ERASMUS UNIVERISITY ROTTERDAM

Erasmus School of Economics

Bachelor Thesis (Urban, port and transport economics)

Take the idea to build a new city in the Markermeer into consideration in future urban policy decisions

Name student: Dytmer van Eijk

Student number: 624531

Supervisor: Mr. Nefs

Second assessor:

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Introduction

One of the biggest problems in the Netherlands is the shortage of housing supply, which is currently almost 400 000 houses and there are 1 000 000 houses needed by 2030 and the shortage of housing supply is only increasing, as shown in figure 1. For Dutch voters, the shortage of housing supply is one of the biggest problems in the Netherlands. Young people between 18 and 35 consider this the biggest problem. The largest housing shortages are in the regions of Amsterdam and Rijnmond. For social housing, the waiting time is often more than 10 years (NOS, 2023). There is a huge shortage of housing supply in the Amsterdam Metropolitan Area (MRA), a very dense area of the Netherlands, raising the question of where to build the houses needed in that area. Of course the houses can be build in the MRA, but this already a dense area, and might reduce the green areas in the MRA.

But, there is also a second option, namely building a new city in the Markermeer, a plan that exist already since 1920s. In 1976 the Houtribdijk was completed, which resulted in the creation of the Markermeer. So the plan to build a new city in the Markerwaard, the area that would exist if land is reclaimed in the Markermeer, is not new. Also, in the past decades the plan was gently suggested by ruling parties VVD and CU, but not continued due to its controversy, given that the area is a Natura 2000 and recreational area. Recently, the plan to reclaim the Markerwaard was again mentioned by the Dutch political party JA21 in their election manifesto. According to them, there is not much space to build left in the Netherlands, due to the Natura 2000 areas, and this plan could partially solve the housing shortage in the Netherlands (Volkskrant, 2023).

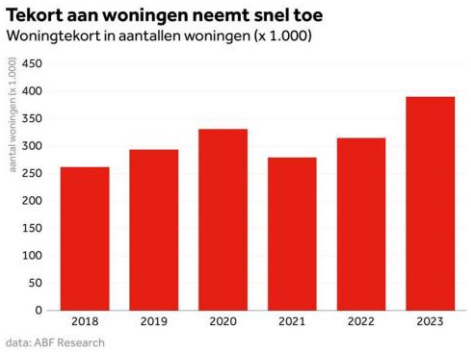

Figure 1: shortage of housing supply in the Netherlands (NOS, 2023)

The subject of the shortage of housing supply in the Netherlands and the question of where to build the houses—namely building new towns, expanding suburbs, or compacting existing

cities—leads to the subject of my thesis. The research question that will be analyzed in my thesis is: What would be the differences in expanding the existing urban core of the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of impact on commuting patterns and urban economic outcomes?

Analyzing the research question 'What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?' is a very relevant research question. There are multiple reasons why this is a relevant subject. One of the biggest reasons is of course the significant shortage of housing supply, which is now almost 400.000 and there are 1 000 000 houses needed in the Netherlands by 2030 (NOS, 2023), where 170 000 houses are needed in The MRA (Intres, 2023).

Also the topic of new towns is a relevant subject because, in past decades, the Netherlands has created multiple new towns , as Zoetermeer, but also in the Ijsselmeer cities like Almere and Flevoland. Over the past decades, there have been two different ways of building new large residential locations. First, in the '70s and '80s, new towns like Zoetermeer, Nieuwegein, and Almere were developed, as shown in Figure 2 (Intres, 2023). In the '90s and early 2000s, the focus shifted towards so-called VINEX-districts, which are large new neighborhoods on the outskirts of big cities, like Leidsche Rijn in Utrecht.

Currently, the focus is mainly on continuing with expanding suburbs, with the political slogan "Straatje erbij", which can be roughly translated into a street extra. But, there are also plans to build new towns in the Netherlands in the upcoming years, such as Het Vijfde Dorp in the Zuidplaspolder (Van Dijk, 2023). Additionally, there are new plans to build large neighborhoods in 17 different locations, named the NOVEX-areas. The Dutch government has allocated 6 billion euros to realize this plan (AD, 2024).

Figure 2: New towns in The Netherlands (INTI, n.d.)

The plan to reclaim the Markermeer dates back to the same time as the plans to create the Noordoostpolder and the Flevopolder. First, the Noordoostpolder was reclaimed, then the Flevopolder, and the plan was also to reclaim the Markermeer, which would result in the Markerwaard. The plan proposed in 1981, with water between the Markerwaard and Flevoland and Noord-Holland, is shown in Figure 3. However, this plan was never executed because, at that time, the disadvantages outweighed the benefits. In the 1980s, reclaiming the Markerwaard was primarily seen as beneficial for farmers, which was not considered an urgent matter. The main disadvantages were ecological, as reclaiming land in the Markermeer would significantly impact nature, affecting many bird species and the protected Natura-2000 area. Additionally, the Markermeer is an important source of fresh water for the surrounding areas. Thus, the ecological concerns and the costs associated with land reclamation led to the decision not to proceed with the Markerwaard project.

However, this discussion took place decades ago, and the situation has changed significantly. This decade, 1 million houses need to be built, and the Netherlands is already one of the

densest countries in Europe, necessitating a new evaluation of whether to preserve nature or reclaim the Markerwaard to build a new city. There is also the question of whether reclaiming the Markerwaard can solve the housing crisis in the short term, as it will take years to reclaim the land and then build a completely new city. Nonetheless, housing is not only needed this decade but also in the coming decades, so this plan can be considered for the long term (nporadio1, 2022). By 2050 are namely 325 000 houses needed in the MRA and in the decades after 2050 even more and a new town in the Markermeer might be a viable solution as a long-term plan for housing (MetropoolRegio Amsterdam - de Nationale Omgevingsvisie, n.d.). Another big advantage is that there is enough space in the Markerwaard for more relatively fruitful farming land, which is needed in the future, because of the increasing food demand in the world, where the Netherlands can play an important role in (Nieuwe Oogst, 2021).

Figure 3: Maps of how the Markerwaard would look like in a proposal of 1981 (Volkskrant, 2022)

For analyzing and answering the research question 'What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?', four sub questions are analyzed. The sub questions are analyzed by making use of the gravity equation. The gravity equation explains the amount of commuters for work between cities. The gravity equation is based on how gravity works in real life. The larger the masses, the stronger the gravitational force, and the shorter the distance, the stronger the gravitational force. Therefore, the larger two cities are, the more people commute for work between them, and the shorter the distance between two cities, the more people commute, and vice versa.

Furthermore, people prefer good amenities and low rents, which are usually found in locations further from big cities. People also prefer higher wages, typically offered in big cities. If everyone lives in The Hague and works in Rotterdam, there will be a lot of congestion, so the number of commuters between two specific locations will also influence work and housing choices. People also prefer lower transportation costs, which means shorter distances between work and home. The gravity equation will be further elaborated in the methodology.

So the main research question is: **What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?**

The first sub question is:

What are the expected advantages and disadvantages the MRA or creating a new town?

The expectation is that there will be both advantages and disadvantages for expanding the MRA vs creating a new town in the Markermeer.

The second sub question is:

What will the difference be in terms of effect on the population changes in the area?

So this sub question will analyze whether there will be differences in population changes in the Netherlands if a new town is build in the Markermeer vs an expansion of the MRA. The hypothesis for this sub question is: There will be similar population changes in the Netherlands after the addition of houses.

The third sub question is:

What will the difference be in terms of effects on the house prices?

So this third sub question will be answered by analyzing whether there will be significant differences on the house prices, if a new town is build versus expanding the MRA. The hypothesis for this sub question is: A new town will provide cheaper housing, so the house prices in the MRA will be higher. This hypothesis is based on the fact that European new towns in general have a bigger focus on mixing different social-economic classes and with both housing for high- and low-income households (Mann, 1970).

The fourth and final sub question is:

What will the difference be in terms of effects on the labor markets and wages in the area?

To answer this sub question the thesis analyzes the difference in effects on the labor market and wages, between building a new town in the Markermeer and expanding the MRA. The hypothesis for this sub question is: There will be higher wages if the houses are built in the MRA, then if a new town is build. This is the expectation because, of positive agglomeration effects, which will cause higher productivity and thus also higher wages in a large metropolitan area like the MRA (Monte et al, 2018).

Theoretical background

So now that the subject has been introduced, the literature needs to be studied and analyzed to understand what existing literature says about creating new towns and urban development in general. Since several new towns have been developed in the Netherlands and land has already been reclaimed to create an entire new province with new towns, it is also important to analyze existing case studies about the new towns developed in the Netherlands in recent decades, such as Zoetermeer, Nieuwegein, and Almere in Lelystad in the reclaimed province of Flevoland. A good description of a new town by the International New Town Institute is: *"...human settlements that were founded at a certain moment in history by an explicit act of will, according to a preceding plan and aiming to survive as a self-sustaining local community and independent local government, able to play a role in the ongoing development of the region in which the new town is located"* (INTA, 2009).

Chronological overview of the different concepts of city expansion

First, the different ways of city expansion will be analyzed, with the earliest ideas about new towns dating from the 19th century. In the Netherlands there were also several new towns built, mainly in the '70s. After 1990, the focus shifted towards expanding existing cities with the so-called vinex-districts, which were large suburbs with their own facilities. Vinex stands for 'Vierde Nota Ruimtelijke Ordening Extra', which can be roughly translated as The Fourth Memorandum on Spatial Planning Extra. This was a document by the Department of Housing, Spatial Planning and environment in 1993 (Radboud University, n.d.). In 2023, there were new plan published about new locations to build, called the Novex-areas (NOVEX - de Nationale Omgevingsvisie, n.d.).

One of the earliest ideas about new towns is the garden cities of tomorrow concept from Ebenezer Howard. The historical evolution of this urban planning model is analyzed. This model emerged in the 19th century as a response to the economic, social and environmental challenges of industrialization. The main point of Howard's garden city concept is to create self-sufficient communities that combine the best of rural and urban life. The garden city concept was a response to the urban development at the end of 19th and beginning of the 20th centuries, because at that time, the rapid urbanization in European cities, due to industrialization, led to poor living conditions, social unrest and pollution of the environment. To tackle those

challenges, urban models were made that prioritized human well-being, better living conditions and focused more on being environment-friendly. Howard introduced the garden city concept in his work "Tomorrow: A Peaceful Path to Real Reform" (1898), inspired by practical experience gained from agricultural communities, as a solution for overcrowding and social inequality in cities. Howard envisioned Garden Cities as self-contained urban settlements surrounded by green belts, with a balanced mix of residential, commercial, and industrial areas. These cities would have sufficient green spaces, enough amenities for the community, affordable housing, and maintain a connection between the community and nature by having green areas surrounding those communities. These characteristics are shown in figure 4.

So, in the garden city concept, environmental stewardship and economic self-sufficiency stood central. Also, Garden Cities are intended to be places for all social classes, with affordable housing for everyone, which is achieved by using a system where land values would be shared collectively. The green spaces between two cities would ensure food security, but also would be there for recreation and for a healthier environment. Furthermore, the green belts would serve as a way to stop urban sprawl and thus guarantee access to nature and a good quality of life. The Garden City concept was also practical implemented in England in 1903, with the creation of Letchworth Garden City, featuring streets with trees, enough parks and mixed land use. The success of Letchworth, inspired the development of other Garden Cities, such as Welwyn Garden City and Hampstead Garden Suburb.

However, the Garden City faced not only positive feedback but also some challenges and criticisms as some urban planners questioned its feasibility and scalability, while others criticized its lack of cultural diversity. Additionally, some criticism was directed about the relevance of the Garden City concept in an era with mass urbanization and more and more technological advancements. But, despite some of its criticism and limitations, the Garden City model can be seen as historical significant urban planning model, with the continuing of the ideas to create sustainable and livable communities with the focus on the human well-being and environmental stewardship, especially with the climate changing and ambition to become climate-neutral (Batchelor, 1970).

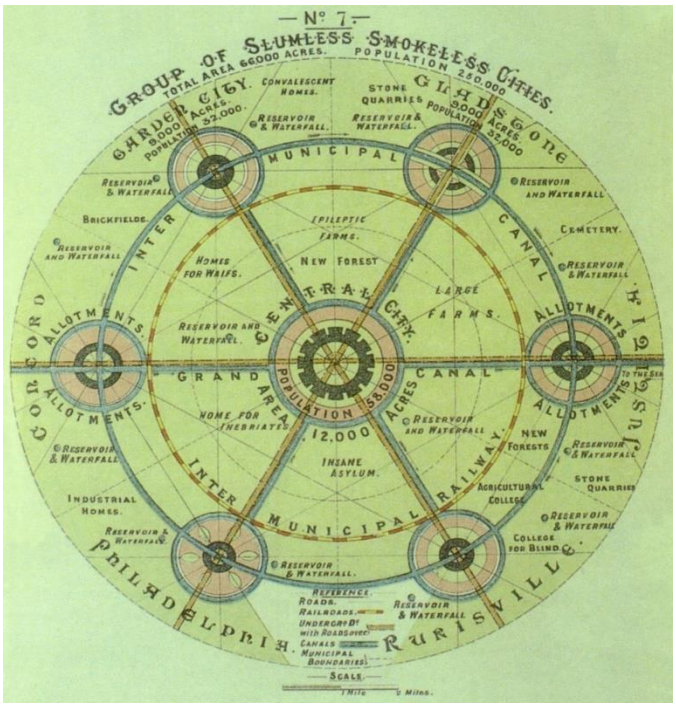

Figure 4: picture of the garden city concept by Ebenezer Howard (Source: Archdaily)

More generally, key issues in transport and urban development, and the links between them, are important to analyze. Transport has a major impact on the spatial and economic development of regions and cities. The attractiveness of an area depends, among other things, on the quality of transport. So, transport and urban development are linked. For example, changes in the dynamics of a city have led to an increase in car use and road infrastructure, which in turn has led to problems like congestion and pollution. For sustainable development, these problems must be tackled, for example by developing more public transport.

There are also main issues and debates regarding whether certain developments work well in transport and urban development. New infrastructure has a substantial impact on the local economy. Regional infrastructure investments aim to improve accessibility and attract more firms, but it is debatable whether this actually benefits local inhabitants. Also, areas where multiple transport modes intersect, such as airport hubs, attract commercial interest and spur developments like science parks and hotels, but benefits may be modest in existing urban areas.

Another note is that transport costs form only a small part of the total cost, so improving the infrastructure will only marginally affect the total cost. Furthermore, public funding for infrastructure projects faces challenges in capturing added value for developers, leading to potential free-rider problems. Fiscal policies also influence housing, car consumption, and use,

which can lead to more development on agricultural land and peripheral locations. The allocation of resources between different transport modes has always caused problems, as the impact on land and resource usage should be considered.

Additionally, there are many different theories on urban development, ranging from classic urban theories to detailed models, but there are often challenges in capturing causality and complexity. Methodological challenges also exist in capturing causality between transport, urban, and economic development, mainly in capturing impact over time (Nathaniel Lichfield et al., 1995).

One of the most famous and the biggest new towns in The Netherlands is Almere, built in Flevoland, a province reclaimed from the IJsselmeer. The purpose of building the new town Almere was to stop the expansion of cities in the Randstad, to preserve the Green Heart, and to accommodate the rising housing demand. Almere was developed not as one big city, but as a polynuclear city, directly based on the principles of Ebenezer Howard (1898), which had several advantages. First, some people preferred the more small-sized settlements. Second, green belts between the city parts, also derived from the Garden City concept by Ebenezer Howard (1898). Third, to keep the size of Almere flexible, as it was not certain whether Almere would realize the planned size. This conception led to discussions among urban planners because it would realize pleasant living conditions but could also cause immense congestion. In the end, Almere would consist of six different parts, with a railway to Amsterdam and a focus on public transportation close to all houses. The planning map of Almere in 1978 is shown below in figure 5.

First, Almere-Haven was built, which was a big success because many people wanted to live in this attractive place near the water, with a marina nearby. After that, Almere-Stad was built, with a focus on an urban character. In 1983, the government wanted to reduce costs by only developing three locations, which led to less green land and more linear building patterns.

One of the things formulated in the plan for Almere was that Almere should be a city for everyone, so Almere built a large number of social houses. In the 90s, people aged 24-40 were overrepresented, and the largest donor areas were The Gooi region and Amsterdam. In the beginning, a fair number of people were employed in Almere, partly because many entrepreneurs moved to Almere and created jobs. However, later more people worked outside Almere, as it is still part of the Amsterdam labor market. Something that was missing around that time was a characteristic profile of Almere, which may influence the further growth of Almere. At that time, people were fairly happy with the quality of life. Despite the high number of

commuters and a relatively high crime rate, the complaints about it were not too bad (Constandse, 1989).

More recently, the town has grown to 180 000 inhabitants around 2010 and aims to reach a population of over 300 000 in the future, making it the 5th biggest city in The Netherlands. Reaching this goal is not only a challenge, but creating over 100 000 jobs and becoming a more self-sufficient city is also a challenge. It is a great task to maintain a strong economy and overcome social and environmental issues while continuing its further development. The main plan for Almere between 2006 and 2015 focused on improving facilities and strengthening the economy, enhancing ecological value and outdoor recreation, improving the quality of education, and better connectivity to the Randstad. Almere's urban growth must align with national spatial development policies, focusing on economic strength in the Randstad for international competition, water management for climate change threats, protecting the Markermeer/IJmeer nature reserve, expanding transportation networks, and growing Schiphol airport. Regional and local planning must also comply with EU nature reserve policies affecting Almere's direction. Decision-making depends on the ruling political party, influencing development focus and policies. Almere's expansion involves extensive actors, including 3 water boards, 14 municipalities, 2 provinces, 5 ministries, and numerous stakeholders and although issues are similar, disagreements are likely to appear and need to be solved.

In conclusion, the main challenges Almere will face are mainly in supplying enough housing and reaching a population goal of 360 000, something another city nearby, such as a new town in the Markermeer, could help with. Of course, there are also challenges in providing a plan that satisfies all stakeholders and authorities, as that is extremely difficult. The question of whether the planning method for new towns in The Netherlands is applicable in the future is that by learning from past developments and using those, there are enough guidelines to bring a new town to success (Thorgeirsdottir, 2010).

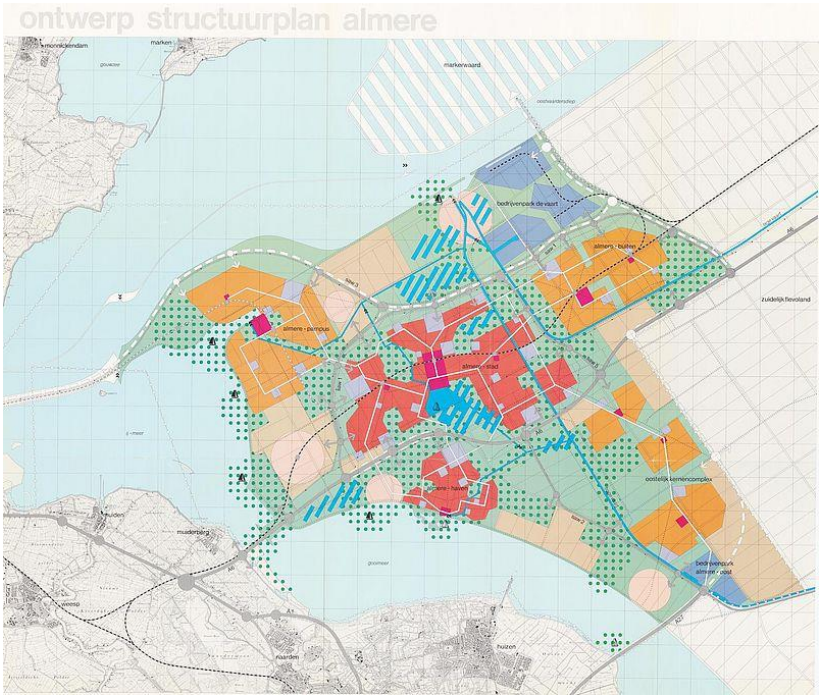

Figure 5: planning map of Almere in 1978 (Stadsarchief Almere, 2023)

Another important new town to consider is Lelystad, a city built on reclaimed land in Oostelijk Flevoland, one of the first new towns developed in the second half of the 20th century. To address problems such as overcrowding and increasing congestion due to a growing population, and to preserve the Green Heart—a mainly green area between the major cities in the Randstad—certain growth centers were designated as cities that could expand significantly. This strategy, known as bundled de-concentration, aimed to balance between total urban sprawl and large metropolitan areas by ensuring that these growth centers had enough facilities to avoid becoming merely large suburbs. Lelystad was designated as one of these growth centers, with its first neighborhood built in 1966. Initially, the plan was to create self-contained neighborhoods with their own facilities, but this was later changed to a plan featuring a more central zone with all commercial and social amenities.

Some of the main criticisms of growth centers like Lelystad include the monotony of housing and neighborhoods, an overabundance of single-family homes, and the energy wasted on commuting. Social issues have also been identified, such as a lack of social cohesion, partly due to socially unconnected neighborhoods. The main problems in Lelystad can be summarized as a lack of social and cultural facilities and a shortage of employment opportunities. In the 21st century, growth centers like Lelystad face challenges related to the energy transition and the need to address the housing supply shortage while maintaining existing qualities (Spoormans et

al., 2019).

Another Dutch new town that can be analyzed is Zoetermeer, a city close to The Hague that celebrated its 60th anniversary in 2022. Positive aspects of Zoetermeer include the presence of sufficient green areas, though the city has been criticized for a lack of dynamism and liveliness, and residents report experiencing an above-average amount of nuisance from loitering youth. However, statistics indicate that Zoetermeer does not have an above-average amount of nuisance. One reason might be that people in suburban areas like Zoetermeer have a lower tolerance for nuisance compared to those in big cities (Van Ginkel et al, 2002).Zoetermeer has also demonstrated several success factors, such as devoted public leadership, ongoing commitment from social housing organizations, sufficient private and institutional investors, and a strong imperative to take action and exceed urban standards. The main area needing development and improvement is downtown Zoetermeer, which is key for urban redevelopment with the goal of creating a more vibrant city center. Essential tasks include promoting integrated land use, recognizing the importance of diverse and high-quality design in housing and public spaces to attract new residents and businesses, and ensuring active stakeholder engagement throughout the planning and development process (Hereijgers, 2024).

What are the different economic consequences between building a new town or expanding a city?

In a paper by Alonso (1970), the question of what new towns are for is analyzed from his perspective, mainly focusing on American new towns. New towns can occur in different types: independent new towns that employ their own citizens, or satellite towns where citizens commute to other cities to work. Presently, most new towns in the US are retirement towns or towns for big projects. There are two different new town policies to distinguish, namely, new town policies that aim to decentralize areas and cities considered too large, and policies that aim to increase population in underdeveloped and underpopulated areas. The focus in this paper is mainly on the decentralization policy. The arguments for building new towns can be divided into three categories: macro geo-economic, social policy, and production and physical purposes.

From a macro geo-economic perspective, new towns can be built to address problems with overpopulation and accommodate population growth, but Alonso argues that it is questionable whether new towns will significantly impact these issues. New towns can also accommodate rural migrants and stimulate economic growth, but Alonso criticizes this idea because it might be difficult to maintain a closed labor market in a new town. This could lead to many people working in the same big cities in the area, resulting in congestion and longer commuting times. Thus, the effectiveness of new towns on economic and urban growth can be questioned.

Another perspective is the social policy angle. New towns may improve mental health because they are smaller and more social. They might also be healthier by encouraging walking and cycling more and having less air pollution, although this largely depends on the new town's policies. New towns may be attractive because of good amenities. However, to house the lower class, large subsidies are needed, and if the focus is not on social integration, this can lead to a town dominated by the white middle class. Another argument is that new towns increase people's choices about where to live, offering unusual architectural structures.

Thirdly, there are production and physical purposes to consider. One argument is that new towns provide cheaper land, but the prices may be drive up because of land speculation. In terms of production, a rapidly growing new town can provide economies of scale in construction and purchasing and foster innovations in design and technology. Companies may see new towns as potential investment opportunities. Recreational aspects also argue for new towns, emphasizing the need for beautiful and functional urban environments. Additionally, new towns

can offer easier access to open land compared to very large metropolitan areas.

In conclusion, according to Alonso (1970), housing millions of people in new towns is unlikely to succeed due to the underestimation of social and economic connections in a modern society. Even though there are several advantages, such as reduced pollution and congestion, the main focus should be on solving problems in existing cities.

An important economic aspect to analyze is agglomeration effects. Agglomeration effects refer to the increase in productivity due to higher employment density and availability. This is a vital aspect to consider because a new town might have lower productivity than a large agglomeration, making it an important economic factor in the urban economics of building a new town. This paper examines the agglomeration effects in the five biggest economies of Europe, which likely provide results applicable to the Netherlands. The results did not differ significantly among these countries, suggesting that Germany's results are probably the most similar to those in the Netherlands. When controlled for different factors, the estimated elasticity of labor productivity with respect to employment density is 4.5 percent, comparable to 5 percent in the US. This means that doubling the employment density leads to a 4.5 percent increase in labor productivity (Ciccone, 2002). However, this agglomeration effect of 4.5 percent is based on a paper over 20 years old. According to more recent research by Monte et al. (2018), agglomeration effects are estimated to be between 0.5 and 2.5 percent, substantially lower than the previously stated value but also far more recent and thus for the rest of this research this value range will be used. This is a value for the US, but the Netherlands appears to have a similar value to that in the US. Thus, assuming the applicability of this research to the Netherlands, the agglomeration effect in the Netherlands is assumed to be between 0.5 and 2.5 percent.

According to Velzing et al. (2023), working together is an important aspect of the urban development of new towns. Complex problems and situations, such as economic resilience and sustainability, require the engagement of different stakeholders: the government, local authorities, companies, and residents. Since all these stakeholders have different visions, cooperation can become challenging. Thus, good communication and a shared vision among stakeholders are crucial. Four different questions can be distinguished: the possibilities for further growth, the required adaptability, the challenges with large-scale housing construction, and the paradox of vulnerabilities in an economically strong area. In general, the density of new cities like Almere and Lelystad is relatively low, meaning these cities should have enough space

to fulfill the housing demand. However, some citizens oppose this idea because it might influence the suburban character of these cities. While Lelystad and Almere can be seen as part of the Amsterdam metropolitan area, which has a very strong and competitive economy, they have some vulnerabilities, such as a high number of commuters and a disappointing knowledge infrastructure. Some challenges these new towns, especially Lelystad and Almere, face include a rapidly growing and aging population, a relatively low number of 'mbo-jobs,' and a relatively low number of people experiencing good health.

The question of whether new towns can become self-sufficient business centers that stand on their own, rather than merely being satellite towns for big cities, is examined by Lee (2008). This research is from South Korea, so it may not be entirely applicable to the Netherlands, but it could still be relevant. Due to population concentration in Seoul, a significant housing shortage has arisen, prompting the development of new towns in the Capital region. This study examines migration and commuting patterns from 1995 to 2005, revealing that migration has followed new town development, expanding the Seoul Metropolitan Area into the northeastern Capital region. Over this period, new towns have increased their job-housing balance and self-sufficiency, indicating their potential to become future business centers and thus focusing on the job-housing balance and self-sufficiency in new towns is suggested to address problems in the capital region in south Korea.

An important urban-economic outcome to consider following the expansion of a metropolitan area is the wage rate. Research by Hoch (1976) suggests that as cities grow, so do wage rates for similar work, and this wage differential remains stable over time. This indicates that higher wages in larger cities are not temporary adjustments but rather compensation for the higher costs associated with increased population size. However, evidence suggest that large metropolitan area with also high wages, have been losing population, which means that higher wagers are not simply attracting more workers and means instead that those higher wages are just a feature that compensates for the higher cost of living. Big cities offer both benefits and costs, but it appears that the costs outweigh the benefits, leading people to move until other locations become less appealing than their current one. Solutions to population distribution issues often arise indirectly from addressing more fundamental problems. An important side note is that this research and these trends are from a few decades ago, so the trends may have shifted.

So in conclusion, there can be different economic consequences and arguments identified in favor of and against both expanding existing cities and building a new town. New towns have several advantages, such as their innovative character, typically quiet and peaceful neighborhoods, and because they are relatively new, usual metropolitan problems are less common, allowing a focus on preventing issues (Uitvoeringsagenda new towns, n.d.). The main positive economic consequences for new towns include the possibility of creating sustainable districts that are less car-oriented. While new towns from some decades ago are quite car-dependent, creating a new town in the upcoming years brings the possibility of creating a less car-dependent and more sustainable town, especially with the increased focus on sustainability and reduced car dependency in recent years. Additionally, the ability to create a large supply of housing is an advantage.

Several disadvantages include the large number of people not working in the new town itself, the low number of jobs, and usually a poorer knowledge infrastructure. New towns have also recently faced several problems, such as the need for more diversified housing due to aging populations and single-person households. There is also a need to improve the image of new towns, address the energy transition, and enhance transport and traffic (INTI, n.d.). For instance, Almere has 607 jobs per 1,000 people, which is substantially lower than the Dutch average of almost 800 (CBS, 2013). Additionally, Almere-Amsterdam is the busiest work-live route in the Netherlands, causing significant congestion (Arbeidsmarkt en Onderwijs | Almere, n.d.).

VINEX districts also have several advantages and disadvantages. VINEX districts are generally nice neighborhoods with a good quality of life and large gardens. Some of the positive economic effects of expanding an existing metropolitan area include increasing agglomeration effects and a robust job market. Additionally, expanding a metropolitan area incurs lower infrastructure costs compared to creating a new town because of the existing infrastructure.

However, these districts have also become one-sided, highly educated enclaves with a median income of more than €70,000, making it difficult for single or divorced people to live there. The houses are primarily intended for families, but the average duration of a family with children living at home is only 25 years, while people often live there longer. Additionally, VINEX districts usually have fewer facilities, meaning that, for example, on a Friday evening, many food delivery scooters need to travel from the city center to the suburbs (AD, 2024). Some of the economic disadvantages of expanding a metropolitan area, like the MRA, include congestion and usually high house prices. So, we can conclude that both expanding existing cities and building new towns have several advantages and disadvantages.

Research methodology

To answer the main research questions, “What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?” two different research methods will be used. The first sub question can be answered by analyzing the different papers and case studies about new towns. The remaining sub questions will be answered by using the gravity equation.

Which usable spatial-economic models exist?

The gravity equation is an urban-economic model for the simultaneous choice of residential location, job location, and transport choice. There are also two other methods to analyze the spatial-economic effects of planning choices, namely New Economic Geography (NEG) Models, where the core-periphery model is an example, and Computable General Equilibrium (CGE) Models. The core-periphery model analyzes the interactions between increasing returns at the firm level, transport costs, and factor mobility (Fujita & Krugman, 2004). CGE models are used to analyze the economy-wide effects of policy changes or external shocks by simulating interactions between different sectors, regions, and agents within an economy (Lofgren et al., 2002). In this research, the gravity equation is used because it can best capture economic effects on residents per municipality, such as land prices and wages. The other two methods focus mainly on the effects on firms or the whole economy. The main point of the gravity equation is to regress flow data on population values between origins and destinations and on the distance between them (Curry, 1972). The type of gravity equation model described by Curry is:

$$\log \text{flow} = a + b \log Po + c \log PD - d \log s \quad [1]$$

In equation 1 a, b, c and d are constants and s is the distance between Origin and destination. According to Curry, the gravity equation can be applied to many different phenomena in spatial analysis. One benefit of using the gravity equation is that this empirical model, based on a few parameters, explains data on not only commuting flows but also trade flows relatively well, while being consistent with general equilibrium (Egger & Pfaffermayr, 2015). The gravity equation has also been used in research about international trade, where it states that bilateral exports are

[1] Curry, L. (1972)

proportional to the size of the economy and inversely proportional to the geographical distance (Bergstrand, 1985).

Gravity equation

The gravity equation tries to describe the preference of people with the following formula:

$$V_{od} = \vartheta \frac{1}{N_{od}^{1/\alpha}} \frac{A_o w_d}{r_o^{\beta} d_{od}} \quad [2]$$

In equation 2 o is the origin, with A the amenities in the place where one lives, so for example restaurants, parks and schools and r is the price of housing. People prefer high amenities and low rents. d is the destination where one work, where one prefer a high wage. The origin-destination (od) combination is dependent on the commuting cost d, and the number of other commuters N, where you prefer low commuting cost and also low amount of other commuters, because otherwise the route will be congested and bring higher commuting cost.

So the commuting flow between any two cities can be derived to the following formula:

$$\log N_{od} = -\alpha \log d_{od} + \alpha \log \frac{A_o}{r_o^{\beta}} + \alpha \log w_d + \log \frac{N}{\sum_{od} v_{od}^{\alpha}} \quad [3]$$

And if we assume that A, r and w are fixed effect per location and the last log is a constant in equation 3, the following equation 4 is obtained (Gerritse, 2024) :

$$lnFlow_{ij} = -\beta log time_{ij} + FE_i + FE_j + c \quad [4]$$

Data

The data required to simulate the gravity equation and apply a shock, is data from the CBS about highways and railways in the Netherlands, and data about the traffic flow from commuters between the work and live location, between all the municipalities and data about the average

[2] Gerritse, M. (2024)
[3] Gerritse, M. (2024)
[4] Gerritse, M. (2024)

house price in all municipalities in the Netherlands. The data with all commuters between every possible origin-destination location is also data form the CBS. However, it's noted that obtaining all required data can be challenging, and in some cases, data may be from a few years ago due to availability and obtainability constraints. In this context, a "shock" refers to changing input variables resulting from alterations such as changes in housing supply, productivity levels, or travel times. These changes can affect commuting patterns and urban-economic outcomes modeled by the gravity equation.

The Gravity equation

In the gravity model used to answer the sub questions, the flow was regressed on the minimum of the logarithm of the highway time and logarithm of the railway time. A logarithm scale was used, because after plotting the commutes vs distance, the results suggested a logarithm relationship. The scatterplots are shown in the appendix. To achieve an accurate understanding of transport times, considered both rail and car travel times were considered. The model uses the faster of the two options to calculate the travel time for each origin-destination pair. Additionally, the model includes a control variable for commuting within municipalities, so the people work in the same municipality as they live in, as well as fixed effects for origins and destinations to capture the attractiveness of each. Those fixed effects include the origin fixed effect and destination fixed effects, which are used to ensure that changes in population, wages or labor market access as output from the model are interpreted relative to conditions specific to each origin or destination, adjusted for all unobserved factors captured by those fixed effects.

So the gravity equation for the flow of commuters between municipalities used is:

$$\log Flow = \beta_1 TransportFactor_{ij} + FE_i + FE_j + c \quad [5]$$

The transport factor is derived from a linear regression that considers the minimum travel time between municipalities and includes a within-municipality commute factor. The fixed effect i (FEi) represents the attraction factor of each travel origin, and FEj represents the attraction factor of each travel destination.

[5] Curry, L. (1971)

Gravity equation and parameters used in the research

The parameters used in the algorithm to optimize the gravity equation after a certain shock — in this case, the addition of 175,000 houses in the MRA, the required amount for this decade — include the housing share expenditure, the location choice sensitivity, and an agglomeration parameter.

The housing share expenditure parameter chosen is 0.23, based on data from CBS (2024), which indicates that the average housing share expenditure in the Netherlands is 23% of income. This variable is crucial in the model because it captures the economic realities of households, thus providing a more realistic model output. For the agglomeration effect a positive parameter of 0.1 was chosen, because according to Monte et al. (2018) the agglomeration parameter is estimated to be between 0.05 and 0.25, so a value approximately in the middle of the range was chosen, because of an assumption made that the MRA would experience average agglomeration effects. The function of the agglomeration parameter is to capture agglomeration economies, which means the benefits that companies derive from being near each other or in clusters. In the literature, a clear value for the location choice sensitivity parameter could not be determined. Therefore, a parameter of 5 was chosen, which aligns with values used in similar models discussed in the Seminar on Urban, Transport, and Port Economics. The gravity equation used in the optimization algorithm is extended to include exogenous variables such as productivity and agglomeration effects, and it also considers distance. All inputs from this model and explanations are detailed in Table 1. So equation 6 captures also the before mentioned parameters:

$$logN_{od} = -\alpha log d_{od} + \log\left(\Omega_o^{\alpha} lma_d\right)^{\frac{-\alpha\beta}{1+\alpha\beta}} + \log\left(\alpha_d^{\alpha} L_d^{\alpha\gamma}\right) + c \qquad 6$$

Where: $c = \log\left(\frac{N}{\sum_{od} v_{od}{}^{a}}\right)^{\frac{a}{1+\alpha\beta}}$ 7

[6] Gerritse, M. (2024)
[7] Gerritse, M. (2024)

Applying a shock

To address the main research question and its sub-questions, a shock can be simulated using the gravity model. Specifically, the impact of constructing 175,000 houses in the MRA can be modeled to assess changes in labor market access, wages, housing prices, and population dynamics. These outcomes will address the second, third, and fourth sub-questions.

The MRA comprises a total of 30 municipalities, with a combined population of 2.5 million inhabitants and 1.15 million houses (MetropoolRegio Amsterdam, 2024). Adding 175,000 houses would increase the housing stock in the MRA by approximately 15.2%. The quantity of houses added per municipality in the MRA is showed in figure 9.

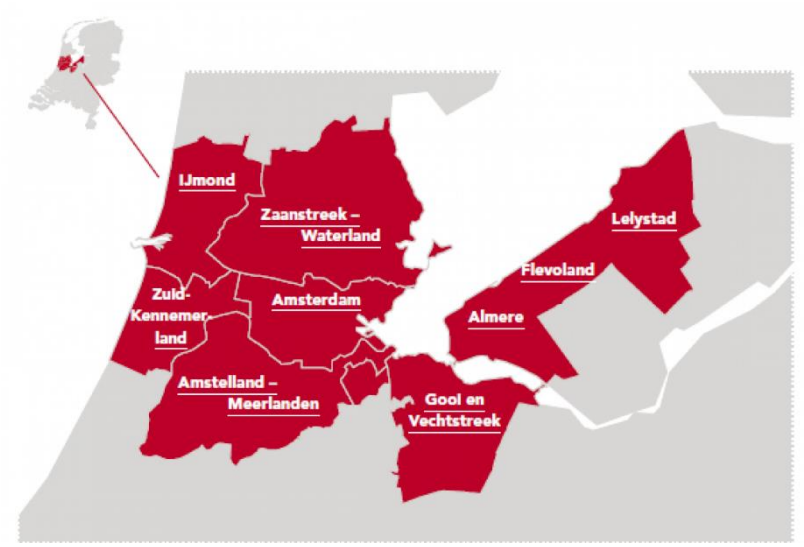

Figure 6: Metropool regio Amsterdam (MRA, n.d.)

Analysis in Stata

The analysis begins by simulating travel times using QGIS, an open-source geographical information system used for data processing, analysis, and visualization. Travel times between all municipalities in the Netherlands are simulated using geographical data on highways and railways sourced from CBS. An algorithm in QGIS calculates the fastest routes between centroids, the most central points within municipalities. This spatial data is then imported into

Stata.

In Stata, additional data on transport flows between municipalities across the Netherlands is utilized. The gravity model yields three critical outputs: firstly, it identifies the attractiveness of each municipality as a destination; secondly, it determines each municipality's attractiveness as an origin; and thirdly, it assesses transportation friction between municipalities, defined as the minimum travel time via road or railway between each pair. In cases where railway travel time data is absent, the model defaults to road travel times. These components comprise the gravity model equation, essential for the technical analysis in this study. By estimating this equation using Stata, various economic factors such as labor market access, wage levels, and changes in house prices can be calculated.

These economic variables are derived based on assumptions regarding parameters such as location choice sensitivity, the agglomeration parameter, and expenditure share on housing. Once these economic fundamentals are established, a shock is applied — initially, the addition of 15% more houses in the MRA. Subsequently, a looping algorithm optimizes the gravity equation. Initial values are inputted, and the loop iterates until convergence is reached, ensuring accuracy in the equation. Key outputs from this process include counterfactual values for rent, wages, labor market access, and population, comparing scenarios with and without the addition of 175,000 houses in the MRA. These values quantify the differences resulting from the hypothetical addition. The data is then used to generate visual representations in QGIS, illustrating the areas affected by the addition of 175,000 houses in the MRA and the extent of these impacts. The complete Stata code used for analysis is provided in the Appendix. An important side note is that there are no houses built in the rest of the Netherlands and this model thus reflects a hypothetical situation.

Markerwaard

Secondly, the analysis aims to answer how creating a new town in the Markermeer will influence its consequences. This addresses the second part of the second, third, and fourth sub-questions: the effects of adding a new town in the Markermeer on changes in labor market access, wages, house prices, and population.

Initially, a new municipality named Markerwaard was added to the database in the Markermeer. Highways and railways were also added to connect Markerwaard to the rest of the Netherlands. The location of this municipality, highways, and railways is based on a 1974 map depicting the potential layout of Markerwaard, as shown in figure 7. The exact routes of the

highways and railways added in QGIS differ slightly from those on the map; however, the primary focus was on ensuring connectivity to Amsterdam, Noord-Holland, and Flevoland, which is crucial for the model. Figure 8 depicts the map of Markerwaard with highways in red and railways in blue.

Subsequently, travel times were re-simulated after adding Markerwaard and used in Stata. The analysis for the situation involving the new municipality Markerwaard with 175,000 houses in Stata is largely similar, with some variables yet to be determined. The three parameters for the gravity equation are the same as in the first analysis, with the houses added to the MRA. But for this new situation with a new municipality, the variable average house price is needed. Also, all potential flows of people who work in the Markerwaard and live in any of the other municipalities in the Netherlands and live in the Markerwaard and work in any of the other municipalities in the Netherlands needs to be determined.

Although this information is not available, predictions were made based on commuting flows from Almere, another new town in a location similar to Markerwaard relative to Amsterdam, assuming similar commuting patterns. Given that Markerwaard would be 1.69 times larger than Almere, the commuting flows were multiplied by 1.69 and added to the flows for Markerwaard. However, the total number of flows cannot exceed the actual population, so the additional commuting flows attributed to Markerwaard were subtracted proportionally from other municipalities in the Netherlands to maintain the overall flow balance.

Given the difficulty in determining the exact changes in flows from each municipality, proportional adjustments were made, resulting in larger municipalities experiencing greater changes in flows compared to smaller municipalities. The average house price in 2023 is 422,000 euros, while a newly-built house costs 500,000 euros (CBS, 2024). However, since the remaining data is from 2019 and 2020 when house prices were lower, an average house price of 350,000 euros was chosen for Markerwaard to maintain comparability with other house prices in the dataset. With all variables determined, the procedure mirrors that of the first situation with the MRA. The gravity equation is optimized using Stata, and the results are visualized in QGIS.

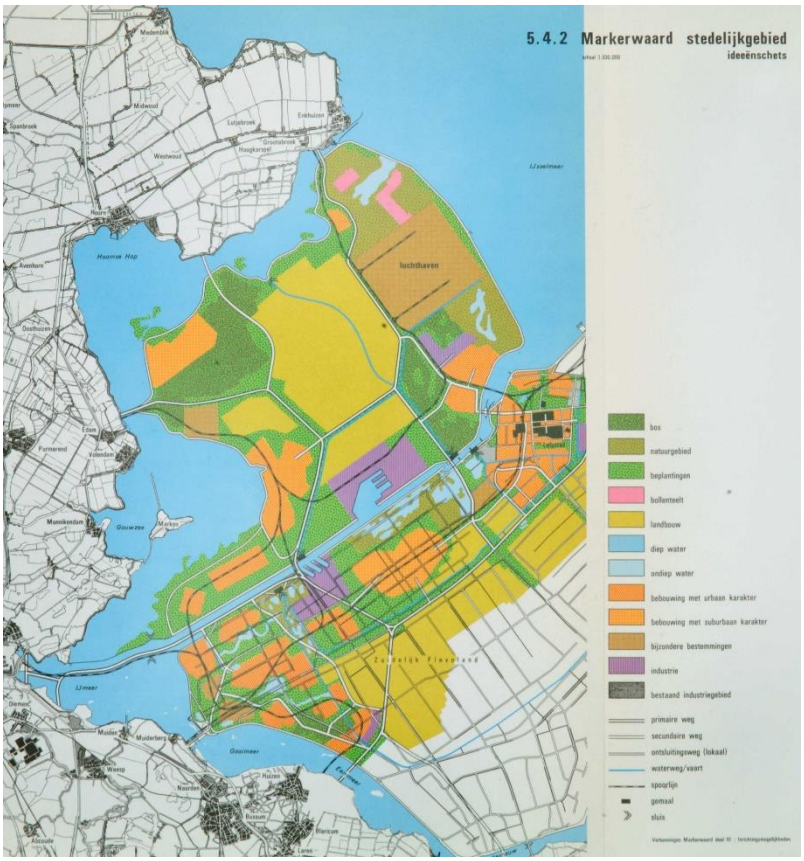

Figure 7: map of how Markerwaard could potentially look (Flevolandsgeheugen, 2018)

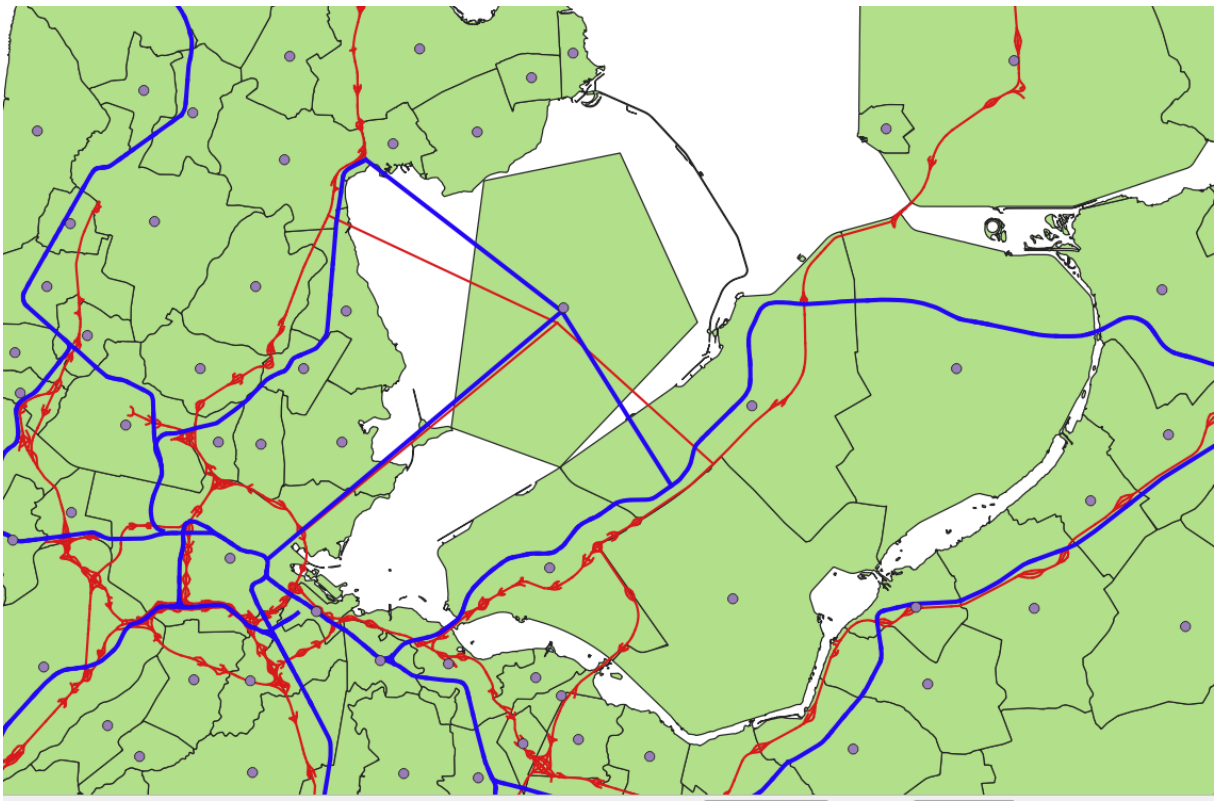

Figure 8: how Markerwaard looks in QGIS, with high- and railways

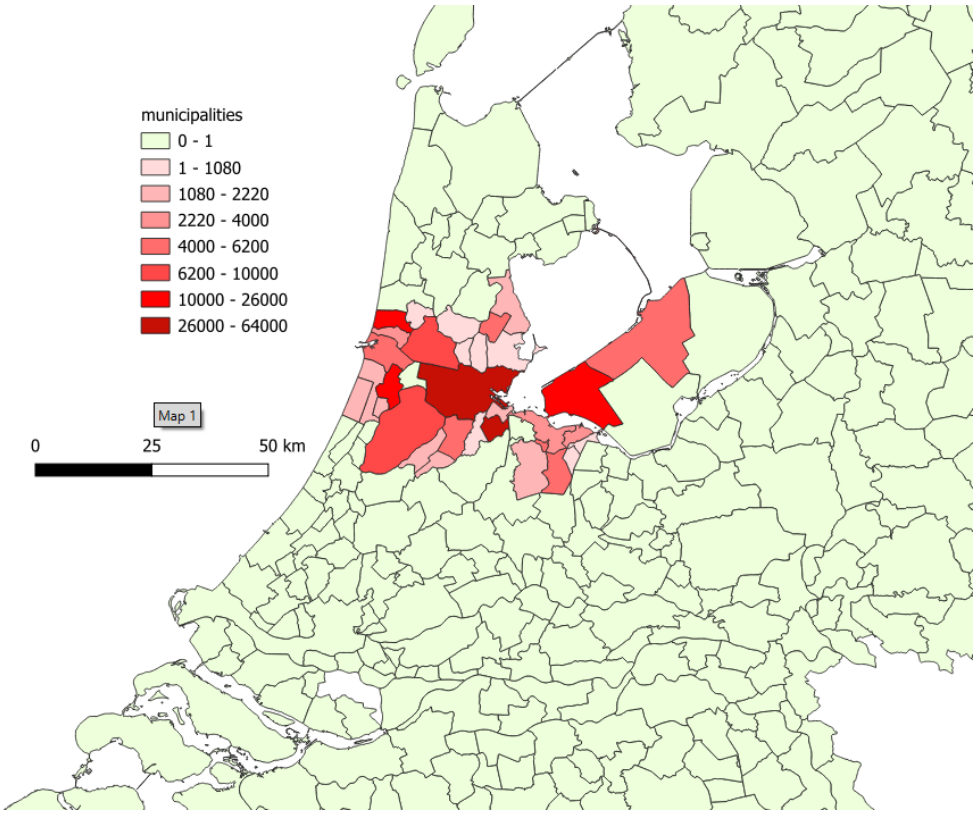

Figure 9: Amount of houses added per municipality in the MRA

Input	***Elaboration***
α	Housing location choice sensitivity, has a value of 5 in this model
β	Housing expenditure share, has a value of 0.23 in this model
γ	Agglomeration parameter, has a value of 0.1 in this model
$\boldsymbol{logN_{od}}$	Logarithm of the flow between origin and destination
$\boldsymbol{-\alpha log d_{od}}$	Negative effect of distance on the flow
$\boldsymbol{log\ (\Omega_o^{\alpha} lma_d)^{\frac{-\alpha\beta}{1+\alpha\beta}}}$	Combined effect or origin residential attraction and destination labor market accessibility
$\boldsymbol{log\left(\alpha_d^{\alpha}\ L_d^{\alpha\gamma}\right)}$	Combined effect of destination's productivity and labor market conditions.
$\boldsymbol{c\ (log(\frac{N}{\sum_{od} v_{od}{}^{a}})^{\frac{a}{1+\alpha\beta}})}$	Constant term effecting flow

Table 1: inputs and parameters gravity equation

Analysis and results

The result from the analysis are shown in the next maps, which can answer the second, third and fourth sub question. These results include several variables, namely the changes in population, the changes in the price of land, reflected by the variable rent and the changes in the labor market access and wages, to show the effect on the economic situation in the Netherlands. These variables are mapped by municipality to show the most significantly affected areas in the Netherlands.

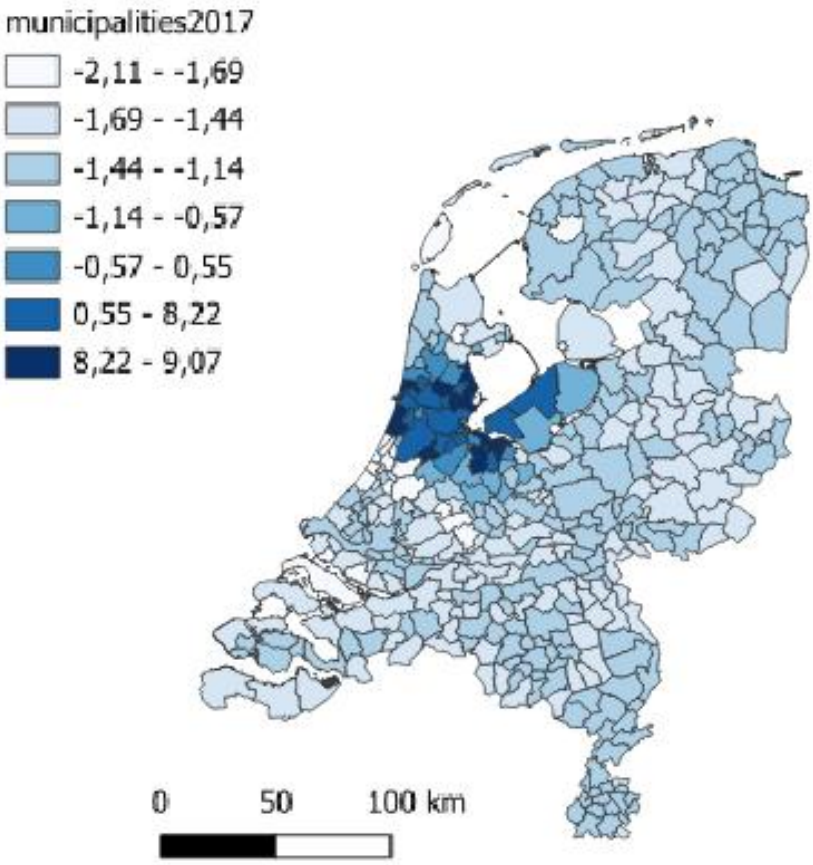

Figure 10: Change (%) of Population by Municipality After Addition of houses in MRA

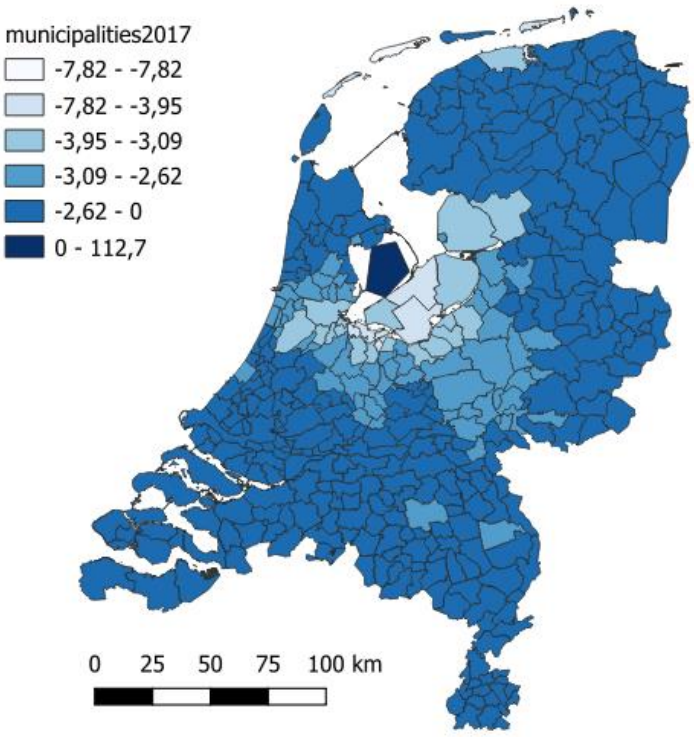

Figure 11: Change (%) of population by municipality after addition of houses in the Markerwaard

Figure 10, depicted above, illustrates the changes in population following the addition of 175,000 houses in the MRA. This figure contributes to answering the second sub-question. The darkest areas on the map indicate the municipalities that experienced the greatest population

increases, while the white areas represent those with the greatest population losses after the housing addition in the MRA. The underlying rationale behind population shifts is straightforward: municipalities within the MRA that received additional housing saw the largest population gains, with some experiencing up to a 9% increase. Conversely, municipalities surrounding the MRA witnessed the most significant population declines. Other areas in the Netherlands showed smaller decreases in population. Assuming a positive agglomeration multiplier, people tend to prefer living in close proximity to others to enhance production efficiency. This preference makes the MRA an even more attractive place to live and work, thereby leading to an increase in population following the housing expansion. An important side note, is that this models simulates a situation where only in the MRA houses are added and shows the effects from this action, but of course this is only a hypothetical situation where this happens, while in real life in the whole off the Netherlands houses will be built and will cause different effects.

Figure 11 illustrates the changes in population following the addition of houses in the new town of Markerwaard. The darkest areas highlight the largest population increases and minimal decreases, while lighter areas indicate significant population declines. A substantial population increase is observed in Markerwaard, which is intuitive given the significant increase in housing supply. Surrounding areas of Markerwaard experienced the largest population decreases, similar to the first scenario where the MRA saw significant declines in population around its periphery. A similar explanation applies here: due to a positive agglomeration parameter, people tend to favor living near each other to enhance productivity, making Markerwaard a more attractive location. This attractiveness prompts people to move and settle in Markerwaard. Small population decreases can also be observed in other parts of the Netherlands, akin to the first simulation. As with the previous scenario, it's important to note that this is a hypothetical situation where housing is only added in Markerwaard, and not elsewhere in the Netherlands.

Thus, the effects would differ if housing developments were distributed across the entire

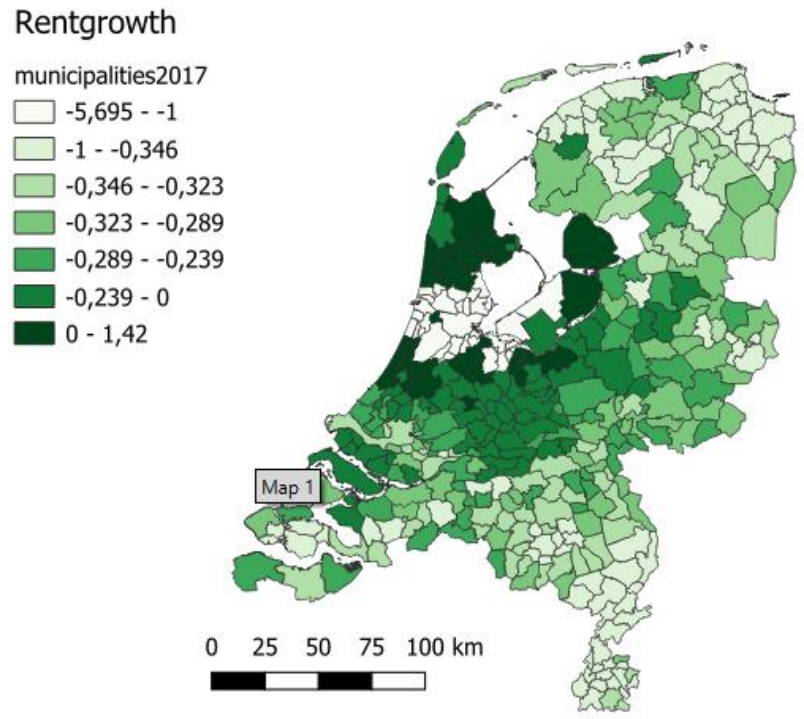

Figure 12: Change (%) in rent by Municipality After Addition of houses in MRA

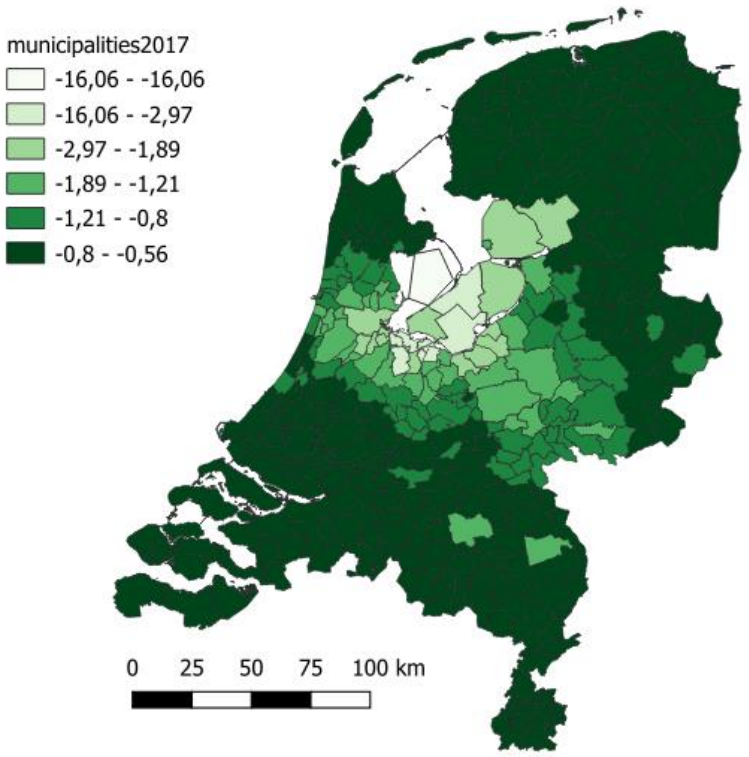

Figure 13: Change (%) in rent by Municipality After Addition of houses in the Markerwaard

country.

Figure 12, shown above, illustrates the projected changes in rent following the addition of 175,000 houses in the MRA. The darkest areas indicate municipalities with the greatest projected increase in rent prices after the anticipated decrease in housing supply, while the lightest areas indicate the largest decreases in projected rent. The underlying intuition here is that the increase in housing supply by adding 175,000 houses in the MRA will lead to a decrease in rent prices, following the law of supply and demand. Although the demand for housing will also increase in the MRA, the rent will decrease less than the increase in demand due to the surplus of houses relative to population growth, resulting in a modest decline in rent. Similarly, in the rest of the Netherlands, a small decrease in rent can be expected due to a slight population decrease and no changes in housing supply. In this models context, the decrease of rent, will make the MRA a more attractive to live in and the rest of the Netherlands slightly less attractive due to the relatively more attractiveness of the MRA. Also here should the same site

note be placed, that this is the hypothetical situation that outside the MRA, and also in the next situation the Markerwaard, no houses are built, which would have caused different effects.

Figure 13 displays the changes in rent following the addition of houses in Markerwaard. The darkest colors represent the smallest decrease in rent, while the lightest colors indicate the largest decreases. The intuition here is that the increased housing supply in Markerwaard due to additional houses will cause rent prices to decrease. Similarly, in the rest of the Netherlands, a slight decrease in rent can be observed due to a small population decline and a decrease in housing supply, following the law of supply and demand. In this model's context, the decline in rent makes Markerwaard more attractive as a place to live compared to other regions in the Netherlands. Again, the side note is that this is the hypothetical situation where only houses are built in the Markerwaard and not in the rest of the Netherlands.

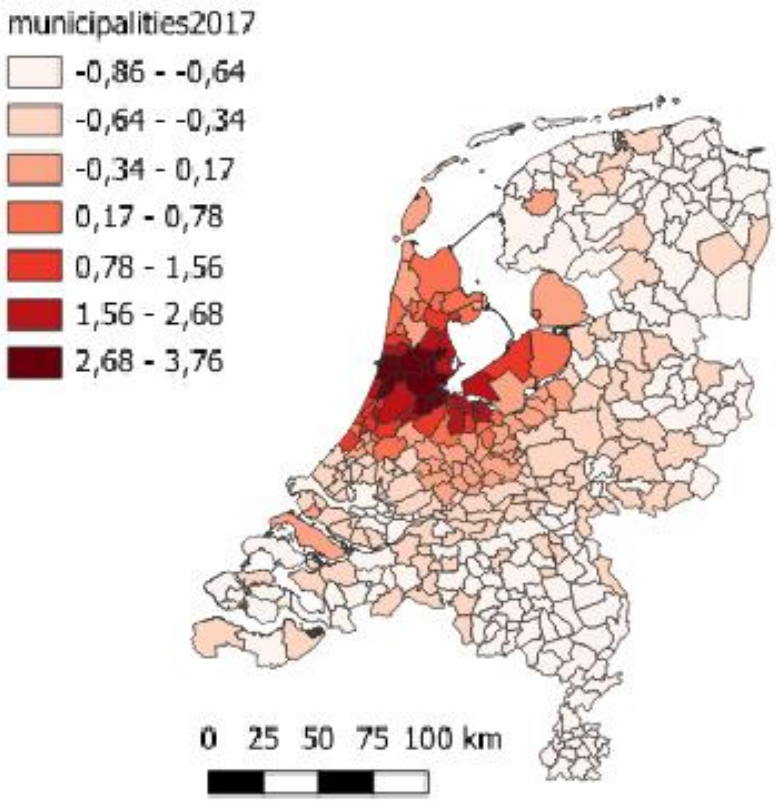

Figure 13: Change (%) in labor market access by Municipality After Addition of houses in MRA

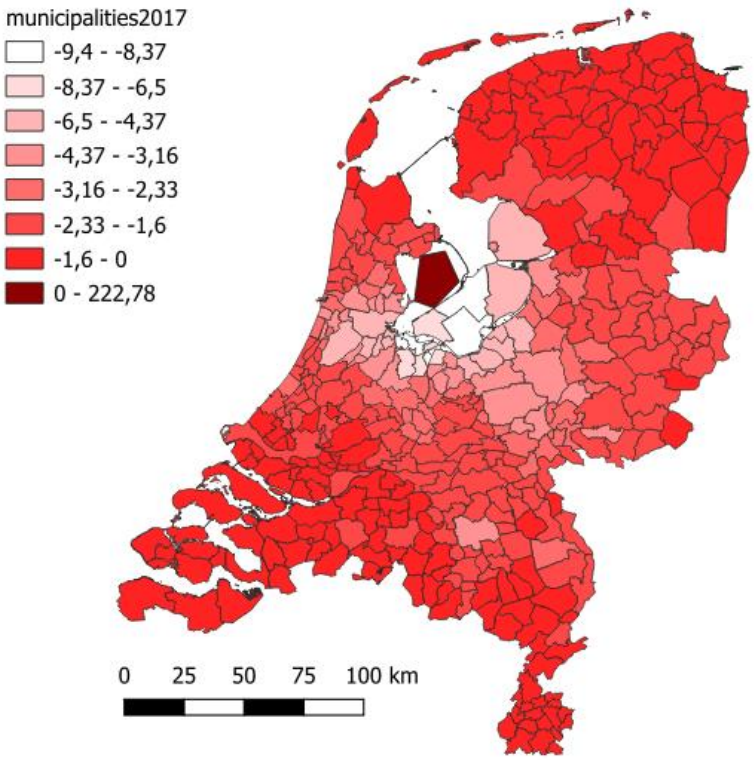

Figure 14: Change (%) in labor market access by Municipality After Addition of houses in MRA

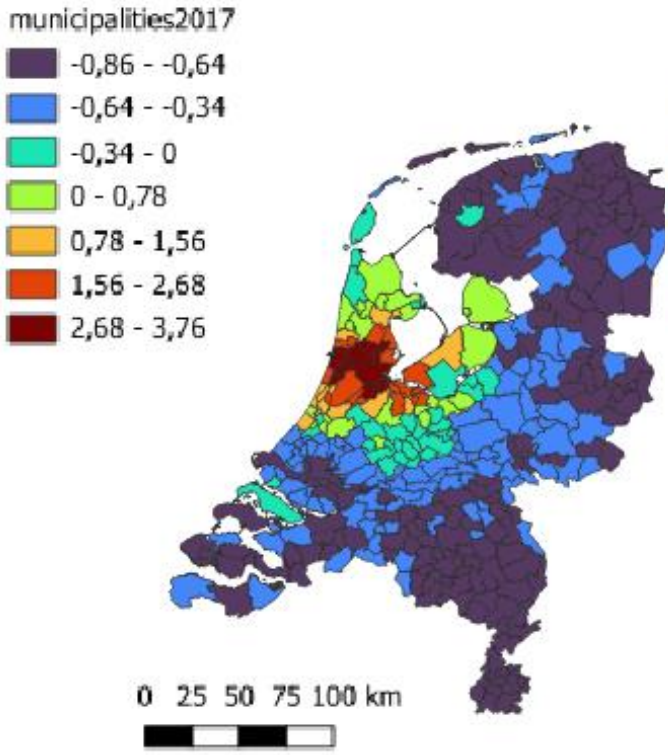

Figure 15: Change (%) in wage by Municipality After Addition of houses in MRA

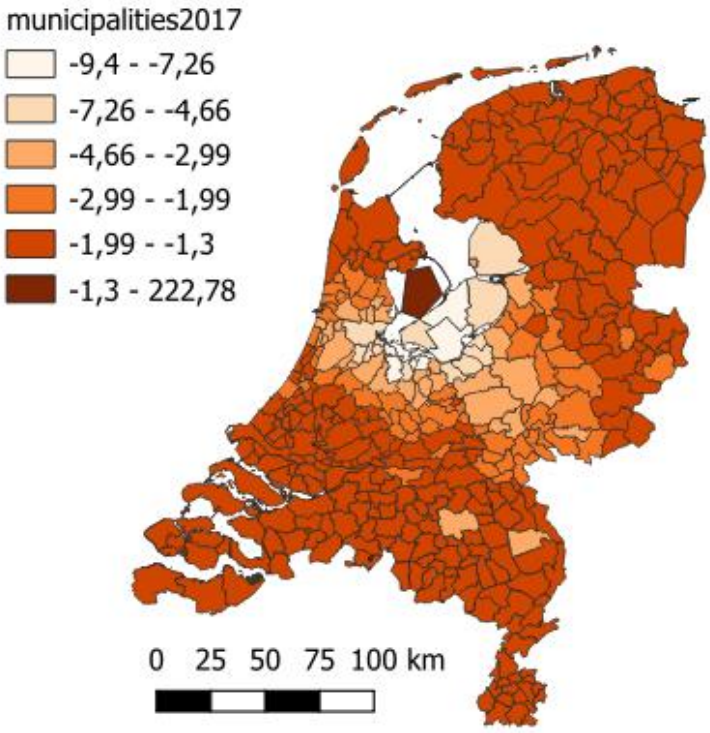

Figure 16: Change (%) in wage by Municipality After Addition of houses in the Markerwaard

In Figures 13 and 15, we observe the changes in wages and labor market access, which contribute to answering the fourth sub-question. In the MRA, there is a slight increase in both labor market access and wages. Similarly, areas close to the MRA show a very slight increase in these factors. Conversely, in the rest of the Netherlands, we see a small decrease in both labor market access and wages. These changes can be attributed to the increase in population due to the expansion of housing supply and the positive agglomeration effects. The agglomeration parameter of 0.1 indicates a moderate sensitivity of the labor market to these changes, resulting in only slight alterations in labor market access. In contrast, the decrease in population in the rest of the Netherlands leads to minor decreases in wages. The other color scale used in figure 15, is so because it makes it easy to show where the wages will increase and decrease, because also in some areas around the MRA the wages slightly increase. In the red, orange and green areas there is an increase in wage, while in the blue and purple areas a decrease in wage occurs.

In Figures 14 and 16, we observe the changes in labor market access and wages following the addition of houses in Markerwaard. Markerwaard shows an increase in both wages and labor market access, while the rest of the Netherlands experiences a decrease in wages. Areas surrounding Markerwaard exhibit the largest decreases in wages and labor market access due to a significant decline in population, reducing agglomeration effects. Conversely, the population increase in Markerwaard enhances agglomeration effects, thereby increasing wages and labor market access. In the rest of the Netherlands, wages and labor market access decrease slightly due to a small decline in population. Also in this two situations with the addition of houses in the MRA or Markerwaard should an important side note be placed. This models simulates the hypothetical situation where only houses are added in this two places. If also in other places in the Netherlands houses are built, which is very likely to happen, different results would be observed.

Conclusions

To answer the research question of this thesis: **"What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?"** fourth sub question need to be answered. An important side note is again that the results in the second, third and fourth sub questions reflect the hypothetical situation where only houses are added in the MRA or Markerwaard and not in the rest of the Netherlands.

The first sub question is:

What are the expected advantages and disadvantages between building in MRA vs creating a new town?

It was anticipated that both scenarios would present distinct advantages and disadvantages. The biggest advantages when building a new town in the Markermeer are that, after reclaiming the Markermeer, there is enough space for housing and a large housing supply can be created Moreover, there is an opportunity to develop a sustainable city with reduced dependence on cars. Since this city does not yet exist, the focus can be on proactively preventing potential issues However, potential disadvantages of creating a new town in the Markermeer include commuting challenges for residents working outside the town, inadequate knowledge infrastructure, and possible ecological impacts on the Markermeer.

So, as expected, we can detect both advantages and disadvantages when creating a new town in the Markermeer. Building in the MRA also bring both advantages and disadvantages. For example, the lower infrastructure cost and the increasing agglomeration effect. On the other hand, the cost of housing is high in the MRA and the space in the MRA is scarce, which might mean that building houses in the MRA is at the cost of green spaces.

In conclusion, both options present clear advantages and disadvantages, making it challenging to decisively favor one over the other based solely on these considerations. However, upon reclaiming Markerwaard, with appropriate policies in place, there exists an opportunity to establish an innovative and sustainable new town.

The second sub question is:

What will the difference be in terms of effect on the population changes in the area?

In the analysis, figures 7 and 8 will help answer this sub-question regarding the difference in population changes in the Netherlands after the addition of 175,000 houses in the MRA vs Markerwaard. Figure 7 illustrates the population changes following the addition of houses in the MRA, where the population increases within the MRA and slightly decreases in the rest of the Netherlands. Figure 8 depicts the population changes after the addition of houses in Markerwaard, showing an increase in population within Markerwaard. The most significant decreases in population are observed in the municipalities surrounding Markerwaard, and similarly, there is a slight population decrease observed in the rest of the Netherlands. Thus, in most parts of the Netherlands, the differences between adding houses in the MRA versus Markerwaard are similar, resulting in slight population decreases. It's important to note that when houses are added throughout the entire MRA, the population increases across all municipalities within the region, whereas in the scenario with houses added only in Markerwaard, population growth is concentrated within Markerwaard. Despite this, due to the addition of houses in all MRA municipalities, the overall outcomes are comparable. Another notable difference is that the population decreases more significantly in surrounding municipalities when houses are added in Markerwaard compared to the MRA. In conclusion, the results align with the hypothesis that there will be similar population changes in both situations. The primary distinction is the greater population decrease observed in surrounding municipalities when houses are added in Markerwaard.

The third sub question is:

What will the difference be in terms of effects on the house prices?

The hypothesis for this sub-question posited that a new town would provide cheaper housing, thereby leading to higher house prices in the MRA. It's important to note that in this model, only houses are added in either the MRA or Markerwaard, not in the rest of the Netherlands, reflecting a hypothetical situation. Figure 12 illustrates the results following the addition of houses in the MRA. Post-addition, rent decreases in the MRA, slightly increases in areas around the MRA, and a minimal decrease in rent is observed in the rest of the Netherlands. Figure 13 shows rent changes after the addition of houses in Markerwaard. Similar to the MRA, a decrease in rent is evident in Markerwaard. The main difference between the two scenarios lies in rent changes

around Markerwaard, where rent decreases instead of increasing as observed around the MRA. Results in the rest of the Netherlands are comparable between the two scenarios, with slight rent decreases. As anticipated by the hypothesis, it was expected that house prices in Markerwaard would be lower than in the MRA, which aligns with the model's results. In conclusion, the primary distinction between the two scenarios is the rent increase around the MRA versus the rent decrease around Markerwaard. Additionally, both scenarios show rent decreases in the MRA and Markerwaard, with slight rent decreases observed in the rest of the Netherlands.

The fourth sub question is:

What will the difference be in terms of effects on the labor markets and wages in the area?

The hypothesis for this sub-question posited that there would be higher wages if houses were built in the MRA compared to building a new town. Figures 13 and 15 illustrate changes in labor market access after houses are added in the MRA, while figures 14 and 16 depict changes after houses are added in Markerwaard. Also here it is important to note that in this model, only houses are added in either the MRA or Markerwaard, not in the rest of the Netherlands, reflecting a hypothetical situation. In the first scenario with houses added in the MRA, both labor market access and wages increase in the MRA, with slight increases observed in the surrounding areas and slight decreases in the rest of the Netherlands. In the second scenario with houses added in Markerwaard, labor market access and wages increase in Markerwaard, decrease in surrounding areas, and slightly decrease in the rest of the Netherlands. The higher increase in labor market access in Markerwaard is intuitive, as it starts as a new town, whereas the MRA already has established high labor market access. Similarly, the higher increase in wages in Markerwaard makes sense due to the initial absence of wages. Differences are also noted in the surrounding areas: a small increase in wages is observed around the MRA when houses are added there, whereas the areas around Markerwaard experience a decrease in labor market access and wages when houses are added there. Results in the rest of the Netherlands are similar in both scenarios, with slight decreases in labor market access and wages. In conclusion, relative wages are projected to increase more in Markerwaard than in the MRA. However, determining if absolute wages will be higher in Markerwaard or MRA based on this model is challenging. According to agglomeration theory, wages are likely to be higher in the MRA, where a larger population resides compared to the new town Markerwaard. Amsterdam, being the largest city, is expected to have the highest wages due to agglomeration effects.

Multiple implications and recommendations can be drawn from this research. Firstly, future policy considerations must seriously evaluate both options: developing established urban areas like the MRA and creating new towns such as Markerwaard. Each option presents distinct advantages and disadvantages, making it crucial to weigh them carefully in order to address housing shortages effectively and ensure an ample housing supply for future generations. Implementing proactive policies is essential to prevent future housing crises, as the construction of housing takes considerable time.

Secondly, an often overlooked aspect in economic research is the impact on health and well-being, which are critical factors for individuals. It is imperative for society to invest in understanding how different urban forms affect public health outcomes and well-being indicators, including access to green spaces, air quality, and mental well-being. Designing healthier cities should be prioritized to enhance overall societal well-being. Additionally, exploring the role of technological innovations such as smart infrastructure and digital connectivity is crucial. These innovations can support sustainable urban growth and improve quality of life by enhancing efficiency in urban developments, whether expanding existing metropolitan areas like the MRA or constructing new towns like Markerwaard.

In conclusion, integrating these considerations into future urban planning and policy-making processes can lead to more sustainable and livable cities, addressing current housing challenges while fostering healthier communities and leveraging technological advancements for enhanced urban living.

Furthermore, several avenues for future research can be suggested. For instance, conducting a cost-benefit analysis comparing the addition of houses in the MRA versus the Markerwaard could provide valuable insights. For example, the cost of reclaiming the Markerwaard and establishing necessary infrastructure is a significant expense not fully addressed in this study, warranting further investigation. While the initial cost of reclaiming the Markerwaard and developing infrastructure will be higher than in the MRA, subsequent construction costs may be lower due to the absence of compensating farmers or other stakeholders. Therefore, conducting a comprehensive cost-benefit analysis comparing both options—expanding housing in the MRA versus establishing a new town in the Markermeer—could provide valuable insights into their respective merits. Additionally, further research could explore the gravity equation by simulating extensive housing development across the Netherlands to analyze broader effects. For instance,

simulating scenarios involving extensive housing development in a new town, the Rotterdam metropolitan region, and throughout the Netherlands to analyze diverse outcomes and impacts. Another direction in which research could be done is analyzing the impacts on the climate and the goal to get CO2 neutral in 2050. It could be possible that building a new town, that might be very sustainable, could help decreasing the CO2 emissions and help reaching the goal of becoming climate neutral.

So four sub question helped answering the main research question: **What would be the differences in expanding the Amsterdam Metropolitan Area (MRA) versus building a new city in the Markermeer in terms of pros and cons and urban economic outcomes?** In conclusion, both expanding the MRA and creating a new town in the Markermeer have different advantages and disadvantages. For instance, expanding the MRA lowers infrastructure costs, but faces space limitations, whereas a new town in the Markermeer offers potential for creating a sustainable and innovative community, albeit with potential congestion issues. Urban economic outcomes differ somewhat, but not drastically. In both scenarios, population increases in the MRA and Markerwaard, and slightly decreases in most other parts of the Netherlands. The main difference is that expanding the MRA leads to a slight population increase in the surrounding areas, while creating the Markerwaard causes a slight decrease in its surrounding areas. Similarly, house prices decrease where housing supply increases, whether in the MRA or Markerwaard, and show a small decrease in the rest of the Netherlands. Labor market access and wages see similar changes across most of the Netherlands in both scenarios, with increases observed in the Markerwaard or MRA. Importantly, these changes in population, house prices, and labor market dynamics are based on a hypothetical scenario where houses are only built in the MRA or Markerwaard, excluding other parts of the Netherlands, which could yield different outcomes if considered.

In summary, there are differences between building a new town in the Markerwaard and expanding the MRA, each with distinct advantages, disadvantages, and some minor differences in urban economic outcomes as per the model. However, further research is essential to determine if one option significantly outweighs the other and provides clearer advantages. For example, a cost-benefit analysis of both options could offer deeper insights into which approach is preferable.

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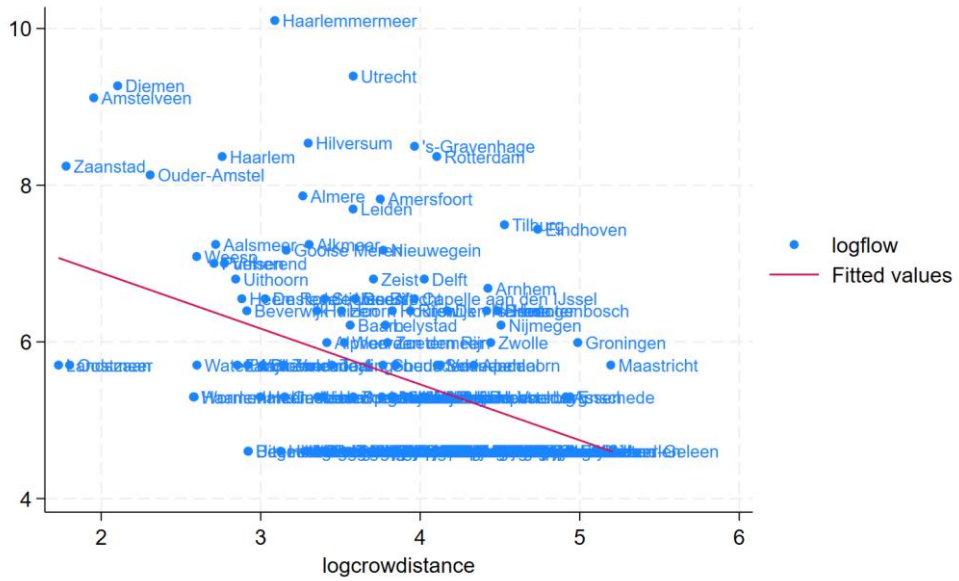
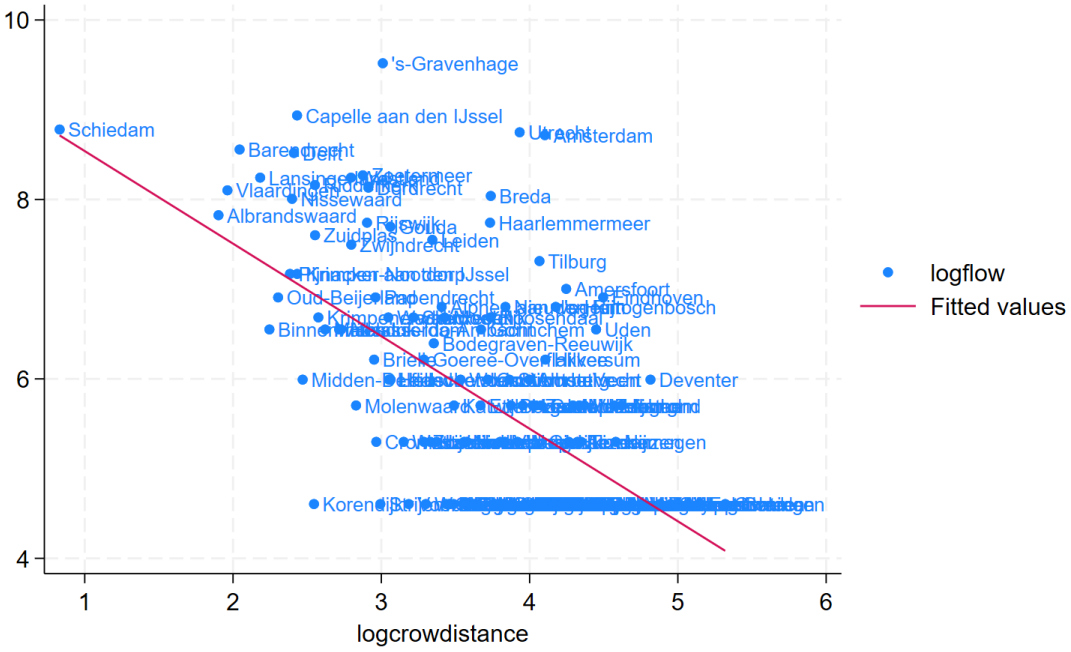
Appendix

Figures which show the logarithmic relationship





Gemeentes MRA:

"Aalsmeer" | "Almere" | "Amstelveen" | "Amsterdam" | "Beverwijk" | "Blaricum" | "Bloemendaal" | "Diemen" | "Edam-Volendam" | "Gooise Meren" | "Haarlem" | "Haarlemmermeer" | "Heemskerk" | "Heemstede" | "Hilversum" | "Huizen" | "Landsmeer" | "Laren" | "Lelystad" | "Oostzaan" | "Ouder-Amstel" | "Purmerend" | "Uitgeest" | "Uithoorn" | "Velsen" | "Waterland" | "Wijdemeren" | "Wormerland" | "Zaanstad" | "Zandvoort

Stata code:

```
cd "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie"

clear

global alpha=5

global beta=0.23

global gamma=0.1

**# Sem

clear

import delimited "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\railwayMRA6.csv"

cap replace total_cost="" if total_cost=="nan"

cap destring total_cost, replace

replace total_cost=network_cost if total_cost==.

rename total_cost railtime

rename origin_id origincode

rename destination_id destinationcode

replace total_cost_rail = total_cost_high if missing(total_cost_rail)

destring total_cost_high, replace

gen loghigh1 = log(total_cost_high)

destring total_cost_rail, replace

gen lograil1 = log(total_cost_rail)

gen logmin_numeric = min(loghigh1,lograil1)

keep *code railtime

save railwayMRA7.dta, replace

**# sem

import excel "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\mraoutput4.xlsx", sheet("Sheet2")
cellrange(A2:K151323) firstrow

drop if logmin == "remove"

rename origin_id origincode

rename destination_id destinationcode

save mraoutput4.dta, replace
```

```
ssc install ppmlhdfe

ssc install reghdfe

ssc install ftools

ssc install spmap

clear

use canvasCFdata.dta

drop if origin==""

merge m:1 origincode destinationcode using railwayMRA7.dta

drop _merge

destring logmin, generate(logmin_numeric)

gen loghigh = log(highwaytime)

gen lograil = log(railtime)

replace lograil = loghigh if missing(lograil)

gen logmin_numeric = min(lograil,loghigh)

gen log2highwaytime = log(highwaytime)

replace logmin_numeric = log2highwaytime if missing(logmin_numeric)

gen within=0

replace within=1 if origincode==destinationcode

ppmlhdfe flow  logmin_numeric within, absorb(origincode destinationcode, savefe) d(sumofFE)

predict flowhat

gen residualratio=flow/flowhat

rename __hdfe1__ FEo

rename __hdfe2__ FEd

gen transportfactor=exp(_b[logmin_numeric]*logmin_numeric + _b[within]*within)

bysort destinationcode: egen workforce=total(flow)

bysort origincode: egen residents=total(flow)

egen totalflow=total(flow)

gen wd=exp(FEd/$alpha)

gen Ad=wd/(workforce^($gamma))

gen wageaccessOtoD=wd^(1+$alpha) * transportfactor

bysort origincode: egen LMAo=total(wageaccessOtoD)

drop wageaccessOtoD

gen Omega=exp(FEo/$alpha) / (LMAo^(-$beta / (1+$alpha*$beta)))

gen Omegacf=Omega

replace Omegacf = Omega*(1.152^($beta / (1+$alpha*$beta))) if origin=="Aalsmeer" | origin == "Almere" | origin == "Amstelveen" | origin == "Amsterdam" | origin == "Beverwijk" | origin == "Blaricum" | origin == "Bloemendaal" | origin == "Diemen" | origin == "Edam-Volendam" | origin == "Gooise Meren" | origin == "Haarlem" | origin == "Haarlemmermeer" | origin == "Heemskerk" | origin == "Heemstede" | origin == "Hilversum" | origin == "Huizen" | origin == "Landsmeer" | origin == "Laren" | origin == "Lelystad" | origin == "Oostzaan" | origin == "Ouder-Amstel" | origin == "Purmerend" | origin == "Uitgeest" | origin == "Uithoorn" | origin == "Velsen" | origin == "Waterland" | origin == "Wijdemeren" | origin == "Wormerland" | origin == "Zaanstad" | origin == "Zandvoort"

gen transportfactorCF=transportfactor

gen Adcf=Ad
```

```
cap gen workforcecf=workforce

gen LMAocf=LMAo

gen flowcf=50

gen flowcfold=40

gen wdcf=1

cap gen workforcecf=workforce

cap gen LMAocf=LMAo

cap gen flowcf=50

cap cap gen flowcfold=40

cap gen wdcf=1

local iter = 1

local convergence = 0

while `iter' <100 & `convergence' <1  {

  qui replace flowcfold=flowcf

  qui replace flowcf= transportfactorCF * Omegacf^($alpha) * LMAocf^(-($beta*$alpha)/(1+$beta*$alpha)) * wdcf^($alpha)
*residualratio

  cap drop totalflowcf

  egen totalflowcf=total(flowcf)

  replace flowcf=flowcf*totalflow/totalflowcf

  drop totalflowcf

  qui gen deviation=abs(flowcf-flowcfold)/flowcfold

  qui sum deviation

  di "At iteration `iter', the relative deviation is `r(mean)'"

  if `r(mean)'< 0.0001 {

    local convergence=1

  }

  drop deviation

  cap drop workforcecf

  qui bysort destination: egen workforcecf=total(flowcf)

  qui replace wdcf=Adcf*workforcecf^$gamma     /*update the wages as the workforces change*/

  qui gen wageaccessOtoD=wdcf^(1+$alpha) * transportfactor

  qui bysort origincode: egen LMAoi=total(wageaccessOtoD)

  qui replace LMAocf=LMAoi

  qui drop wageaccessOtoD LMAoi

  local iter = `iter' + 1

}

drop flowcfold

if `convergence'==1 {

  di "Convergence achieved in `iter' iterations"

}
```

```
if `convergence'== 0{

   di "Convergence not achieved"

}

cap drop  residentcf

bysort origincode: egen residentcf=total(flowcf)

gen populationgrowth=residentcf/residents*100-100

preserve

collapse (mean) populationgrowth, by(origincode)

sort origincode

egen municipalid=group(origincode)

format populationgrowth %12.2f

spmap populationgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in Population" "after housing supply decreases")

graph export "PopulationChange.png", as(png) replace

restore

drop populationgrowth

cap drop workforcecf

bysort destinationcode: egen workforcecf=total(flowcf)

gen wagegrowth=workforcecf^($gamma)/workforce^($gamma)*100-100

preserve

collapse (mean) wagegrowth, by(destinationcode)

sort destinationcode

egen municipalid=group(destinationcode)

format wagegrowth %12.4f

spmap wagegrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in wages" "after housing supply decreases")

graph export "WageChange.png", as(png) replace

restore

drop wagegrowth

gen Hs=1

gen rent=(1/Hs*LMAo)^(1/(1+$alpha*$beta))

replace Hs=1.152 if origin=="Aalsmeer" | origin == "Almere" | origin == "Amstelveen" | origin == "Amsterdam" | origin == "Beverwijk" | origin == "Blaricum" | origin == "Bloemendaal" | origin == "Diemen" | origin == "Edam-Volendam" | origin == "Gooise Meren" | origin == "Haarlem" | origin == "Haarlemmermeer" | origin == "Heemskerk" | origin == "Heemstede" | origin == "Hilversum" | origin == "Huizen" | origin == "Landsmeer" | origin == "Laren" | origin == "Lelystad" | origin == "Oostzaan" | origin == "Ouder-Amstel" | origin == "Purmerend" | origin == "Uitgeest" | origin == "Uithoorn" | origin == "Velsen" | origin == "Waterland" | origin == "Wijdemeren" | origin == "Wormerland" | origin == "Zaanstad" | origin == "Zandvoort"

gen rentcf=(1/Hs*LMAocf)^(1/(1+$alpha*$beta))

gen rentgrowth=rentcf/rent*100-100

preserve

collapse (mean) rentgrowth, by(origincode)
```

```
sort origincode

egen municipalid=group(origincode)

format rentgrowth %12.2f

spmap rentgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Greens2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in house prices" "after housing supply decreases")

graph export "LandPriceChange.png", as(png) replace

restore

drop rentgrowth

gen LMAgrowth=LMAocf/LMAo*100-100

preserve

collapse (mean) LMAgrowth, by(origincode)

sort origincode

egen municipalid=group(origincode)

format LMAgrowth %12.2f

spmap LMAgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Reds2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) labor market access" "after housing supply decrease")

graph export "LabourMarketAccess.png", as(png) replace

restore

drop LMAgrowth

preserve

bysort destinationcode: egen workforceCF=total(flowcf)

gen emplgrowth=workforceCF/workforce*100-100

collapse (mean) emplgrowth, by(destinationcode)

sort destinationcode

egen municipalid=group(destinationcode)

format emplgrowth %12.4f

spmap emplgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in jobs" "after housing market decrease")

graph export "EmploymentChange.png", as(png) replace

restore

export delimited using "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\MRAdataexport3.csv", replace

cd "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie"

clear

global alpha=5

global beta=0.23

global gamma=0.1

**# Sem

clear

import delimited "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\railwayMRA6.csv"
```

```
cap replace total_cost="" if total_cost=="nan"

cap destring total_cost, replace

replace total_cost=network_cost if total_cost==.

rename total_cost railtime

rename origin_id origincode

rename destination_id destinationcode

replace total_cost_rail = total_cost_high if missing(total_cost_rail)

destring total_cost_high, replace

gen loghigh1 = log(total_cost_high)

destring total_cost_rail, replace

gen lograil1 = log(total_cost_rail)

gen logmin_numeric = min(loghigh1,lograil1)

keep *code railtime

save railwayMRA7.dta, replace


**# sem

import excel "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\mraoutput4.xlsx", sheet("Sheet2")
cellrange(A2:K151323) firstrow

drop if logmin == "remove"

rename origin_id origincode

rename destination_id destinationcode

save mraoutput4.dta, replace


ssc install ppmlhdfe

ssc install reghdfe

ssc install ftools

ssc install spmap


clear

use canvasCFdata.dta

drop if origin==""

merge m:1 origincode destinationcode using railwayMRA7.dta

drop _merge

destring logmin, generate(logmin_numeric)

gen loghigh = log(highwaytime)

gen lograil = log(railtime)

replace lograil = loghigh if missing(lograil)

gen logmin_numeric = min(lograil,loghigh)

gen log2highwaytime = log(highwaytime)
```

```
replace logmin_numeric = log2highwaytime if missing(logmin_numeric)

gen within=0

replace within=1 if origincode==destinationcode

ppmlhdfe flow  logmin_numeric within, absorb(origincode destinationcode, savefe) d(sumofFE)

predict flowhat

gen residualratio=flow/flowhat

rename __hdfe1__ FEo

rename __hdfe2__ FEd

gen transportfactor=exp(_b[logmin_numeric]*logmin_numeric + _b[within]*within)


bysort destinationcode: egen workforce=total(flow)

bysort origincode: egen residents=total(flow)

egen totalflow=total(flow)


gen wd=exp(FEd/$alpha)

gen Ad=wd/(workforce^($gamma))

gen wageaccessOtoD=wd^(1+$alpha) * transportfactor

bysort origincode: egen LMAo=total(wageaccessOtoD)

drop wageaccessOtoD

gen Omega=exp(FEo/$alpha) / (LMAo^(-$beta / (1+$alpha*$beta)))

gen Omegacf=Omega


replace Omegacf = Omega*(1.152^($beta / (1+$alpha*$beta))) if origin=="Aalsmeer" | origin == "Almere" | origin == "Amstelveen" | origin == "Amsterdam" | origin == "Beverwijk" | origin == "Blaricum" | origin == "Bloemendaal" | origin == "Diemen" | origin == "Edam-Volendam" | origin == "Gooise Meren" | origin == "Haarlem" | origin == "Haarlemmermeer" | origin == "Heemskerk" | origin == "Heemstede" | origin == "Hilversum" | origin == "Huizen" | origin == "Landsmeer" | origin == "Laren" | origin == "Lelystad" | origin == "Oostzaan" | origin == "Ouder-Amstel" | origin == "Purmerend" | origin == "Uitgeest" | origin == "Uithoorn" | origin == "Velsen" | origin == "Waterland" | origin == "Wijdemeren" | origin == "Wormerland" | origin == "Zaanstad" | origin == "Zandvoort"

gen transportfactorCF=transportfactor

gen Adcf=Ad

cap gen workforcecf=workforce

gen LMAocf=LMAo

gen flowcf=50

gen flowcfold=40

gen wdcf=1


cap gen workforcecf=workforce

cap gen LMAocf=LMAo

cap gen flowcf=50

cap cap gen flowcfold=40

cap gen wdcf=1
```

```
local iter = 1

local convergence = 0

while `iter' <100 & `convergence' <1  {

  qui replace flowcfold=flowcf

  qui replace flowcf= transportfactorCF * Omegacf^($alpha) * LMAocf^(-($beta*$alpha)/(1+$beta*$alpha)) * wdcf^($alpha)
*residualratio

  cap drop totalflowcf

  egen totalflowcf=total(flowcf)

  replace flowcf=flowcf*totalflow/totalflowcf

  drop totalflowcf

  qui gen deviation=abs(flowcf-flowcfold)/flowcfold

  qui sum deviation

  di "At iteration `iter', the relative deviation is `r(mean)'"

  if `r(mean)'< 0.0001 {

    local convergence=1

  }

  drop deviation

  cap drop workforcecf

  qui bysort destination: egen workforcecf=total(flowcf)

  qui replace wdcf=Adcf*workforcecf^$gamma     /*update the wages as the workforces change*/

  qui gen wageaccessOtoD=wdcf^(1+$alpha) * transportfactor

  qui bysort origincode: egen LMAoi=total(wageaccessOtoD)

  qui replace LMAocf=LMAoi

  qui drop wageaccessOtoD LMAoi

  local iter = `iter' + 1

}


drop flowcfold

if `convergence'==1 {

  di "Convergence achieved in `iter' iterations"

}

if `convergence'== 0{

  di "Convergence not achieved"

}


cap drop  residentcf

bysort origincode: egen residentcf=total(flowcf)

gen populationgrowth=residentcf/residents*100-100


preserve
```

```
collapse (mean) populationgrowth, by(origincode)

sort origincode

egen municipalid=group(origincode)

format populationgrowth %12.2f


spmap populationgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in Population" "after housing supply decreases")


graph export "PopulationChange.png", as(png) replace


restore

drop populationgrowth


cap drop workforcecf

bysort destinationcode: egen workforcecf=total(flowcf)

gen wagegrowth=workforcecf^($gamma)/workforce^($gamma)*100-100


preserve

collapse (mean) wagegrowth, by(destinationcode)

sort destinationcode

egen municipalid=group(destinationcode)

format wagegrowth %12.4f


spmap wagegrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in wages" "after housing supply decreases")


graph export "WageChange.png", as(png) replace


restore

drop wagegrowth


gen Hs=1

gen rent=(1/Hs*LMAo)^(1/(1+$alpha*$beta))


replace Hs=1.152 if origin=="Aalsmeer" | origin == "Almere" | origin == "Amstelveen" | origin == "Amsterdam" | origin == "Beverwijk" | origin == "Blaricum" | origin == "Bloemendaal" | origin == "Diemen" | origin == "Edam-Volendam" | origin == "Gooise Meren" | origin == "Haarlem" | origin == "Haarlemmermeer" | origin == "Heemskerk" | origin == "Heemstede" | origin == "Hilversum" | origin == "Huizen" | origin == "Landsmeer" | origin == "Laren" | origin == "Lelystad" | origin == "Oostzaan" | origin == "Ouder-Amstel" | origin == "Purmerend" | origin == "Uitgeest" | origin == "Uithoorn" | origin == "Velsen" | origin == "Waterland" | origin == "Wijdemeren" | origin == "Wormerland" | origin == "Zaanstad" | origin == "Zandvoort"

gen rentcf=(1/Hs*LMAocf)^(1/(1+$alpha*$beta))
```

```
gen rentgrowth=rentcf/rent*100-100


preserve

collapse (mean) rentgrowth, by(origincode)

sort origincode

egen municipalid=group(origincode)

format rentgrowth %12.2f


spmap rentgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Greens2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in house prices" "after housing supply decreases")


graph export "LandPriceChange.png", as(png) replace


restore

drop rentgrowth


gen LMAgrowth=LMAocf/LMAo*100-100


preserve

collapse (mean) LMAgrowth, by(origincode)

sort origincode

egen municipalid=group(origincode)

format LMAgrowth %12.2f


spmap LMAgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Reds2) osize(vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) labor market access" "after housing supply decrease")


graph export "LabourMarketAccess.png", as(png) replace


restore

drop LMAgrowth


preserve

bysort destinationcode: egen workforceCF=total(flowcf)

gen emplgrowth=workforceCF/workforce*100-100


collapse (mean) emplgrowth, by(destinationcode)

sort destinationcode

egen municipalid=group(destinationcode)
```

```
format emplgrowth %12.4f


spmap emplgrowth using municipalitycoordinates.dta, id(municipalid) fcolor(Blues2) osize(vvthin vvthin vvthin vvthin vvthin vvthin
vvthin vvthin vvthin vvthin) ndsize(vvthin) clmethod(q) clnumber(10) legend(pos(3) ring(1)) legstyle(2) legtitle("Change (%) in jobs"
"after housing market decrease")


graph export "EmploymentChange.png", as(png) replace


restore

export delimited using "C:\Users\dytme\OneDrive - Erasmus University Rotterdam\Bachelor jaar 3\Sciptie\MRAdataexport3.csv",
replace
```