature (Ouwehand, 2018).

In addition, research at district or neighborhood level is recommended to have a more detailed model. Adding more variables could also improve the accuracy and robustness of the models. Finally, I recommend that follow-up studies also include the impact of external factors such as technological developments and changing consumer behavior, and the use of e-comerce.

Policy recommendation

Policymakers should invest in economic stability and infrastructure in lower-income, non-urban areas to combat structural vacancy rates. Another recommendation that is much discussed at the moment is the topic of transforming vacant properties into housing. According to this study, especially non-urban areas with low average income deal the most with structural vacancy. Therefore, policymakers should do more research into the question, "How can we adapt to retail vacancy and what options do we have?”

Reflection

Reflecting on the research, I can conclude several things. I am very satisfied that I am the first researcher in science to distinguish between the three different types of vacancy. However, it turned out that doing research about this was not very easy and a fully valid model did not come out when doing the analyses. I tried to make it valid, but due to lack of knowledge about Panel Generalised Linear Models, this didn’t work out the way as expected. Looking back on the process, I am very satisfied that, despite a difficult start, I was able to complete the research and still found some interesting insights.

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APPENDIX

APPENDIX 1 : Overview of categories Urbanisation

Category	Address Density (addresses per square kilometre)
(1) Extremely urbanised	2,500 or more
(2) Strongly urbanised	1,500 to 2,500
(3) Moderately urbanised	1,000 to 1,500
(4) Hardly urbanised	500 to 1,000
(5) Not urbanised	Fewer than 500

APPENDIX 2 : Overview of merged municipalities between 2015 - 2022

New Municipality	Merged Municipality	Year
Alkmaar	Graft-De Rijp	2015
	Schermer	
Berg en Dal	Millingen aan de Rijn	2015
	Groesbeek	
	Ubbergen	
Nissewaard	Bernisse	2015
	Spijkenisse	
Krimpenerwaard	Bergambacht	2015
	Nederlek	
	Ouderkerk	
	Schoonhoven	

	Vlist	
Den Bosch	Maasdonk	2015
Gooise Meren	Bussum	2016
	Muiden	
	Naarden	
De Fryske Marren	De Friese Meren	2016
Edam-Volendam	Zeevang	2016
Meierijstad	Schijndel	2017
	Sint-Oedenrode	
	Veghel	
Westerwolde	Bellingwedde	2018
	Vlagtwedde	
Midden-Groningen	Hoogezand-Sappemeer	2018
	Menterwolde	
	Slochteren	
Waadhoeke	Franekeradeel	2018
	Het Bildt	
	Littenseradiel	
	Menameradiel	
Leeuwarden	Leeuwarderadeel	2018
	part of Littenseradiel	
Zevenaar	Rijnwaarden	2018
Groningen	Groningen	2019
	Haren	
	Ten Boer	
Hoeksche Waard	Binnenmaas	2019
	Cromstrijen	
	Korendijk	
	Oud-Beijerland	
	Strijen	
Vijfheerenlanden	Leerdam	2019
	Vianen	
	Zederik	
Altena	Aalburg	2019
	Werkendam	
	Woudrichem	
Beekdaelen	Nuth	2019
	Onderbanken	
	Schinnen	
Haarlemmermeer	Haarlemmerliede	2019
	Spaarnwoude	
Het Hogeland	Bedum	2019
	De Marne	
	Eemsmond	

	Winsum	
Westerkwartier	Grootegast	2019
	Leek	
	Marum	
	Zuidhorn	
Molenlanden	Giessenlanden	2019
	Molenwaard	
Noardeast-Fryslân	Dongeradeel	2019
	Ferwerderadiel	
	Kollumerland	
Noordwijk	Noordwijk	2019
	Noordwijkerhout	
West Betuwe	Geldermalsen	2019
	Lingewaal	
	Neerijnen	
Purmerend	Beemster	2022
Dijk en Waard	Heerhugowaard	2022
	Langedijk	
Maashorst		2022
	Uden	
Land van Cuijk	Boxmeer	2022
	Cuijk	
	Mill en Sint Hubert	
	Sint Anthonis	

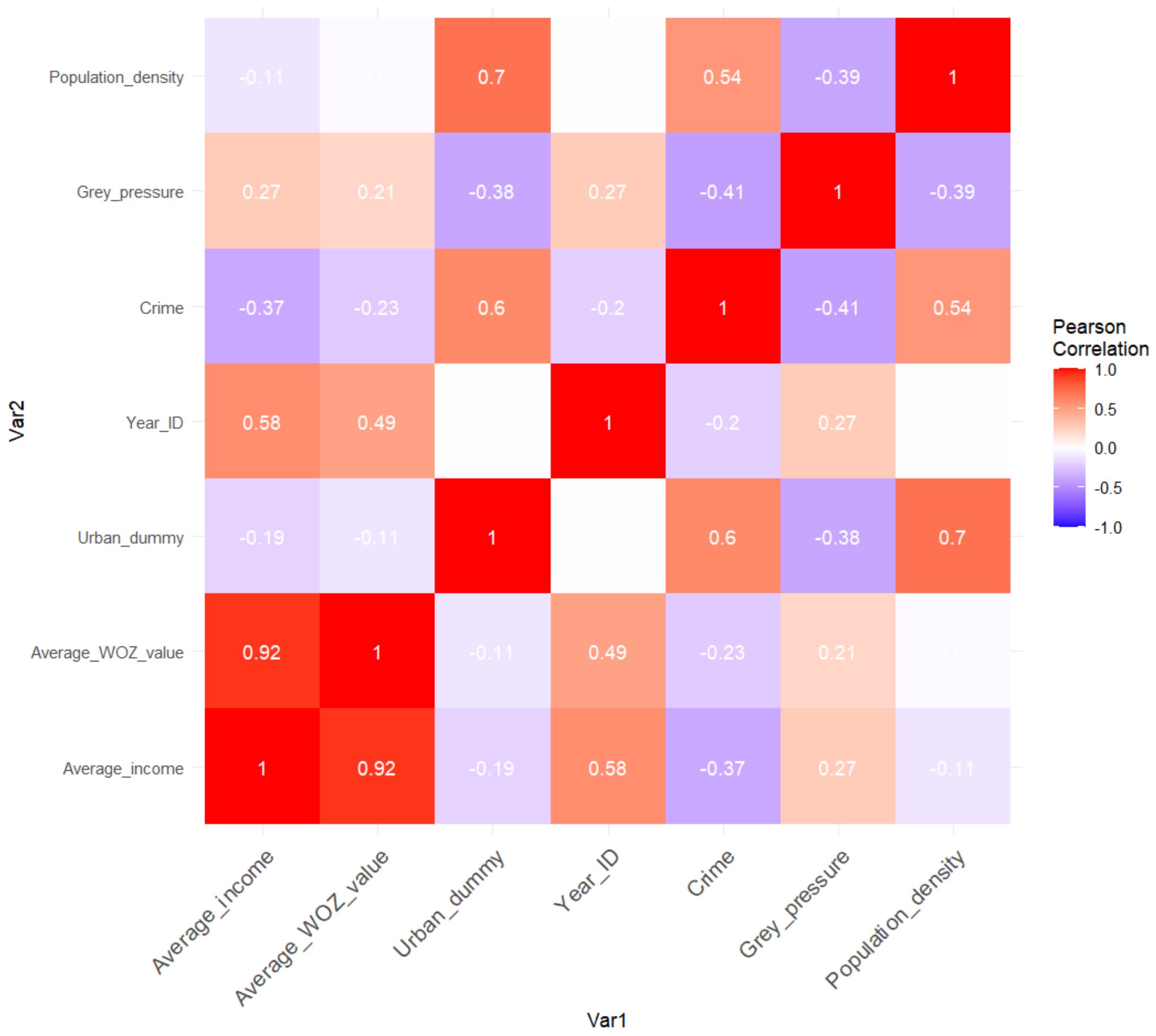
APPENDIX 3: Method used for data merging

Average income	$= \frac{\sum_{j=1}^{x}\sum_{i=1}^{n} \text{Population}_{i,j} \times \text{Income}_{i,j}}{\sum_{j=1}^{x}\sum_{i=1}^{n} \text{Population}_{i,j}}$
Average WOZ	(NOT USED IN THE MODEL)
Urban Dummy	Most recent value has been applied (1/0)
Population density	$= \frac{\sum_{j=1}^{x} \sum_{i=1}^{n} \text{Population}_{i,j}}{\sum_{j=1}^{x} \sum_{i=1}^{n} \text{Area}_{i,j}}]$
Grey pressure	$= \frac{\sum_{i=1}^{n} (\text{Population}_i \times \text{Aging Percentage}_i)}{\sum_{i=1}^{n} \text{Population}_i}$

APPENDIX 4: correlation matrix

	Average_income	Average_WOZ_value	Urban_dummy	Year_ID	Crime	Grey_pressure	Population_density
Average_income	1						
Average_WOZ_value	0,9228189	1					
Urban_dummy	-0,18958	-0,1091835	1				
Year_ID	0,5817252	0,4857002	-0,0054847	1			
Crime	-0,3702671	-0,2264609	0,5984243	-0,2023927	1		
Grey_pressure	0,2674979	0,2147226	-0,3805714	0,267955	-0,4126513	1	
Population_density	-0,1091711	-0,0206907	0,7036872	0,0055716	0,5364836	-0,387909	1

APPENDIX 5: Heatmap correlation matrix



APPENDIX 6: Variance Inflation Factor (VIF)

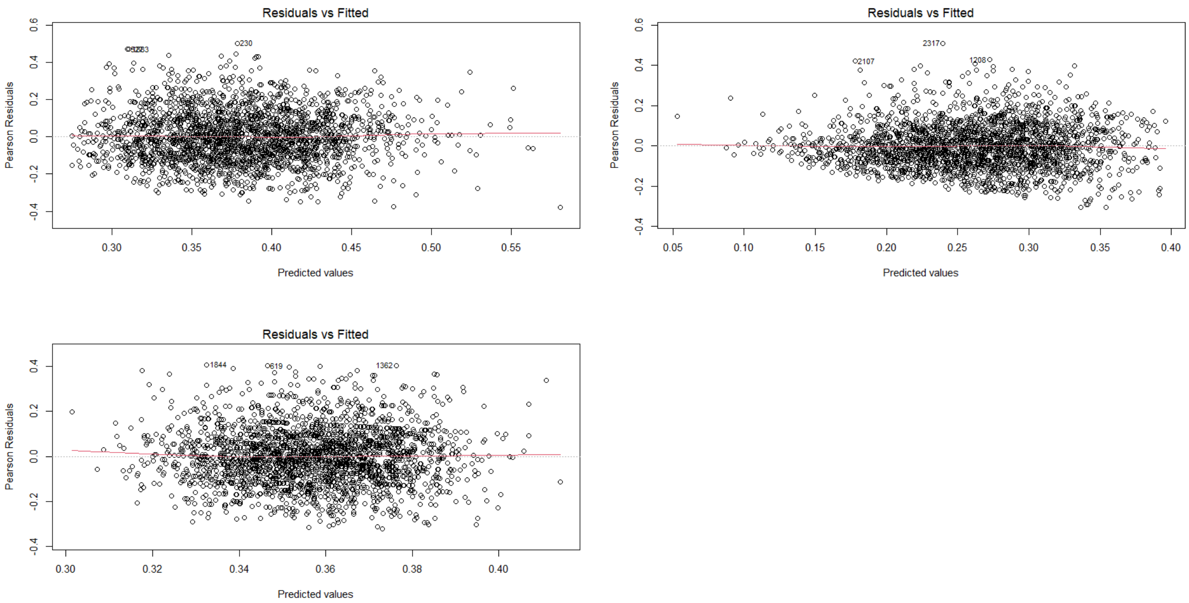
Variance Inflation Factor (VIF)	
Variable	**Value (R)**
Grey_pressure	1,34
Year_ID	1,70
Log_Average_income	1,89
Log_Crime	1,94
Urban_dummy	2,54
Log_Population_density	2,62

APPENDIX 7: Example unbalanced panel data (Croissant, 2022)

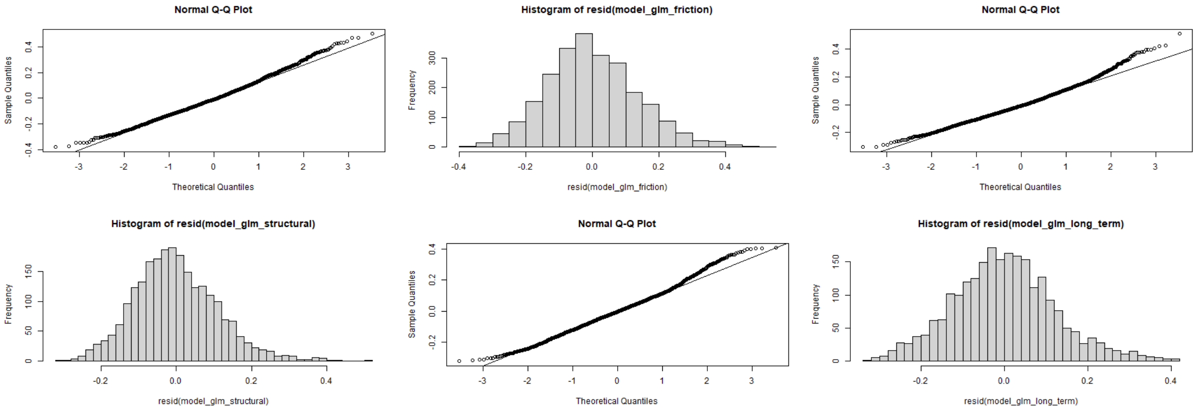
```
## a gaussian example on unbalanced panel data

data(Hedonic, package = "plm")
ra <- pglm(mv ~ crim + zn + indus + nox + age + rm, Hedonic, family = gaussian,
model = "random", print.level = 3, method = "nr", index = "townid")
```

APPENDIX 8: Example unbalanced panel data (Croissant, 2022)



APPENDIX 9: Normality of Residual



APPENDIX 11: Durbin-Watson test for serial correlation in panel models

```
        Durbin-Watson test for serial correlation in panel models

data:  Friction ~ Log_Average_income + Urban_dummy + Year_ID + Log_Population
_density +  ...
DW = 2.015, p-value = 0.6187
alternative hypothesis: serial correlation in idiosyncratic errors
```

```
Durbin-Watson test for serial correlation in panel models

data:  Structural ~ Log_Average_income + Urban_dummy + Year_ID + Log_Populati
on_density +  ...
DW = 1.3782, p-value < 2.2e-16
alternative hypothesis: serial correlation in idiosyncratic errors
```

```
Durbin-Watson test for serial correlation in panel models

data:  Long_Term ~ Log_Average_income + Urban_dummy + Year_ID + Log_Populatio
n_density +  ...
DW = 1.9708, p-value = 0.2192
alternative hypothesis: serial correlation in idiosyncratic errors
```