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Master Thesis Urban, Port and Transport Economics

Deal or No Deal:
Identifying the effect of the 2016 Brexit vote outcome on the demand for distribution centres in the Netherlands

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Abstract

During the past decade, the Netherlands has seen a significant rise in contemporary large-scale distribution centres, sparking social and political concerns. The outcome of the Brexit vote in 2016 and the subsequent actual leave from the EU, prompted numerous UK companies to relocate businesses and warehouses to foreign destinations in anticipation of changing market accessibility and geopolitical instability. This study explores the impact of the Brexit vote outcome in 2016 on distribution centre development among COROP regions in the Netherlands through a difference-in-differences analysis. In-depth interview responses indicate that a period of increased socio-political uncertainty followed after the Brexit vote which led to a delayed out-migration of UK companies to the Netherlands. Furthermore, the difference-in-differences analysis suggests that COROP regions in Zuid-Holland and Noord-Brabant experienced a larger impact on the development of logistics real estate compared to other COROP regions in the Netherlands. Both the qualitative and quantitative findings are in line with current literature which states that many exporting British companies have started looking for warehouses in the Netherlands, following the 2016 Brexit vote outcome, to serve customers in continental Europe as the UK's formal exit from the European Single Market has made the UK a 'third country'.

Keywords: Brexit, Difference-in-Differences, Distribution Centres, Propensity Score Matching, Quasi-experiments, Supply Chain, Trade Relations

Contents

1 Introduction

Being North Sea neighbours, the United Kingdom (UK) and the Netherlands have a long-standing relationship that has included trade, investment, and the sharing of ideas in the fields of academics, art, and design. Foundations of this alliance rest on both countries having important ports serving as green gateways to inland markets, a highly developed maritime sector and similar infrastructures (Ministerie van Buitenlandse Zaken, 2021; Pye, 2015). The establishment of an integrated European market in 1993 stimulated existing trade relationships between the UK and the Netherlands by guaranteeing a free movement of goods, people, services and capital in the European Union (EU) (European Council, 2023). The Netherlands is considered to be one of the biggest logistics hubs in Europe due to its large international port in Rotterdam, the good hinterland accessibility both by rail, road, and water and the presence of an advantageous business climate (CBS, 2021).

Nevertheless, the long-standing partnership between the two nations was placed under extreme pressure when the United Kingdom, on the 23^{rd} of June 2016, voted in favour of a British exit (abbreviated: Brexit) from the European Union. On January 31^{st} in 2020, the United Kingdom formally left the EU and became a third country to the European Union.

According to Jochem Sanders, Associate Director of CBRE[1] in the Northeast of the Netherlands (personal communication, July 11, 2023), as a consequence of Brexit, a plethora of UK companies have shifted their businesses – partially – to overseas territories such as the Netherlands in an attempt to maintain their connectivity with the EU, profiting from ease-of-trade between member countries, or to sustain their access to certain markets. Through company relocation, most businesses attempted to avoid extensive paperwork, additional taxes, and charges, among other factors following the implementation of new trade barriers after the referendum (Tielmann & Schiereck, 2017; Helm, 2021b; NFIA, 2021). According to Remco Buurman, managing director of NDL/ HIDC[2], the Netherlands directly saw an exponential increase in the request for logistics service providers by UK companies after the 2016 Brexit vote outcome. Indirectly, this has generated an increase in the request for logistics real estate (personal communication, July 13, 2023). Precisely, between 2017 and 2018, the number of multinational companies from a UK origin within the Netherlands grew by 30% (CBS, 2021).

[1]CBRE is the world's largest commercial real estate and investment advisor, with more than 30 offices in over 20 countries and can be accessed via cbre.nl.

[2]Holland International Distribution Council (NDL/ HIDC), accessed via hollandinternationaldistributioncouncil.com, is an association directly or indirectly concerned with logistics and supply chain management. NDL/ HIDC aims to attract logistics investments and goods flow to the Netherlands and to promote the export of Dutch logistics knowledge, skills and products abroad.

The migration of both multinational and small- and medium-sized UK enterprises to overseas territories such as the Netherlands comes at a time when the Dutch market for distribution facilities already experiences a strong increase in the physical presence of distribution facilities (Prick, 2018; Nefs et al., 2022). Specifically, in many spatial-economic landscapes within the Netherlands, large distribution centres (DCs) have become an increasingly relevant feature due to their economic significance but also due to their role in spatial planning debate and environmental regulations as well as their importance in global logistics and supply chains.

The development of contemporary large-scale DCs across the world dates back to the 1980s and parallels the network conditions of an interconnected society and global value chains (Castells, 2009). In the past, goods storage was dispersed across the supply chain, with many warehouses found at manufacturing and recipient sites, often connected by intermediate warehouses. Most of these warehouses were smaller in scale and were situated in urban areas near industrial zones, docklands and rail yards. However, due to factors related to land use regulations and the need for more resilient operational structures, modern logistics facilities are now predominantly located within specialised logistics clusters on the outskirts of metropolitan regions near motorway networks, major airports, and seaports (Aljohani & Thompson, 2016; Heitz et al., 2017).

In the Netherlands, the end of the worldwide financial crisis in 2014 and the advancement of economies of scale within distribution centres, fuelled the emergence of large DCs across the Dutch landscape, especially on the outskirts of metropolitan regions, and propelled logistics sprawl; the migration of DCs from urban to rural regions (Nefs et al., 2022). Furthermore, due to the rising popularity of e-commerce, low-interest rates, and expanding world trade in recent years, the Netherlands has witnessed exponential growth in the number of DCs (Beckers et al., 2021; Klumpenaar, 2022). Nevertheless, the "verdozing" or "boxification" of the Dutch landscape during the past decades, as a result of both logistics sprawl and the increase in the number of DCs, has been a hot topic on the political agenda as of 2008 and has fuelled both political and civil dissatisfaction about the construction of DCs.

With the mass exodus of UK-based companies to neighbouring European countries, in an attempt to avoid additional taxes, costs and administrative burdens, as well as ensure sufficient inventories on both sides of the maritime border for a resilient supply chain, the number of logistical facilities within Europe can be expected to increase (Tielmann & Schiereck, 2017; Helm, 2021b; de Weerd, 2019). Evidence was already found that a large share of the UK textile and apparel industry as well as the – automotive - manufacturing industry moved warehouses to an EU country (Casadei

& Iammarino, 2021; Ewing, 2021). Additionally, NDL/ HDIC found that of the 659 new investment projects in 2021, 323 were from the UK. Of these 323 projects, 227 were related to businesses operating in the lifestyle and agri-food sectors. Hence, both the lifestyle and agri-food industry sectors have been heavily impacted by the Brexit vote outcome, shifting operations to the continent (Nederland Distributieland (NDL), 2023).

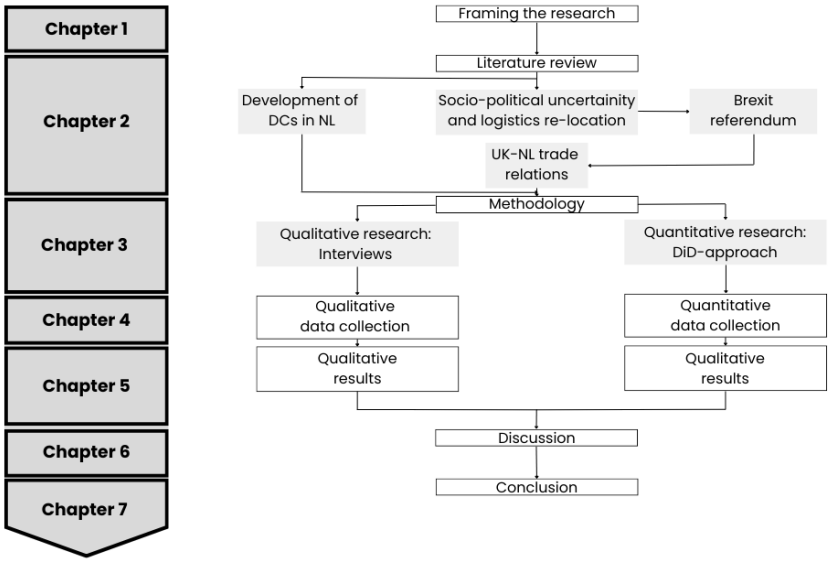
With increasing public and political debate concerning the negative influence of the construction of DCs on landscape alteration (Cooiman & Aarnoudse, 2022), environmental problems (Feng Li et al., 2008), and sector and labour transformation (Benvegnù et al., 2018, 2022); it is of importance to understand to what extent external shocks, such as the 2016 Brexit vote outcome, may contribute to the acceleration of the boxification of the Dutch landscape and whether this effect is concentrated in certain regions or spread throughout the country. Thus, this paper explores to what extent the outcome of the 2016 Brexit vote has advanced the development of DCs among NUTS3-regions[3], also known as COROP regions, in the Netherlands. Specifically, the research question for this paper reads as follows:

What is the effect of the 2016 Brexit vote outcome on the development of distribution centres among COROP regions in the Netherlands?

This thesis, as graphically depicted in Figure 1, proceeds as follows. Chapter 2 contains the literature review, which provides background information on the developments of DCs in the Netherlands, the Brexit referendum and UK-Dutch trade relations and gives examples of logistical relocation following increased socio-political uncertainty. Additionally, Chapter 2 formulates the hypotheses. Chapter 3, the methodology, outlines the difference-in-difference approach, which allows for causal inference and Chapter 4 describes the qualitative and quantitative data that has been collected. Chapter 5 presents the findings obtained from the analysis, supported by appropriate statistical evidence and insights derived from the interviews. Finally, Chapter 6 discusses the limitations of this study and provides further research and policy recommendations and Chapter 7 concludes the key findings.

[3]The NUTS, Nomenclature of Territorial Units of Statistics, is the regional division of the European Statistical Bureau Eurostat. NUTS was introduced to ensure comparable regions across Europe, guaranteeing that European statistics can be regionally compared (CBS, n.d.-b). NUTS-3 regions can be seen as small regions which contain one or more municipalities and are analysed for specific diagnoses (Eurostat, 2022).

Figure 1: Thesis progression flowchart.



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1.1 Academic and social relevance

The contribution of this research to the currently available academic literature lies in the fact that most existing papers have investigated the impact of the Brexit vote outcome on general UK – NL trade relations in pre- and post-Brexit times (Smith et al., 2018; van Berkum et al., 2018; Belke & Ptok, 2018; Thissen et al., 2020). Nevertheless, limited attention has been paid to the role that this geopolitical disruption, Brexit, may have played in the relocation of both UK distribution and manufacturing facilities as well as the restructuring of value chains for UK production companies.

Furthermore, because of the Brexit vote outcome, the UK is enduring significant supply chain transformations to accommodate for longer lead times and increased production uncertainties (The Economist, 2017; Bailey & De Propris, 2017). Businesses must ensure somewhat flexible supply chains in order to deal with fluctuating demand if they want to continue to be successful and competitive (Bengtsson & Olhager, 2002). By increasingly stockpiling large inventories in warehouses on both sides of the Channel, businesses try to mitigate the risks arising because of the Brexit vote outcome (Kalra et al., 2018). In order to accommodate a large inventory, companies may decide to expand existing DCs or construct new DCs in both domestic and foreign locations.

The social relevance of this paper rests in identifying and defining the influence that the Brexit vote outcome in 2016 has had on the development of DCs in Dutch COROP regions, which is associated with increasing social and political unrest. The detrimental environmental implications of DCs, such as landscape alteration and congestion, are now more and more recognised as issues within spatial policy (Nefs & Daamen, 2022; Nefs et al., 2022). Subsequently, the Netherlands has arguably reached its threshold for accommodating DCs in some regions and the Dutch land market for distribution facilities finds itself in a nearly saturated stage (Prick, 2018).

Although regional authorities are frequently enthusiastic about the arrival or expansion of logistical activities within their region, due to their anticipated positive effect on local employment, there are downsides to these logistical activities and their positive effect on local employment is questionable. It appears that a large share of the operational activities within a DC, which make up 50% to 60% of the jobs (Strootman et al., 2019; Kalkhoven, 2017), are fulfilled by foreign workers who cover great distances during their sifts and work erratic hours as local workers are not overly eager to work at a DC since the wages are low and the work intensity is high (Heijne & Noten, 2020). Additionally, the majority of the order pickers lack the financial means to arrange decent housing and subsequently their employers house them in neglected holiday bungalows, frequently crammed up with multiple people in one bedroom fuelling disturbance within the surrounding neighbourhood (Janssen, 2021).

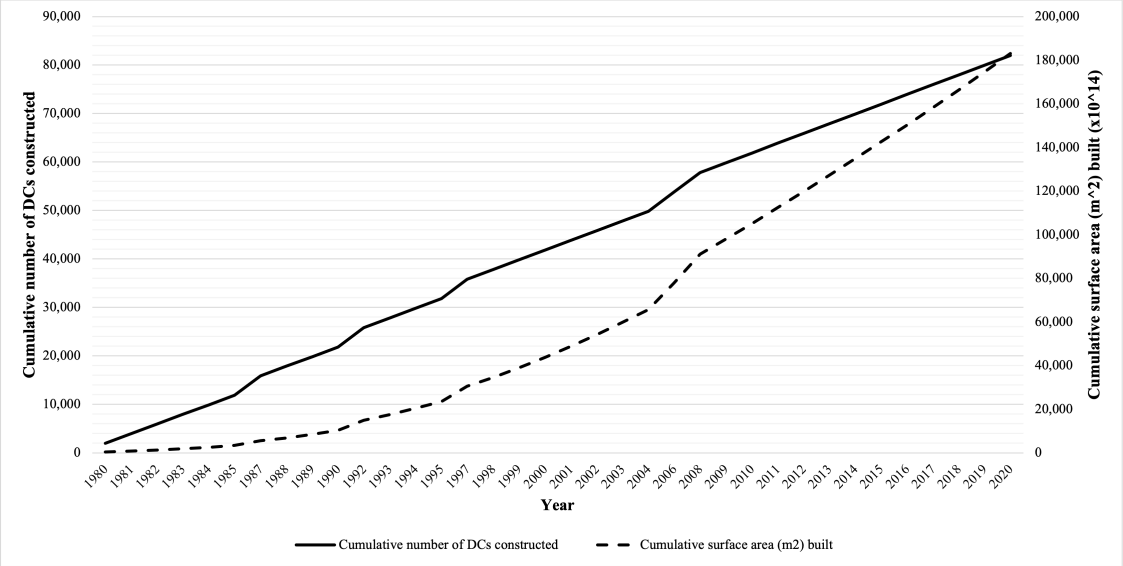
2 Literature Review

This chapter serves as a literature review to establish the hypotheses underlying the research question. Chapter 2.1 gives an overview of the development of DCs in the Netherlands throughout the 20^{th} and 21^{st} century, and Chapter 2.2 looks at examples in which increased socio-political uncertainty, such as after the Brexit vote outcome, led to the relocation of businesses. Lastly, Chapter 2.3 explores trade relations between Dutch COROP regions and the UK.

2.1 Development of distribution centres in the Netherlands

In many spatio-economic landscapes around the world, big DCs have become an increasingly relevant feature. Their development parallels, as seen in Figure 2, the network conditions of a current interconnected, globalised society and can be dated to the 1980s (Castells, 2009).

Figure 2: Cumulative number of distribution centres and the total surface area of distribution centres constructed in the Netherlands per year.

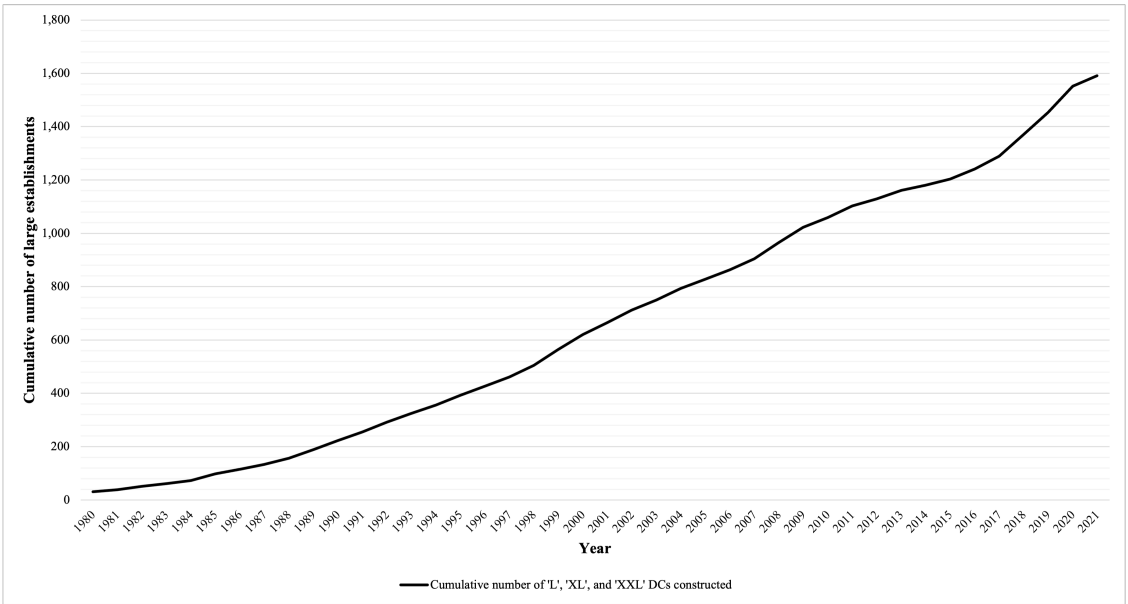


Source: Own design based on Nefs (2022)

In the Netherlands, the years around the beginning of the 21^{st} century, in the aftermath of the dot-com crisis, saw a surge in the development of logistics real estate, specifically DCs. Especially after 2014, when the world was recovering from the global financial crisis and when economies of scale in DCs arose, the number of large DCs in the Netherlands increased exponentially (Nefs et al., 2022), as illustrated in Figure 3 and Appendix A, Figure 8. Furthermore, the past decade has been characterised by strong e-commerce growth, one that has, according to Jim Orsel, Head of Industrial

and Logistics Netherlands at CBRE (personal communication, July 11, 2023), undoubtedly grown even more due to the pandemic shock around COVID-19, which has fuelled logistics real estate development (Beckers et al., 2021; Gao et al., 2020; Guthrie et al., 2021).

Figure 3: The cumulative sum of L, XL, and XXL DCs constructed in the Netherlands per year.



Source: Nefs (2022)

Besides global societal developments and external shocks, the number of DCs, especially large DCs, in the Netherlands has increased due to national policy changes. The Dutch Mainport strategy, introduced in the 1980s in response to the country's economic issues, favoured the development of Schiphol Airport and the Port of Rotterdam as primary hubs of economic growth (Grey, 2016). Subsequently, the Dutch Mainport strategy stimulated the logistics industry and created an increased demand for logistics real estate in hinterland corridors through large-scale hinterland infrastructure and land developments (Raimbault et al., 2016; Rli, 2016; Kuipers et al., 2018; Nefs et al., 2022). Additionally, the expansion of DCs near hinterland corridors in the Netherlands is driven by the aspiration of the Netherlands to be a "Gateway to Europe" (Nefs et al., 2022) and by changes in the logistics system such as the centralisation of distribution networks, aiming to serve large parts of the pan-European market, minimise high land prices and avoid congestion near busy logistics hubs (Flämig & Hesse, 2011; A. T. C. Onstein et al., 2019).

Nevertheless, the considerable increase in the number of large DCs in both urban regions and hinterland locations in the Netherlands has contributed to 'logistics sprawl', a phenomenon in which

DCs spatially shift from urban regions to peripheral regions. This logistics sprawl is a consequence of more large DCs being constructed in greenfields (new logistics areas) rather than brownfields (existing industrial sites and buildings) which has caused a "verdozing" or "boxification" of the Dutch landscape fuelling both political and social spatial planning debate, becoming a hot topic on the political agenda (Buck Consultants International (BCI), 2022; Nefs et al., 2022). The increasing logistics sprawl threatens the quality of life in urban and hinterland regions, causes congestion and air pollution through increased truck movements and frequently eliminates other spatial purposes due to the height and size of the DCs (Nefs & Daamen, 2022).

Opposition against the arrival of more, mainly large, DCs in the Netherlands is increasing at both the national and local level (Lalkens, 2021b). The provinces of Drenthe, Gelderland, Noord-Brabant, Noord-Holland, Overijssel, Utrecht and Zuid-Holland announced in April 2022, to work towards rules to curb the development of large distribution centres (KRO-NCRV, 2022). In mid-September 2022 it appeared that a majority in the Dutch House of Representatives supported an appeal, made by the Christian-democratic Party (CDA), which called to curb the construction of new large DCs. The CDA is supported by the Christian Union (CU) and liberal-democratic party D66. These parties believe that no more large DCs should be built outside existing industrial estates (de Weerd, 2022). Especially in the southern provinces, such as Noord-Brabant and Limburg[4], with a high concentration of DCs, municipal councils have hit the brakes since 2022, causing the number of new areas for DC construction to 'dry up' (Lalkens, 2022). As of February 2023, Noord-Brabant has implemented a policy to curb the development of large DCs in the form of a "voorbereidingsbesluit" (Adema & Buijtels, 2023).

The 21^{st} century saw an exponential growth of large DCs in the Netherlands due to rising e-commerce and national policy. This growth lasted until 2022 when increased political and social unrest complicated the land availability for the construction of new DCs following new demand. According to Twan van Lankveld, Programme Manager Smart Logistics at Midpoint Brabant[5], local policy adjustments, in 2022, on the construction of new DCs could potentially influence the current trend of demand for logistics real estate in the Netherlands (personal communication, July 12, 2023). Thus, this study will consider a time frame up to and including the year 2021. Accordingly, the effect of this 'new' shock on the demand for DCs does not need to be taken into account in the analysis.

[4]The problems surrounding large distribution centres (with a footprint of at least 40,000 m^2) are prominent in Noord-Brabant and Limburg. Together, these two provinces account for 43% of logistics real estate in the Netherlands. Large concentrations of DCs are concentrated around Tilburg and Venlo (Lalkens, 2022).

[5]Midpoint Brabant, accessed via midpointbrabant.nl, is the economic development organisation of central Brabant. As an independent party, it forms the link between businesses, education, governments and civil society organisations.

2.2 The relocation of businesses: socio-political uncertainty and Brexit

2.2.1 Socio-political uncertainty and logistical relocation

During times of increased political, social, economic, etc. uncertainty, it is not uncommon for businesses to relocate to neighbouring countries or regions with less uncertainty. After World War II, the allies (Great Britain, France, the USA, and the Soviet Union) all took control over their own part of Nazi Berlin, which divided the city into four 'zones' and placed the city under international jurisdiction. With increasing unrest between the capitalist Western countries and the communist Soviet Union, socio-political uncertainty increased in Berlin which led to the construction of the Berlin Wall in 1961 (Governing Mayor of Berlin, n.d.). This heightened uncertainty caused most banks, insurance companies, media centres and large industrial companies to leave Berlin and move to West Germany or Munich. Although both employment and population rates had plummeted during the time of the Berlin Wall due to business out-migration, both skyrocketed shortly after the fall of the Wall following reduced uncertainty within Berlin (Gornig & Häussermann, 2002).

Another external shock which created political uncertainty and stimulated the relocation of businesses to overseas territories was former US president Trump's imposed tariffs on the imports of aluminium and steel (Schneider-Petsinger, 2019). During his presidential period, Donald Trump imposed a 25% import tariff on steel and a 10% import tariff on aluminium in part of his economic policy concerning "America First". The industry which suffered the most from this sudden external shock, resulting from the imposed tariff, was the automotive industry. Not surprisingly, many European automotive companies, such as BMW, reduced their investments and workforce within the US and shifted production facilities overseas (Bryan & Oziel, 2018).

The recent COVID-19 pandemic also shows that heightened geopolitical uncertainty leads to company relocation. For the past four decades, China has been known as the "The World's Factory". However, a reevaluation of this status by businesses was triggered following the late coronavirus pandemic (Tan, 2022). China's continued national lockdowns, supply chain disruptions and travel restrictions increased political and economic uncertainty in China which forced many companies to reconsider their supply chains (Cheng, 2022). Consequently, several companies, such as Apple, Nike, Samsung, and Sony, decided to move their supply chains away from China to increase their supply chain's resilience and diversify their supply chain origins (Tan, 2022; GEODIS Strategic Departement, 2023).

2.2.2 The Brexit referendum

The Brexit vote is a referendum held on the 23^{rd} of June 2016, in the United Kingdom and concerned the UK's European Union membership. The referendum focused on whether the UK should retain its membership with the EU or not. The outcome of the vote showed that the majority of the British people wished to leave the EU. Opting for Brexit had huge implications for the geopolitical situation in the UK. The day before the vote, many companies were convinced that the UK would remain part of the EU (Cohn, 2016). However, when the news broke, Prime Minister David Cameron stepped down and the Pound Sterling exchange rate plummeted following the sudden uncertainty (Phipps, 2016). Subsequently, many questions were raised by the result such as: "When will the UK leave the EU?", "When will a deal on a new trade regime be agreed?", and "What will the new trade regime look like?".

For internationally active firms, the lack of clarity about border import duties, non-tariff measures, and border controls in the months and years after the Brexit vote, created large uncertainty around the UK's future trade relationship with the EU. Although nothing officially changed in the UK and EU's trade relations until January 1^{st}, 2021, the uncertainty surrounding Brexit resulted in a significant slowdown in the growth in international trade between the EU and the UK (Franssen & Rooyakkers, 2021). Furthermore, a plethora of UK-based companies announced that they would cut down on jobs in the UK and increase their operations in the EU. Car manufacturer Nissan stated in early 2019 that it would stop producing the new X-Trail SUV at its plant in Sunderland and move production to Kyushu, Japan. Additionally, British engine maker Rolls-Royce announced a large cut on jobs in the UK for 2020 shortly after the 2016 Brexit vote outcome and stated that it would proceed forward with its plans to move large aero-engines design approval from Derby to Germany (Sommerlad & Chapman, 2019). Similarly, tech giant Philips reported that it would close its only UK factory in Suffolk, shifting all operations to the Netherlands (BBC, 2019). Likewise, to avoid any tax complications related to Brexit, Japanese conglomerate Panasonic announced in August 2018 that it would relocate its European headquarters from London to Amsterdam (BBC, 2018).

As briefly highlighted in the introduction, there are a number of reasons, following the 2016 Brexit vote outcome, which has stimulated UK companies to move their businesses to overseas territories such as the Netherlands. The most prominent motivations for UK companies to shift their activities to foreign nations are listed and discussed below.

The UK has been a member of the EU, or one of its predecessors, for almost 45 years, which

enabled the kingdom to be part of the 1993-instituted European Single Market. This single market facilitated the free movement of goods between participating countries in which no import duties or quotas would be imposed on either the importing or exporting party. Hence, a free trade goods flow between the Netherlands and the UK persisted until the UK's formal exit from the European Single Market on January 1^{st}, 2021 (Franssen & Rooyakkers, 2021). Although the Trade and Cooperation Agreement (TCA), a post-Brexit trade agreement between the UK government and EU members, states that businesses can continue to import and export goods tariff and quota-free, the trade in goods with the UK changed dramatically as of January 1^{st} 2021. For instance, the UK and the EU now have a physical border where goods may be inspected with regard to their compliance with international trade regulations. Furthermore, if the goods do not adhere to the Trade and Cooperation Agreement's rules of origin, import duties may still be imposed on the trader of the goods (UK Government, 2021). Thus, following the Brexit vote outcome, tariff-and quota-free trade is no longer a certainty. Where trade once flowed freely across borders, goods must now need to be cleared by customs. Moreover, companies must now actively apply for the preferences and provide the required paperwork in order to be able to claim tariff- and quota-free imports. These new rules and regulations have generated additional taxes, costs and administrative burdens for both EU and UK-based importing and exporting companies (Franssen & Rooyakkers, 2021) and have subsequently stimulated UK companies to register new businesses in the EU Single Market, in order to benefit from free trade agreements (Moradlou et al., 2021; Helm, 2021a; NFIA, 2021).

Not only the additional taxes, costs, and administrative burdens provided to be a motivator for UK firms to move to overseas territories but also ensuring sufficient inventories on both sides of the Channel for a resilient supply chain (Tielmann & Schiereck, 2017; Helm, 2021b; NFIA, 2021; de Weerd, 2019). Prior to the Brexit vote in 2016, supply chain strategies mainly focused on efficiency and cost-minimisation. After the Brexit vote outcome, many companies were forced to change their supply chain strategy, prioritising resilience and flexibility over efficiency and cost-containment, despite potential cost increases, in order to prevent possible supply chain disruptions due to an "increasingly fractured trade environment" (Offerman, 2020). The adaptation of firm supply chain strategies allows the creation of an inventory buffer which minimises the influence of geopolitical uncertainty on supply chain operations and limits profit fluctuations resulting from the Brexit vote outcome. Storing large product inventories acts as a buffer against anticipated border delays due to new rules and regulations. Furthermore, to ensure a resilient supply chain, current trade routes may be diversified to prevent bottlenecks, requiring new inventory storage spaces. Additionally, de-

ciding to increase inventories throughout the supply chain can cause manufacturing operations to be relocated to different countries (Uddin et al., 2022).

The evidence presented in Chapters 2.2.1 and 2.2.2 suggest that the Brexit vote outcome, being a major geopolitical disruption, contributed to increased uncertainty for businesses within the UK. This heightened uncertainty has stimulated a large number of UK companies to move their business to foreign destinations in anticipation of changing market accessibility and geopolitical instability (Moradlou et al., 2021). Subsequently, the first hypothesis reads as follows:

Hypothesis 1: Increased uncertainty following the Brexit vote in 2016 has led to an immediate out-migration of UK companies to the Netherlands.

2.3 UK-NL trade relations

In order to explore the effect that the Brexit vote outcome may have had on the construction of DCs in the Netherlands as a whole, one has to understand the relationship between the UK and individual COROP regions in the Netherlands. The outcome of the Brexit vote in 2016 may lead to a heterogeneous effect on the construction of DCs throughout COROP regions in the Netherlands as some regions may have stronger ties with the UK than other regions. It is especially important to understand which COROP regions have a large import and export trade flow with the UK. Moreover, it is important to understand which regions have an advantageous geographical location for trade with the UK because of a region's logistical location or due to the presence of a seaport, ferry connection and/ or airport within the region.

The UK has been one of the Netherlands' main trading partners for decades. In the years prior to the 2016 Brexit vote, the Netherlands mainly exported fruit and vegetables, meat, and refined petroleum products to the UK whilst it primarily imported crude oil, other mineral fuels and medicines from the UK (CBS, n.d.-a, 2019). The COROP regions with the largest share in these import and export industries, in the year 2015, are listed in Table 1.

Table 1: COROP regions with largest import and export industries.

Industry	COROP region(s)
Export: Fruit and vegetables	West-Noord-Brabant, Noord-Limburg, Zuid-Limburg
Export: Meat	Veluwe
Export: Refined petroleum products	Groot-Rijnmond
Import: Crude oil	Alkmaar en omgeving, Groot-Amsterdam, Agglomeratie 's-Gravenhage, Groot-Rijnmond
Import: Other mineral fuels	Kop van Noord Holland, Agglomeratie 's-Gravenhage, Zuidoost-Drenthe, Delft en Westland, Groot-Rijnmond, West-Noord-Brabant, Noord-Limburg
Import: Medicines	Noordoost-Noord-Brabant, Agglomeratie Leiden en Bollenstreek, Utrecht

Source: CBS (2023d)

Due to the increased uncertainty following the Brexit vote outcome, the UK's importance in Dutch exports declined each year between 2015 and 2019 (CBS, 2020). Conversely, the Dutch importance in UK imports remained almost unchanged over the same period. In 2015, the year prior to the Brexit vote, the Netherlands had a 7.5% share of UK imports. In 2019, when trade restrictions were not yet in place, the UK imported 7.7% of its goods from the Netherlands (Creemers & Draper, 2021). Nevertheless, despite the results of the Brexit vote, the Netherlands has remained the 3^{rd} largest export market for UK businesses (UK Government, n.d.). In 2019, just before the UK officially left the EU, the total value of imports and exports between the Netherlands and the UK were 38.4 billion Euros and 43.1 billion Euros respectively (CBS, 2023a).

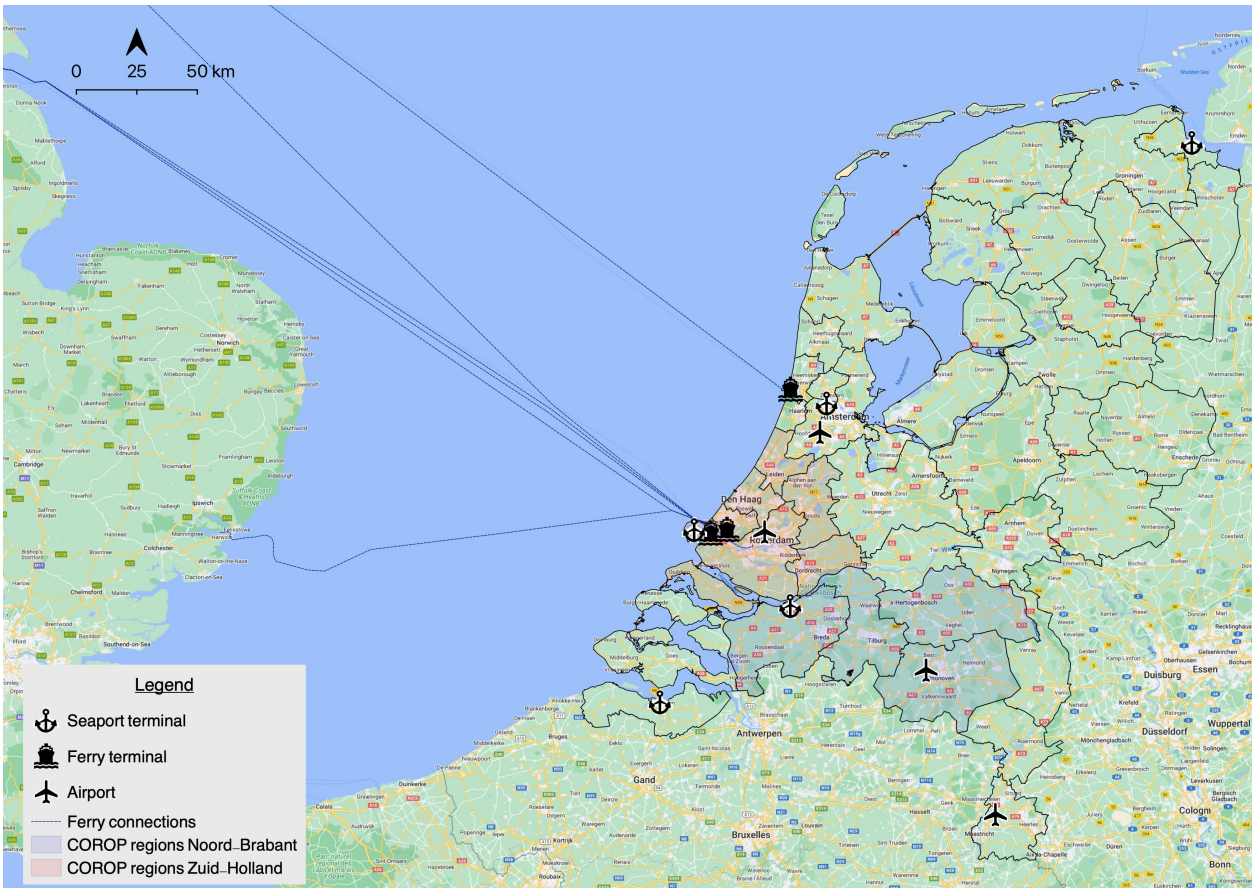
According to CBS (2016), both Noord-and Zuid-Holland as well as Noord-Brabant were the most important provinces for trade with the UK prior to the Brexit vote, accounting for roughly two-thirds of products traded with the UK. These findings are in line with the COROP regions listed in Table 1 suggesting that COROP regions in the provinces of Zuid-Holland and Noord-Brabant in particular account for the largest share of the trade in goods between the Netherlands and the UK.

The presence of a seaport, ferry connection and airport may be one of the reasons why both Noord- and Zuid-Holland have one of the largest trade flows with the UK as these transport hubs facilitate direct connections for the trade in goods. The locations of these important international hubs in comparison to the COROP regions considered in our analysis, are visualised in Figure 4.

Slightly less than half of the imported goods from the UK are re-exported by the Netherlands through European DCs to other countries, leaving over half of the goods imported from the UK destined for consumption or production in the Netherlands (CBS, 2019). Hence, the Netherlands has a very important distribution function as a gateway to Europe for goods coming from the UK, with the port of Rotterdam playing a major role in this distribution network (Creemers et al., 2021). The Netherlands also has a favourable geographical location combined with a well-developed Dutch logistics and data infrastructure. Moreover, the Netherlands is experienced in complex logistical processes and has a relatively highly educated labour force making it an important transit hub for goods arriving from all corners of the world to their European hinterlands (Kuypers et al., 2012).

The Netherlands' two main international transport corridors are the East and Southeast corridors. Both corridors, as visualised in Appendix A Figure 9, run from the port of Rotterdam (Maasvlakte) to the border with Germany at Beek/ Lobith (corridor East) and Venlo (corridor Southeast), and from the German border to Duisburg, Europe's main inland logistics hub (Ministerie van Infrastructuur en Milieu (IenM), 2017). These corridors not only connect the port of Rotterdam to the

Figure 4: Dutch COROP regions and their international transport connections.



Source: own design

Note: Map of the Netherlands including all 40 COROP regions and the major airports, seaports and direct ferry connections with the United Kingdom. The COROP regions in red are located in the province of Zuid-Holland and the COROP regions in blue are located in the province of Noord-Brabant.

German hinterland (and beyond), but along these corridors, many value-added economic activities take place in the region.

With the increasing national and supraregional relevance of the Dutch East-Southeast Freight corridor, being the "Gateway to Europe", COROP regions located in these freight transport corridors find themselves in an advantageous location for the import, export and re-exportation of goods from the UK. Furthermore, considering that major international shippers prefer to locate themselves along the East and Southeast corridors, COROP regions located in these corridors are likely to experience a larger effect from international socio-political shocks which influence the international trade of goods. Thus, COROP regions located in the East and South-East freight corridors potentially maintain closer ties with the UK than COROP regions outside these corridors and as a result, the outcome of the Brexit vote could have a larger impact on these regions than on other Dutch

COROP regions.

At present, it seems that COROP regions in the densely populated parts of the Netherlands are likely to be most impacted by the Brexit vote. According to Ewing (2021), the province of Zuid-Holland in particular experiences positive trade effects from the Brexit vote outcome on employment in manufacturing industries. According to Gasiorek et al. (2019), a large share of the UK manufacturing industry is likely to relocate its warehouses following the Brexit vote outcome. The province of Zuid-Holland appears to be an attractive location for the relocation of these warehouses both in a 'no-trade deal' scenario and in a 'retain membership of the European Economic Area' (EEA) scenario (Gasiorek et al., 2019). Additionally, Zuid-Holland in particular experiences large trade effects due to the province's advantageous geographical location in the Dutch-East-Southeast Freight corridor for the import, export and re-exportation of goods from the UK.

In addition to Zuid-Holland, COROP regions in the province of Noord-Brabant are expected to experience an above-average impact from the Brexit vote outcome. Like Zuid-Holland, Noord-Brabant makes up a large part of the Dutch-East-Southeast Freight corridor. The province is a popular location for the logistics sector due to its close proximity to the main ports of Rotterdam and Antwerp and the Ruhr Area (Nefs & Daamen, 2022). Furthermore, the COROP regions in the province of Noord-Brabant make up a large share of the value of the Dutch import and export of goods in the Dutch trade of goods with the UK. Subsequently, one may also expect to see large trade effects in COROP regions in Noord-Brabant following the 2016 Brexit vote outcome.

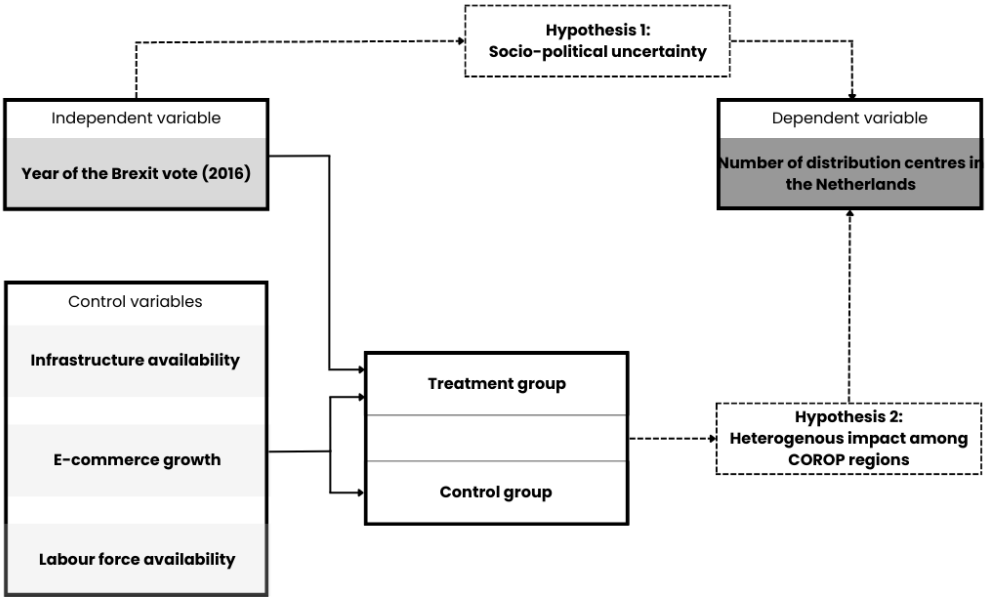
By understanding which COROP regions in the Netherlands are important for the trade of goods with the UK, we are able to make careful predictions about the potential effect that the Brexit vote outcome may have had on the development of DCs in the Netherlands within these specific regions compared to the rest of the Netherlands. Given that the Dutch COROP regions located in the Dutch East-Southeast transport corridor have robust waterway and hinterland connections to both the UK and the European continent, it is likely that a geopolitical disruption, such as the outcome of the Brexit vote, would have more significant consequences in these regions than in other parts of the Netherlands. Therefore, these regions experienced the 2016 Brexit vote outcome as an intervention which allocates them to a treatment group. The remaining Dutch regions fall within a control group, having experienced no effect of the 2016 Brexit vote outcome. The methodology that builds upon analysing the differences between this treatment and control group is explained in Chapter 3.1. Accordingly, the second hypothesis reads as follows:

Hypothesis 2: COROP regions in the provinces of Zuid-Holland and Noord-Brabant are expected to experience a larger impact on the development of logistics real estate compared to other COROP regions, following the 2016 Brexit vote outcome.

2.4 Conceptual framework

The objective of this research is to understand what influence the 2016 Brexit vote outcome has had on the development of DCs among COROP regions in the Netherlands. Drawing on the literature and concepts discussed, combined with in-depth interviews with industry experts and the gathering of quantitative data, a conceptual framework is pictured in Figure 5. This framework also indicates which hypothesis is linked to which part of the model.

Figure 5: Conceptual research framework.



Source: own design

3 Methodology

In order to test the hypotheses and form a model, this research will uses a mixed-methods approach which combines both qualitative and quantitative research methods to construct an exploratory sequential design. Combining quantitative and qualitative methods allows us to yield a better understanding of the recent and complex phenomenon in our study on which limited data is available. Obtaining not only information from literature but also from practice, through in-depth interviews, helps us get a full picture of current trends in the demand for logistics real estate as well as the potential effects resulting from the 2016 Brexit vote outcome. Thus, qualitative data collection establishes and frames the issue, and may provide an answer to our first hypothesis stating that increased uncertainty following the Brexit vote outcome in 2016 has led to an out-migration of UK companies to the Netherlands.

The quantitative approach, a difference-in-differences (DiD) approach, allows us to test the second hypothesis by constructing a model based on the qualitative data collection. Subsequently, one can establish if there is a correlation between the Brexit vote outcome and the demand for DCs in the Netherlands.

Firstly, one must understand why this research does not run an OLS-regression of the year 2016, the year in which the Brexit vote was held, on the number of DCs in the Netherlands. As opposed to an OLS regression, a DiD approach accounts for time effects by comparing changes in a treatment group with changes in a control group over time. A DiD approach allows one to control for and isolate the effect of other variables that change over time such as infrastructure availability or e-commerce growth because these variables are likely to be evenly distributed between the treatment and control group. Hence, a DiD methodology is adopted to obtain a more accurate causal assessment of the relationship. To test the second hypothesis, which posits that COROP regions in Zuid-Holland and Noord-Brabant are expected to experience a larger impact on logistics real estate development following the 2016 Brexit vote outcome compared to other regions, a standard DiD approach is applied.

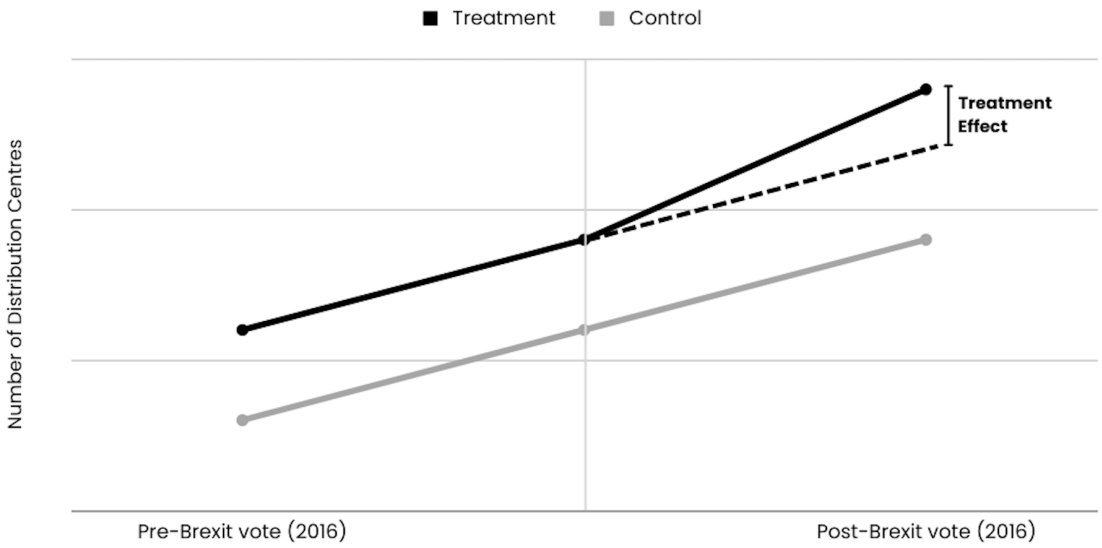
3.1 Difference-in-differences

3.1.1 Basic model

The difference-in-differences method is a quasi-experimental research design that leverages an exogenous shock to create two distinct groups: the control unit (COROP regions not exposed to the shock) and the treatment unit (COROP regions exposed to the shock) (Schwerdt & Woessmann,

2020; Wing et al., 2018). We can identify any deviation in the trend of the treatment group related to the trend of the control group as the causal impact of the exogenous shock.

Figure 6: Difference-in-differences model.



Source: own design, based on Schwerdt & Woessmann (2020)

The DiD model allows us to assess the effect on DC development within a COROP region before and after the 2016 Brexit vote. We can then compare this change to DC development in regions unaffected by the Brexit vote outcome during the same time period. Thus, the DiD model consists of two phases:

1. Pre – post phase

   In the pre-post phase, the change in DC development within a COROP region before the 2016 Brexit vote ($E[Y|Pre]$) is compared to the change in DC development after the 2016 Brexit vote ($E[Y|Post]$). The difference in the trends for both the treatment (T) and the control group (C), during the pre-and post-phase, can be expressed as follows:

$$\begin{aligned} \delta_T &= (E[Y_T|Post] - E[Y_T|Pre]) \\ \delta_C &= (E[Y_C|Post] - E[Y_C|Pre]) \end{aligned} \tag{1}$$

   One must ensure that the COROP regions included in our control groups are a valid counterfactual for the COROP regions in our treatment group in the absence of the treatment. Therefore, the following two conditions must apply:

(a) Parallel trends assumption: The trend of the control group must be identical to the trend of the treatment group in the absence of the intervention. Accordingly, no other factors change differentially over time for the treatment group relative to the control group (Wing et al., 2018).

(b) Stable Unit Treatment Value assumption (SUTVA): There may be no interactions between treatment and control units and neither may there be a response from the treated or untreated units to the existence of the other group. In cross-sectional data, this also implies that the composition of groups remains the same. In other words, non-compliance with SUTVA leads to a violation of valid counterfactuals since the control trend includes a response to the treatment (Wing et al., 2018).

2. Control – treatment phase

   During the control-treatment phase, the outcomes of the control group (ΔY_C) – COROP regions not economically affected by the 2016 Brexit vote outcome – are compared to the changes within the treatment group (ΔY_T) – COROP regions economically affected by the Brexit vote outcome. A prerequisite for COROP regions allocated to the control group is that the regional characteristics such as demography, available infrastructure, and international border proximity, among other characteristics, must be similar to those of the COROP regions allocated to the treatment group.

3.1.2 Treatment and control group

As mentioned earlier, the control group comprises COROP regions unaffected by the Brexit vote outcome, while the treatment group consists of regions impacted by it. The classification of a COROP region into the control or treatment group is based on two key factors: the region's import and export activity with the UK and its location in the Dutch East-Southeast transport corridor. Regions with significant trade ties to the UK and those situated in the Dutch East-Southeast corridor are expected to be most affected by the 2016 Brexit vote outcome. This leads to the formation of control and treatment groups determined through a weighted average analysis that assesses each region's vulnerability to the 2016 Brexit vote outcome. A COROP region's vulnerability to the Brexit vote outcome is computed as follows:

$$V_i = [(\frac{1}{3}) * (\frac{I_i}{1,000,000,000})] + [(\frac{1}{3}) * (\frac{E_i}{1,000,000,000})] + [(\frac{1}{3}) * c_i] \tag{2}$$

where V represents the dependent variable, a COROP region's i vulnerability to the 2016 Brexit vote outcome. A higher V_i indicates potentially stronger trade ties with the UK and a higher likelihood of experiencing significant consequences from the Brexit vote outcome. The continuous variable I_i represents the value of a COROP region's imports from the UK in Euros and the continuous variable E_i represents the value of a COROP region's exports to the UK in Euros. Additionally, c_i is a dummy variable that indicates if a COROP region is located in the Dutch East-Southeast transport corridor (1) or not (0).

Data unavailability on the size of UK imports and/ or exports for the COROP regions Oost-Groningen, Delfzijl en omgeving, Noord-Overijssel, Zuidwest-Overijssel, Alkmaar en omgeving, Agglomeratie Haarlem and Het Gooi en Vechtstreek eliminates these regions from the dataset, leaving 33 COROP regions for analysis. The 16 regions with the largest vulnerability to the Brexit vote outcome are assigned to the treatment group and the 17 regions with the lowest vulnerability to the Brexit vote outcome are assigned to the control group. Thus, the treatment and the control group will have relatively similar sizes.

3.1.3 Control variables

Control variables, or covariates, in a DiD regression, can help address any confounding factors. Confounding factors are variables that are associated with both the treatment (Brexit vote outcome) and the outcome (development of distribution centres), and therefore they can obscure the interpretation of the treatment effect. By including control variables in the DiD regression, one can control for these confounding factors to a certain extent and subsequently rule out potential alternative explanations for the observed changes in the development of DCs. Thus, the DiD design requires exogeneity which states that the timing of treatment exposures be statistically independent of the likely outcome distributions, subject to the group-and time-fixed effects (Wing et al., 2018). To identify the treatment effect and reduce the variance in the error term, the following covariates are included in our DiD regression: (1) The number of physical shops per COROP region, (2) the total road length within each COROP region, (3) the nearest distance for each COROP region to a seaport or inland shipping terminal, and (4) the total unemployed labour for each COROP region.

3.2 Full model

Based on the aforementioned, our model relies on the following DiD estimator:

$$y_{it} = \beta_0 + \beta_1 * T_i + \beta_2 * P_t + \beta_3 * (T_i * P_t) + \beta_4 * X_i + \epsilon_{it} \tag{3}$$

where y represents the dependent variable, the number of DCs for a COROP region i in the control or treatment group in the pre-or post-intervention period t. The dummy variable T_i represents the treatment group and the dummy variable P_t represents the post-intervention period. Furthermore, $(T_i * P_t)$ is the interaction term that is the product of the treatment variable and the post-treatment period variable. Specifically, it captures the difference in the treatment effect between the treatment group and the control group over time. Lastly, X_i represents the control variables included in the model that vary for each COROP region.

3.3 Propensity score matching

A difference-in-differences method is frequently used in tandem with a matching technique to increase the probability that the parallel trends assumption will hold. Through 'matching', treatment units are linked to simulated counterfactual control units which are characteristically similar units. In the absence of a randomised controlled experiment, as is the case in our study, the effects of a treatment programme are frequently estimated using propensity score matching (PSM) (Rosenbaum & Rubin, 1983). PSM is mostly applied when working with observational data, including pre-programmed characteristics that assign a subject or object to the treatment or control group, and is a method used to correct for measured confounding in observational studies.

When applying PSM, individuals from the treatment and control groups are matched based on their 'propensity score', which is the probability of being exposed to the treatment (T) conditional on observed baseline covariates (X_K) (Rosenbaum & Rubin, 1983). The propensity score is estimated through a logit or probit regression in which the likeliness to treatment exposure is predicted based on relevant covariates and is written as follows (Austin, 2011):

$$Prob(T = 1|X_1, X_2, ..., X_K) \tag{4}$$

In PSM, probit models use the cumulative standard normal distribution function $\phi(\cdot)$ to model the probabilities of a binary dependent variable. To understand how well the covariates in our model

explain the treatment probability, one should look at the pseudo-R2. Sianesi (2004) argues that there should be no systematic differences in the distribution of the covariates between the two groups after matching and that accordingly, the pseudo-R2 must be relatively low. Therefore, a re-estimation of the propensity score on the matched model, i.e. solely on participant and matched nonparticipants, should yield a similar pseudo-R2. McFadden (2021) has defined pseudo-R2 values ranging from 0.2 to 0.4 to indicate an excellent fit of the model.

This study applies the radius matching technique to the sample as the most common matching technique, the nearest neighbour technique, may lead to inaccurate matching due to the relatively small sample size in this study. This relatively small sample size can lead to matches that are numerically distant which may result in poor matching and biased estimates. The radius matching technique imposes a maximum propensity score distance for matching. Hence, this approach solely uses the comparison units that find themselves within a predefined propensity score radius of 0.2, allowing for the usage of additional units when adequate matches are available and fewer units when they are not Baser (2006).

4 Data

4.1 Qualitative data collection

As Brexit is a very recent phenomenon, little research has been conducted to this date on its impact on different matters. Current literature that has examined the potential effect of the Brexit vote outcome has mainly focused on the intended and anticipated effect of Brexit on certain topics (Smith et al., 2018; van Berkum et al., 2018; Belke & Ptok, 2018; Thissen et al., 2020). By applying qualitative research methods, such as in-depth interviews with industry experts, practical insight can be gained regarding the observed impact of the Brexit vote outcome. The in-depth interview responses contribute to determining which variables should be included in the quantitative research.

In-depth interviews will allow the exploration of the perceptions and experiences of decision-makers within the logistics and logistics real estate industry in the Netherlands concerning the potential influence of the Brexit vote outcome on the development of distribution centres. Therefore, conducting interviews with industry experts such as warehouse developers, logistics real estate agents, and municipalities may provide valuable insights into the impact of the Brexit vote outcome on the development of warehouses within the Netherlands. Following the experts' responses, an answer to the first hypothesis may be generated and a quantitative model can be designed. The data collection will be based on semi-structured interviews which will include the following questions:

1. Have you noticed a change (increase or decrease) in the request for distribution centres in the Netherlands after 2016?
2. In what regions in the Netherlands do you see the largest change (increase or decrease) in the demand for distribution centres?
3. In what industry (agriculture, automotive, chemicals, textile, etc.) do you notice the largest change in the demand for distribution centres?
4. Have you noticed a change (increase or decrease) in the type of customer (Dutch, UK, or European orientation) requesting distribution centres?
5. What is the underlying reason for UK businesses to request distribution centres in the Netherlands?
    - Do UK firms want to increase their buffer stock following the Brexit vote outcome?
    - Do UK firms want to limit additional paperwork following the Brexit vote outcome?
    - Do UK firms want to accommodate for the longer customs declarations of goods following the Brexit vote outcome?

- Are firms increasingly concerned about the implications of quality administrations following the Brexit vote outcome?

6. Bonded warehouses are specialized storage facilities where imported goods can temporarily be stored, processed, or manipulated without the payment of import duties, taxes, or customs fees. Bonded warehouses are typically under the supervision and control of the country's customs authorities as they are effectively duty suspension zones that allow "depositors to avoid duties on goods that will be exported again and to defer duties on goods that aren't ready to circulate in the (...) market yet." (John K. Philips, n.d.). Now that the UK is officially outside of the EU, do you notice a change in the demand for bonded warehouses?
7. Are you aware of any changes in trends and location choices for distribution centres on the other side of the Channel?
8. What changes in the demand for distribution centres do you anticipate for the future now that the Trade and Cooperation Agreement has been enforced?

4.2 Quantitative data collection

Following the qualitative data collection, quantitative data will be gathered on a COROP region level, from secondary data sources. A COROP region contains one or more neighbouring municipalities within a province. The Netherlands is divided into 40 COROP regions, also known as the European NUTS-3 level, which are visible in Figure 10 and listed in Figure 11 in Appendix A.

4.2.1 Distribution centres

The first data set used provides longitudinal data on the geographical location and construction moments of 26,951 logistics buildings in the Netherlands, with a footprint larger than 500 m^2, built before November 2021 (Nefs, 2022). The data set contains a plethora of variables and is revised such that the variable's construction year, footprint and COROP identification number are maintained.

4.2.2 E-commerce

Unfortunately, little data is available on the topic of e-commerce penetration both on a national and a COROP region level. In order to account for the strong e-commerce growth which has undoubtedly fueled logistics real estate development (Nefs et al., 2022), data on the number of physical shops per COROP region is included, being a proxy variable. The number of physical shops in the Netherlands has been characterised by a downward trend since 2010. This decline in the number of physical shops

contrasts with the sharp increase in the number of online shops during this period as the years after 2010 have been characterised by a quadrupling of the number of web shops (CBS, 2023c). Annual data on the number of physical shops per COROP region are retrieved from CBS (2023d).

4.2.3 Infrastructure

Compared to other European countries, the Netherlands scores well on laws and regulations, transport infrastructure and the price/ quality ratio of logistics services. Also due to the easily accessible waterways and roads, the physical infrastructure in the Netherlands is considered one of the best in Europe which contributes to a positive business climate for both national and international businesses (Kindt et al., 2020). Partly due to this good infrastructure as well as its favourable geographical location, the number of logistics buildings in the Netherlands has increased significantly in recent years.

The available infrastructure is the most important factor within the location factors regarding accessibility. The proximity to a motorway and waterway connection or shipping terminal appears to be a relevant factor for logistics companies Verhetsel et al. (2015). Proximity to a rail terminal appears to be unimportant for inbound and outbound transport (S. Onstein et al., 2018).

Detailed data on the Dutch road network for each COROP region is retrieved from the Central Bureau of Statistics (CBS, 2023b). In addition, data on the Dutch inland shipping and terminal network is obtained through QGIS[6]. In QGIS, all the Dutch inland ports and transshipment terminals as illustrated by Stead & Meijers (2015) were marked. Thereafter, the fastest distance, using the Dutch road network, from a hypothetical DC located in the centre of a COROP region to one of the terminals was calculated.

4.2.4 Other

As the number of online orders has grown significantly in recent years, and consequently the number of DCs in the Netherlands has grown, a larger labour force is required. Labour force accessibility is one of the most important 'resource' location factors, when deciding on a location to build a DC, and has been a stable factor over time (Kang, 2020). Both shippers and logistics service providers look for logistics workers within the same labour pool, both at post-secondary vocational education (MBO in Dutch) and higher-professional education (HBO in Dutch) or university education (WO

[6]QGIS is an open-source geographic information system, which allows geographical data to be analysed and can be accessed via qgis.org.

in Dutch). Due to increasing scarcities in the Dutch labour market and the glaring shortage of staff, especially in the transport and logistics sector, shippers are starting to divert to areas outside popular logistics location regions - even when these locations are sub-optimal from a transport cost perspective (S. Onstein et al., 2018). Since COROP regions with higher labour availability may house more future DCs, this study must take this development into account. Thus, the size of the unemployed labour pool, defined as the number of unemployed people who are actively looking for a job, is considered for each COROP region. As the dataset of the covariate 'unemployed labour pool' runs from 2013 up to the year 2021, this analysis will consider a time frame from 2013 to and including 2021. Accordingly, the final dataset includes 9 time snapshots for 33 COROP regions which totals 297 observations.

5 Results

The following section highlights and describes the results obtained from both the in-depth interviews as well as the regressions and argues whether the hypotheses must be rejected or not. Accordingly, the obtained results are compared to the current literature to ascertain their congruence and logical coherence.

5.1 Qualitative results

The first hypothesis explores the relationship between the increased socio-political uncertainty following the 2016 Brexit vote outcome and the immediate out-migration of UK companies to the Netherlands through in-depth interviews.

The evidence gathered from the interviews with Midpoint Brabant, (personal communication, July 12, 2023), CBRE (personal communication, July 11, 2023) and NDL/HIDC (personal communication, July 13, 2023), strongly support the notion that the Brexit vote outcome has resulted in heightened socio-political uncertainty, subsequently driving the out-migration of UK companies to the Netherlands. Both Jochem Sanders, Associate Director of East-Netherlands at CBRE and Jim Orsel, Head of Industrial & Logistics Netherlands at CBRE, point out that in 2020 and 2021, after the Brexit vote, there was an exponential growth in the demand for outsourced logistics activities in the Netherlands coming from the UK. Remco Buurman, CEO of NDL/HIDC, reaches the same conclusion as Sanders and Orsel and states that in particular after January 1^{st}, 2021, a significant surge in British companies seeking logistics services in mainland Europe was notable. As the Brexit vote was held in 2016, it seems that there is a delay in the movement of UK companies to overseas territories. This delay in the movement of UK companies indicates that the uncertainties arising from the Brexit vote outcome played a pivotal role in companies' decision-making. In other words, the delay in companies taking action until after the referendum had fully taken effect indicates that companies were assessing the actual consequences of Brexit vote before making strategic moves, and this assessment process was influenced by the uncertainties created by the referendum outcome.

Additionally, both interviews with CBRE and NDL/HIDC provide evidence indicating that the primary motivation for the relocation of UK companies to the Netherlands was to maintain their competitiveness in the European market. The increased administrative costs, potentially longer lead times, and uncertainty associated with new, post-Brexit, customs and trade procedures compelled these companies to seek solutions in the Netherlands (NDL/ HIDC, personal communication,

July 13, 2023). This trend is expected to continue as Buurman anticipates an ongoing demand for British companies seeking logistical solutions in mainland Europe to remain competitive, showcasing the enduring impact of socio-political uncertainty sparked by the Brexit vote. Subsequently, the aforementioned evidence showcases that the Brexit vote outcome has indeed led to increased socio-political uncertainty in the UK in the years after the referendum. Hence, we are unable to reject the first hypothesis as we find evidence suggesting that the increased socio-political uncertainty following the Brexit vote outcome in 2016 has led to an out-migration of UK companies to the Netherlands.

5.2 Quantitative results

5.2.1 Parallel trends assumption

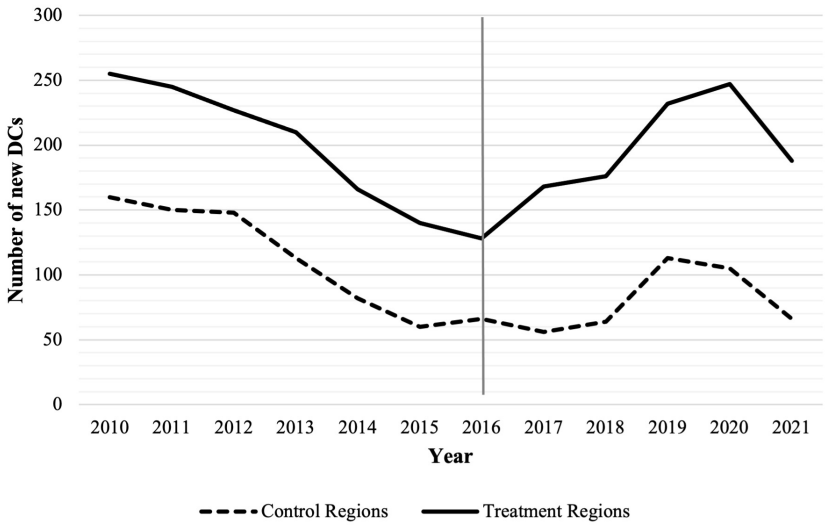
COROP regions unaffected by the Brexit vote outcome show a similar pre-intervention trend in the outcome variable compared to those affected by the Brexit vote outcome. Figure 7 graphically shows that both groups develop similarly over the course of time prior to the intervention, a crucial prerequisite for the difference-in-differences method. For instance, in both groups, the number of new DCs decreased slightly between 2010 and 2012 but considerably between 2012 and 2015. Somewhat surprisingly between 2015 and 2016 the control and treatment group trends develop differently. Nevertheless, despite this slight difference in the trajectories, the pre-intervention period trends develop relatively similarly over time and one may assume that in the absence of the treatment, the trends would continue to develop similarly in the post-intervention period.

5.2.2 Propensity score matching

The probit output generated after applying PSM is not of significant relevance as PSM is merely a reprocessing step to create a more balanced dataset by matching treated and control units based on their propensity scores. The probit regression model used in PSM helps estimate propensity scores, but the specific coefficients and significance of covariates in this model are not the focus of this analyis. Therefore, the obtained results and the overall model evaluation are not reported; rather, both are solely discussed.

As indicated in Chapter 3.3, one should look at the pseudo-R2 in the initial probit model and the re-estimated matched model to understand how well the covariates explain the treatment probability. An excellent fit of the model is indicated by a pseudo-R2 ranging from 0.20 to 0.40 (McFadden, 2021). The pseudo-R2 in our models approximate 0.17 and 0.14 respectively which indicates that

Figure 7: Graphical exploration of the parallel trends assumption.



Source: Own design based on Nefs (2022)

our model is a good fit. However, as we do not obtain a perfect fit but merely a good fit, a non-linear relation between our modelled probability and the covariates may be present or interaction effects may exist among the observed covariates in our model.

The radius matching technique in our propensity score model allows a treated unit to be matched with one or multiple control units within the specified radius and controls for covariate imbalances. In other words, following the balance in the propensity score's mean and distributions, the COROP regions with an essentially analogous propensity score across the control and treatment groups are now akin despite their fundamental difference, being their susceptibility to the 2016Brexit vote outcome. This one-to-many matching technique eliminates all 18-time snapshots of COROP regions in the control group that are not matched, resulting in 279 matched time-snapshot observations in the sample. Table 3 in Appendix B shows the corresponding matching results.

5.2.3 Difference-in-differences analysis

In order to explore the second hypothesis, the relationship between the Brexit vote outcome and the number of newly constructed DCs within a given COROP region is identified. The obtained results from the regressions are illustrated in Table 2. The first model solely includes the covariates incorporated into our model and examines the association between the covariates and the dependent variable over time. Subsequently, model (1) does not assess the causal effect of the treatment itself

but explores how the covariates are related to the outcome in the absence of the treatment. The covariates included in the regression are different from the covariates used to estimate the propensity scores as this allows one to test the sensitivity of the results and explore the robustness of the findings. In the second model, the independent variable - number of DCs within a certain COROP region -, the treatment dummy and the time dummy are included. In addition to the second model, the third model includes the interaction effect between the treatment and the time dummy.

Table 2: The complete difference-in-differences model.

Dependent variable: Number of DCs	(1)	(2)	(3)
Variables			
Total road length	0.052***	0.047***	0.047***
	(0.004)	(0.004)	(0.006)
Distance to nearest shipping terminal	-0.179***	-0.127**	-0.126*
	(0.040)	(0.038)	(0.065)
Number of unemployed labourers	0.008	0.024	0.022
	(0.008)	(0.019)	(0.022)
Number of physical shops	0.007	0.010**	0.011
	(0.005)	(0.005)	(0.008)
Treatment dummy		4.093***	2.550**
		(0.678)	(1.137)
Post-Brexit dummy		1.108*	-0.085
		(0.666)	(0.502)
Treatment*Post-Brexit			2.313*
			(1.236)
R-squared	0.3914	0.4675	0.4734
Number of observations	279	279	279

Note: The number of DCs constructed within a COROP region after the Brexit referendum. The sample comprises the final post-propensity score-matching dataset between 2013 and 2021 with 279 treated and untreated observations. The DiD-coefficients are obtained through an OLS regression. The robust standard errors are displayed in the parentheses. The statistical significance is denoted through *, **, and *** which indicate significance levels of 10%, 5%, and 1% respectively.

The coefficients obtained in the three models visualised in Table 2 allow us to draw a number of conclusions. From the first model, it appeared that the covariates "Total road length" and "Distance to nearest shipping terminal" are statistically significant at a 1% significance level, indicating that changes in both variables were associated with changes in the dependent variable, "Number of DCs", ceteris paribus. The covariates "Number of employed labourers" and "Number of physical shops" were not statistically significant at a 10%, 5% or 1% significance level meaning that these covariates are not statistically associated with the dependent variable.

The covariate "Distance to nearest shipping terminal" had a negative coefficient in all three models. This negative coefficient indicated that fewer DCs were built in COROP regions that have a greater distance to a shipping terminal than in COROP regions that have a smaller distance to a shipping terminal. The fact that the covariate "Distance to nearest shipping terminal" maintained its significance in all three models indicated that this covariate had a robust and consistent association with the dependent variable across different model specifications. Hence, the covariates' significance is a strong indicator of its importance in predicting the dependent variable.

As previously specified, the second model in Table 2 included all covariates as well as the treatment and time dummy. The treatment dummy is defined as the average difference in the dependent variable between the treatment and control group preceding the intervention. The significant and positive coefficient, at a 1% significance level, indicated that the treatment group experienced a greater increase in the number of DCs compared to the control group after the 2016 Brexit vote outcome, ceteris paribus. This suggests that the Brexit vote outcome has had a positive impact on the number of DCs within a COROP region. The time dummy describes the average change in the dependent variable of the control group in the post-intervention period. The significant and positive coefficient of the time dummy, at a 10% significance level, implied that both the treatment and control groups experienced an increase in the number of DCs over time, ceteris paribus. However, the treatment group exhibited a greater increase than the control group. Thus, there was a general upward trend in the number of DCs within COROP regions but the treatment group experienced a more pronounced increase in the number of DCs compared to the control group. The estimated effect of the time dummy takes the pre-existing differences between the treatment and control groups in the pre-intervention period, as seen in Figure 7, into account. Therefore, the significant difference in the number of DCs constructed between the control and treatment groups has no further implications for the obtained estimates as a DiD regression helps control for any pre-existing differences.

Despite the significant coefficients of both the time and treatment dummy in Model 2, only the treatment dummy maintained its significance in Model 3. The insignificant time dummy suggests that the inclusion of the interaction term between treatment and time has introduced some multicollinearity or interaction effects that affected the statistical significance of the time dummy coefficient. In order to analyse potential multicollinearity issues, a Variance Inflation Factor test (VIF) was performed. The results of the VIF test are found in Chapter 5.3.2.

In addition to the above, it appears from Model 3 in Table 2 that the primary parameter of interest - the interaction effect displayed in column 3 - is statistically significant at a 10% significance

level. The interaction effect captures the treatment effect and presents the average change in the dependent variable of the treatment group in the period after the intervention, in comparison to the same group if the treatment hadn't taken place. Hence, a statistically significant interaction effect suggests that the effect of the treatment variable, the 2016 Brexit vote outcome, on the outcome variable, the construction of distribution centres, varies significantly across different COROP regions. As the interaction effect is a significant and positive coefficient, we are unable to reject the second hypothesis. Therefore, evidence is found suggesting that all COROP regions located in the provinces of Zuid-Holland and Noord-Brabant experienced a larger impact on the development of logistics real estate compared to the other COROP regions in the Netherlands, following the 2016 Brexit vote outcome.

5.3 Data robustness checks

5.3.1 Correlation matrix

To strengthen the data's robustness, the correlation between the variables was examined in a correlation matrix, shown in Appendix B Table 4. High correlations between variables, which may cause multicollinearity issues, can be identified using the correlation matrix. Green (1991) asserts that multicollinearity may be of issue for correlations greater than 0.8. Fortunately, the variables in our model indicate no relationships greater than 0.8, as to be seen in the correlation matrix. The highest correlation, of 0.58 is to be found between the dependent variable - the number of DCs - and the covariate - total road length - and is statistically significant at a 1% significance level. Although a correlation of 0.58 lies well below the high correlation threshold of 0.8 one should be aware of the potential consequences this relatively high level of correlation may have. The inclusion of strongly correlated control variables in our model can attenuate the predicted treatment effect. Thus, although Table 4 in Appendix B shows no signs of multicollinearity, our estimated treatment effect may still be influenced by relatively high levels of correlations present in our model.

5.3.2 Variance Inflation Factor test

In order to further analyse probable multicollinearity issues, a Variance Inflation Factor (VIF) test was performed. According to Daoud (2017) and Alin (2010), VIF values larger than 5 suggest potential multicollinearity difficulties, and VIF values greater than 10 signify severe collinearity issues. Table 5 in Appendix B shows the results of the VIF test for each of the variables included in the com-

plete model. The variable "Unemployed labour" holds the largest VIF value of 1.17. This VIF value indicates that there is little to no multicollinearity among the independent variables a covariates in our regression model.

Altogether, both the results obtained through the correlation matrix and the Variance Inflation Factor test show no indication of multicollinearity issues in our model. All values in the correlation matrix are well below 0.8, implying no high correlations are present. Additionally, all VIF test results are significantly lower than 5 suggesting that our model does not suffer from multicollinearity problems.

5.3.3 Clustered standard error

The results from our DiD model are compared over the course of time and therefore, autocorrelation may be present in both the model's variables and in the error term. Specifically, the observations in our model may not be independent of each other over time or space as a variable's current value may be correlated with its past values at different lags. For that reason, Drukker's autocorrelation test, an extension of Wooldrigde's, test was executed (Drukker, 2003). The null hypothesis of Drukker's test states that there is no first-order autocorrelation in the error term of the regression model. Appendix B Table 6 shows the results of the extended Wooldridge test for our model. According to the results, the null hypothesis can be rejected as the p-value is significant at a 1% significance level. Therefore, our model likely suffers from autocorrelation or serial correlation issues which may cause the estimated coefficients to be less efficient and less precise. Serial correlation problems are accounted for in the DiD model, by clustering the standard errors at the regional level (Wooldridge, 2010). By clustering standard errors, one can account for heteroskedasticity that may exist across clusters of observations.

6 Discussion

Both the qualitative and quantitative findings are in line with recent literature which states that many exporting British companies have started looking for warehouses in the Netherlands, following the 2016 Brexit vote outcome, to serve customers in continental Europe as the UK's exit from the EU has made the UK a 'third country' (Partridge, 2021; Annexum, 2021; Lalkens, 2021a). "This exit causes higher costs and longer delivery times for UK companies" according to Remco Buurman (personal communication, July 13, 2023), causing many UK companies to partly shift their logistics flows, including inventories and distribution.

However, the results drawn in the previous chapter do need to be interpreted with caution as this study also knows its limitations. This chapter discusses the shortcomings of the implemented research design and argues their potential consequences for the interpretation of the results. In addition, this chapter provides several further research and policy recommendations.

Despite the limitations, this research bridges a significant gap in the literature. Most recent papers have investigated the impact of the Brexit vote outcome on general UK – NL trade relations in pre- and post-Brexit times but have not explored the role that this geopolitical disruption may have played within the relocation of both UK distribution and manufacturing facilities as well as the restructuring of value-chains for UK production companies. Considering that large DCs have become an increasingly relevant feature and will remain a relevant feature in the Dutch landscape, despite their growing opposition, it is interesting to understand what factors and shocks contribute to their rise within the Netherlands. This research thus provides a good foundation for further research into the impact of a large geopolitical shock, the Brexit vote outcome, on the development of DCs in the Netherlands.

6.1 Limitations

The first limitation pertains to the validity of the obtained results as the control group in the DiD analysis is likely exposed to the treatment. The Brexit vote outcome is a huge geopolitical shock that has brought along a diverse range of economic, social and political implications, among many other implications, for a plethora of different countries, regions and industries. The outcome of the Brexit vote and the subsequent process of disentangling the UK from the EU's economic framework have had profound global consequences. Changes in trade agreements, regulations, and market access have affected businesses, employment, and consumer prices all across the globe. Individuals may

experience the impact of these changes through their livelihoods, purchasing power, and economic stability. Therefore, it is highly improbable that the COROP regions in our control group remain unaffected by the Brexit vote in 2016, given its global implications. Regions with physical transport links to the UK, such as ferry connections, may even experience more pronounced impacts in terms of warehouse demand. This widespread influence on various aspects of life and the economy questions the validity of the DiD analysis, as it challenges the core assumption of the method. This challenge makes it more difficult to isolate the causal effect of the treatment since there is no longer a valid counterfactual group for comparison. Consequently, this violation of the assumption may introduce bias and potentially compromise the reliability of the results.

The second limitation concerns the time frame considered in the analysis. From the literature review, evidence was found that a period of increased uncertainty arose for businesses within the United Kingdom following the Brexit vote outcome in 2016. This heightened uncertainty stimulated a large number of UK companies to move their business to foreign destinations in anticipation of changing market accessibility and geopolitical instability. Accordingly, this analysis considered an immediate out-migration from UK businesses to overseas territories following the Brexit vote. However, from the in-depth interviews, it appeared that there was a delay in the movement of UK companies and the significant surge in British companies seeking logistics services in mainland Europe was especially notable after January 1^{st}, 2021. Alas, the dataset used in this research runs until 2021 and therefore, the potential effect after 2021 could not be explored. This delay in the migration of businesses is not only a limitation but also a significant outcome of the research, shedding light on previously unknown dynamics. As such, the analysis must be interpreted within the context of the time frame chosen, acknowledging that the effects may vary depending on the specific time frame. In this regard, while the conclusions drawn from the estimated effect between 2016 and 2021 remain valid for that period, further investigation using a more recent time frame is warranted to capture the evolving dynamics, including the delayed migration of businesses.

Another limitation pertains to a potential bias in one of the model's control variables. The control variable "Number of physical shops" is used as a proxy for e-commerce penetration. However, the declining trend in physical shops in the Netherlands cannot be solely attributed to the increasing number of online shops. A shift in the 'purpose' of a city's centre has played a significant role. In addition to shopping, housing, restaurants, cafes, and cultural institutions have become increasingly prominent features (Slob, 2023). Modern city centres now offer a multifaceted experience, reflecting changes in consumer preferences and addressing housing shortages. To mitigate the potential bias

introduced by changes in the city centre's function, better COROP data for e-commerce penetration is required. Alternatively, an appropriate instrumental variable (IV) such as "zoning regulations" could be included in the model. An IV isolates the exogenous variation in the variable "Number of physical shops" that is related to a change in the function of a city centre. Zoning regulations have the capacity to influence the mix of businesses and activities in a city centre. For instance, relaxed zoning regulations that permit more cultural institutions, restaurants, or housing developments can impact the number and types of physical shops in a city centre. Consequently, the IV "zoning regulations" could help isolate a portion of the variation in the "Number of physical shops." This, in turn, could lead to a more robust and less biased estimate of the causal relationship between the independent variable, the Brexit vote outcome, and the dependent variable, the total number of DCs.

A final limitation highlights the relatively high correlation observed between the covariate "Total roadlength" and the dependent variable "Total number of DCs". This correlation introduces potential concerns related to endogeneity and the direction of causality. In practice, it is likely that the relationship between road length and the number of DCs is bidirectional: DC construction may lead to road expansions but road expansions may also drive the demand for more DCs within a certain region through improved infrastructure. This dynamic interplay raises concerns about the assumption of exogeneity, particularly in cases where road infrastructure projects may be influenced by the presence of DCs or other unobserved factors. If road length is affected by the construction of DCs within a region, this bidirectional relationship could introduce bias in our treatment effect estimates.

Furthermore, the significant correlation between the covariate and the dependent variable prompts a deeper consideration of the direction of causality. While this research aims to establish a causal relationship between the treatment (the 2016 Brexit vote) and the outcome (the total number of DCs), the strong correlation with the covariate warrants scrutiny. It is important to assess whether the relationship is being driven by road length changes rather than the Brexit vote outcome, particularly given the practical context. For instance, in regions like Zuid-Holland and Noord-Brabant, where there were virtually no major road extension projects, it is important to understand why road length might suddenly become a driver of DC development in the post-Brexit vote period. One plausible explanation could be supply chain adaptations: post-Brexit, companies may have adjusted their supply chain strategies to minimise cross-border disruptions. This could include the relocation of DCs to regions with good transportation infrastructure (e.g., ports, airports, railways) and proximity to major markets. Consequently, these findings call for cautious interpretation and emphasize the importance of considering not just associations but also the direction and drivers of causality.

6.2 Future research recommendations

This research delves into the spatial consequences of the 2016 Brexit vote outcome on the construction of DCs in the Netherlands, offering a focused perspective on regional dynamics. Although this research provides a valuable spatial lens, it is important to acknowledge its limitations in drawing specific causal conclusions. The analysis raises important questions that warrant further exploration, including a need for a deeper understanding of the observed delay in DC development after the Brexit vote outcome. Furthermore, as data become available for the period after 2021, more robust results can be expected, providing a clearer picture of the longer-term impact. Additionally, future research might explore alternative modelling approaches to disentangle the effects of various factors, especially those with currently unclear impacts, such as road length. Nevertheless, despite the limitations the insights gained at the regional level hold promise. In light of ongoing developments related to the Brexit vote outcome, these findings can inform and guide further research in the evolving landscape of logistics and warehousing. In order to obtain more valuable insights in the future, a number of recommendations are listed below for further research.

Firstly, this research only considers the intended effect of the Brexit vote outcome in 2016 on the development of DCs in the Netherlands. However, many more moments within the Brexit period may have influenced the dependent variable in our analysis. Therefore, defining the Brexit shock proves to be the first challenge as the period following the vote is characterised by several occasions of mounting tension and uncertainty; the 2016 Brexit vote, the anticipated leave from the EU in March 2019 and the formal leave from the EU on the 31^{st} of December, 2020. Further research should incorporate these important moments and capture their potential effects as they may explain part of the obtained results. Thus, the pre-and post-variable included in our model does not justify the complex and variable effect that Brexit potentially has or had on the development of DCs in the Netherlands.

Secondly, further research should consider using a different covariate, such as the number of online purchases per region or municipality, to control for the strong e-commerce growth, which has fuelled logistics real estate development. As previously highlighted, the covariate "Number of physical shops" is likely exogenous and therefore the obtained results may be biased. Not controlling for e-commerce will generate a confounding variable and lead to omitted variable bias and thus, the model requires an explanatory variable related to e-commerce.

Lastly, opposition against the arrival of more, mainly large DCs in the Netherlands, has in-

creased over the past decade at both the national and local level (Lalkens, 2021b). Following the increased social and political unrest fuelled by the construction of new and large DCs, a number of provinces, such as Noord-Brabant, announced at the beginning of 2022 to work towards rules to curb the development of large distribution centres (KRO-NCRV, 2022; Adema & Buijtels, 2023). Moreover, a majority in the Dutch House of Representatives supported an appeal stating that no more large DCs should be built outside existing industrial estates (de Weerd, 2022). The estimated model in this research has not controlled for the increased opposition against the construction of more DCs in the Netherlands, which is arguably higher in the two treated provinces, and neither has it controlled for changes in both regional and national policy resulting from this. Further research should include a control variable for regional policy changes or increased socio-political unrest as this can have a significant impact on the number of DCs that are constructed within a COROP region in the post-intervention time period.

6.3 Policy recommendations

From the results, it appears that certain COROP regions, particularly those located in Zuid-Holland and Noord-Brabant, experienced a larger impact on the development of DCs within their regions compared to other regions in the Netherlands following the 2016 Brexit vote outcome. Policymakers in these regions should prioritize sustainable infrastructure development to accommodate the growing demand for DCs and to mitigate their negative consequences, such as congestion and air pollution. Furthermore, these insights provide an opportunity for policymakers to plan more strategically in the future. With a deeper understanding of the effects of Brexit, policymakers can collaborate not only to share best practices but also to develop coordinated strategies for optimizing DC cluster locations. Such collaboration can lead to a more balanced distribution of DCs and their associated benefits and drawbacks, contributing to the overall efficiency and sustainability of the logistics landscape in the Netherlands.

7 Conclusion

Although several papers have previously investigated the impact of the Brexit vote outcome on general UK – NL trade relations in pre- and post-Brexit times (Smith et al., 2018; van Berkum et al., 2018; Belke & Ptok, 2018; Thissen et al., 2020), this paper is the first of its kind to measure the effect of the Brexit vote outcome on the development of distribution centres among COROP regions in the Netherlands through a mixed methods approach. By combining in-depth interviews with quantitative methods such as the propensity score matching technique and the difference-in-differences analysis, this paper draws careful conclusions about the potential increase in socio-political uncertainty in the UK following the 2016 Brexit vote outcome as well as the impact of the Brexit vote outcome on the development of DCs for given COROP regions in the Netherlands. The analysis in this paper is based on a one-to-many matching technique, resulting in 279 matched observations in the sample. The time period of the sample is determined by both the availability of data and the year in which the Brexit vote was held; 2016. Thus, the post-matched dataset contains data on multiple regional and economic variables, ranging from 2013 to 2021.

Semi-structured interviews were conducted with industry experts such as Midpoint Brabant, CBRE and NDL/ HIDC. Both interviews with CBRE and NDL/ HIDC provided evidence that the Brexit vote outcome had led to an increase in socio-political uncertainty, which has subsequently driven the out-migration of UK companies to overseas territories such as the Netherlands. However, although evidence exists that the increased uncertainties following the outcome of the Brexit vote have influenced companies' decision-making, a delay in the out-migration of companies existed as companies first wanted to understand the potential changes fully. Moreover, both CBRE and NDL/ HIDC noted that the primary motivation for the relocation of UK companies to the Netherlands was to maintain competitiveness in the European market, given the increased administrative costs and uncertainties associated with new customs and trade procedures post-Brexit vote. Hence, we are unable to reject the first hypothesis and we find evidence that the increased uncertainty following the 2016 Brexit vote outcome led to an immediate out-migration of UK companies to the Netherlands.

The second hypothesis argues that COROP regions in the provinces of Zuid-Holland and Noord-Brabant are expected to experience a larger impact on the development of logistics real estate than other COROP regions following the 2016 Brexit vote outcome. An answer was derived from analysing the interaction between the post-intervention period and the treatment regions. The significant and positive estimate suggested that the COROP regions belonging to the treatment group experienced a

larger increase in the number of DCs that were constructed after the Brexit vote outcome, compared to COROP regions that did not belong to the treatment group. Therefore, the Brexit vote outcome appears to have contributed to an increase in the number of DCs within COROP regions in the provinces of Zuid-Holland and Noord-Brabant compared to other COROP regions in the Netherlands. Nonetheless, one must be cautious when drawing conclusions concerning the aforementioned causal effect as the estimate is significant at a 10% significant level. This significance level is relatively high and therefore, one could argue that the obtained estimate represents a feeble standard of evidence.

Additional robustness checks regarding the data used show no indication of multicollinearity. Both the estimates obtained in the correlation matrix and in the Variance Inflation Factor test were well below the critical thresholds which suggested that multicollinearity posed no immediate risk to our model. In order to control for potential autocorrelation in the model's variables and in the error term, Drukker's autocorrelation test was executed. The test result indicated that the Did model likely suffered from autocorrelation and subsequently, the standard errors were clustered at the regional level to account for heteroskedasticity. Accordingly, one should interpret the estimates obtained through the difference-in-differences model cautiously as the estimates may not be precise.

The research question at the beginning of this study read as follows:

What is the effect of the 2016 Brexit vote outcome on the development of distribution centres among COROP regions in the Netherlands?

The results obtained from the qualitative and quantitative analysis suggest that the 2016 Brexit vote outcome has had a substantial effect on the development of distribution centres in the Netherlands. After the Brexit vote outcome, there was a significant yet delayed out-migration of UK companies to the Netherlands due to the increased socio-political uncertainty in the UK. This migration was driven by the need to remain competitive in the European market, among other factors. The impact varied across the Netherlands, with COROP regions in Zuid-Holland and Noord-Brabant experiencing the most pronounced changes compared to other Dutch COROP regions.

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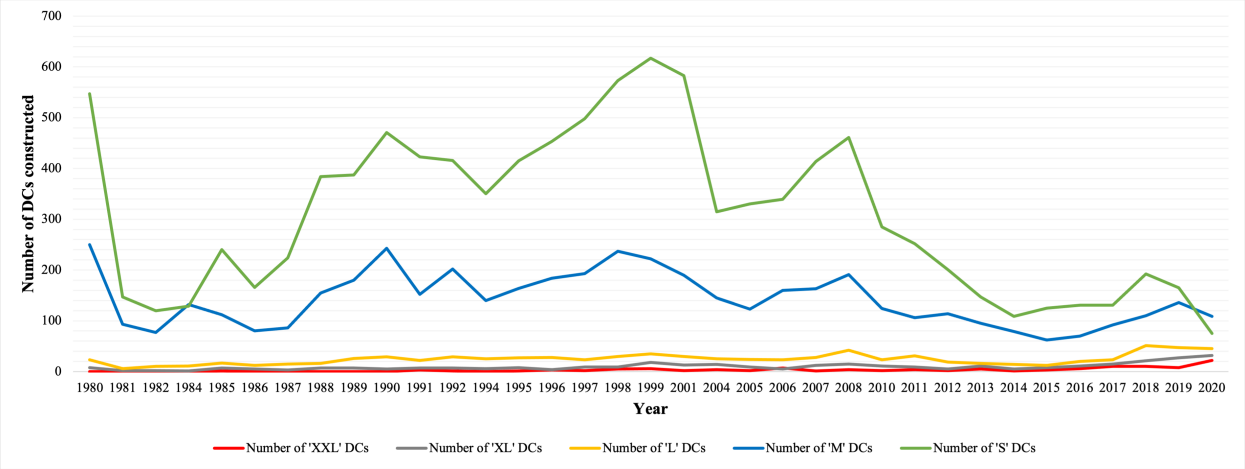
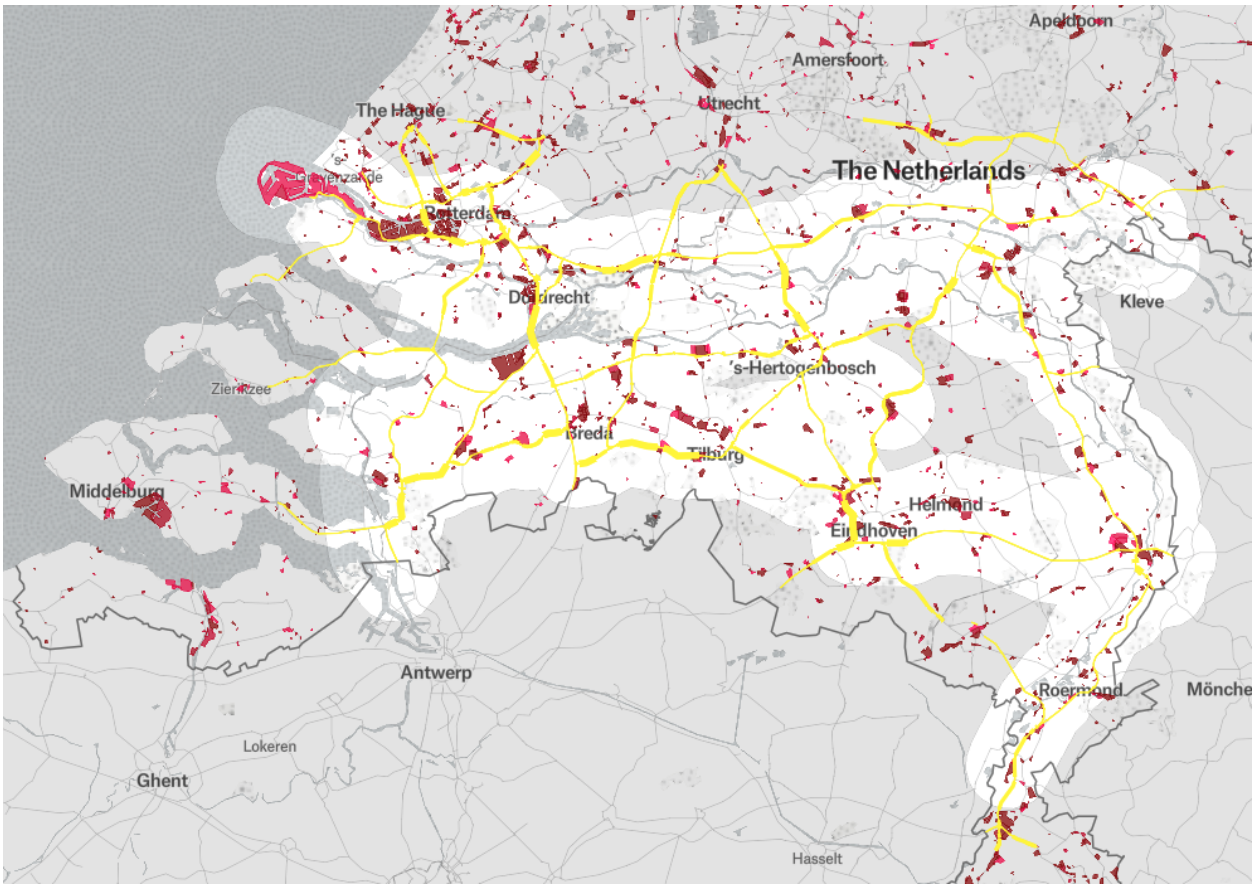
9 Appendix A

Figure 8: Number of distribution centres constructed in the Netherlands per type and per year.



Source: Own design based on Nefs (2022)

Figure 9: Dutch East-Southeast freight corridor.



Source: Nefs (2021)

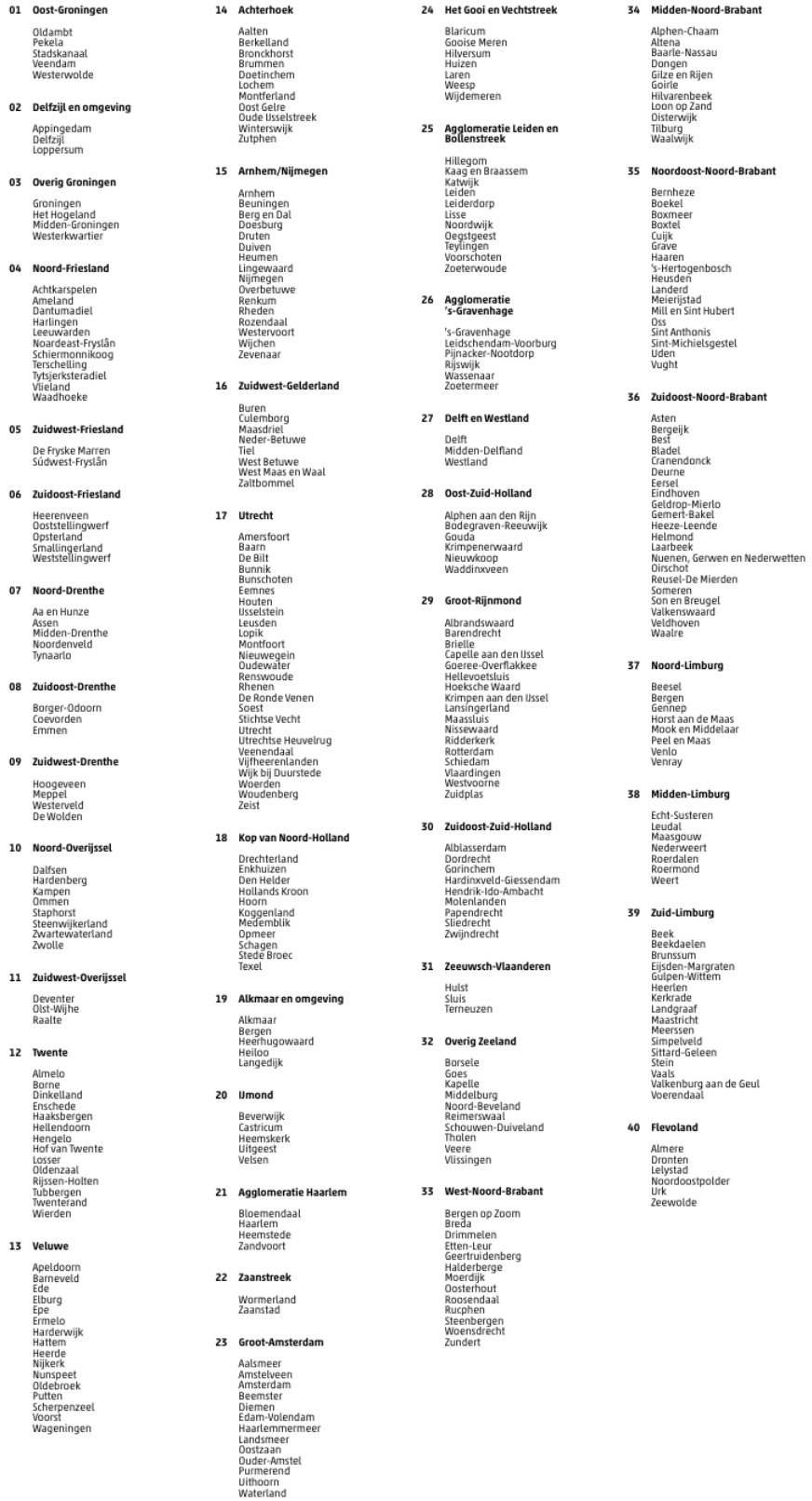
Note: The "Landscapes of trade" map is a simplified representation of the spatial dataset used by researcher Merten Nefs in his doctoral research Landscapes of trade - a collaboration of TU Delft, Erasmus School of Economics and Vereniging Deltametropool. The map is intended for anyone who wants to understand the spatial pattern of logistics in the Netherlands, and in particular the East-South-East freight transport corridor, the most intensive in the Netherlands.

Figure 10: Division of the Netherlands into 40 COROP areas.

Source: NVM Business (2021)

Note: Municipal breakdown of the Netherlands on as of January 1^{st}, 2021.

Figure 11: Division of the Netherlands into 40 COROP areas with associated municipalities as of January 1st, 2022.



Source: NVM Business (2021)

10 Appendix B

Table 3: Covariate balance check pre- and post-propensity score matching.

Covariate	Before propensity score matching						
	Treatment = 0		Treatment = 1				
	Mean	SD	Mean	SD	Pr(T <t)	Pr(|T| >|t|)	Pr(T >t)
Trade value	17.41176	8.478711	16.5625	10.56033	0.7780	0.4441	0.2220
Logistics corridor	0.2941176	0.4571415	0.75	0.4345241	0.0000	0.0000	1.0000
	After propensity score matching						
	Treatment = 0		Treatment = 1				
	Mean	SD	Mean	SD	Pr(T <t)	Pr(|T| >|t|)	Pr(T >t)
Trade value	15.53333	0.6164145	16.5625	0.8800274	0.1724	0.3447	0.8276
Logistics corridor	0.3333333	0.4731602	0.75	0.4345241	0.0000	0.0000	1.0000

Note: The table shows the means and standard differences for the treated and untreated observations by covariate and displays the p-values of the three different alternative hypotheses, representing a one-tailed or two-tailed test. The results suggest that the covariate "trade value" follows a more normal distribution due to propensity score matching but the covariate "logistics corridor" did not completely achieve balance for the "logistics corridor" covariate suggesting that the treatment and control groups differ significantly even after matching.

Table 4: Correlation matrix.

	Total DCs	Total roadlength	Distance to shipping terminal	Unemployed labour	Physical shops	Treatment dummy	Time dummy
Total DCs	1						
Total roadlength	0.5821*	1					
Distance to shipping terminal	-01809**	0.0654	1				
Unemployed labour	-0.1584**	-0.2984***	0.0576	1			
Physical shops	0.0099	0.1652***	-0.1186**	0.2614***	1		
Treatment dummy	0.4295***	0.2530***	-0.1975***	-0.2399***	-0.1485**	1	
Time dummy	0.0894	0.0356	0.0000	-0.0091	-0.0356	0.0000	1

Note: The table shows the correlation coefficients between each of the models' variables. The coefficients are obtained through a Pearson's correlation. The statistical significance is denoted through *, **, and *** which indicate significance levels of 10%, 5%, and 1% respectively.

Table 5: Variance Inflation Factor test.

	VIF	1/VIF
Total road length	1.11	0.9009
Distance to shipping terminal	1.03	0.9709
Unemployed labour	1.17	0.8547
Physical shops	1.10	0.9091
Treatment dummy	1.12	0.8929
Time dummy	1.10	0.9091
Mean VIF	1.12	

Note: The table provides the variance inflation factor and the tolerance (1/VIF) for each of the model's variables. A VIF value larger than 5 suggests potential multicollinearity difficulties. A VIF value greater than 10 signifies severe collinearity issues.

Table 6: Drukker's autocorrelation test.

F(1, 30)	24.788
Prob >F	0.0000

Note: The table presents the outcome of Drukker's autocorrelation test. The null hypothesis of Drukker's autocorrelation test states that that there is no first-order autocorrelation in the error term of the regression model. Rejecting the null hypothesis suggests that evidence is found that autocorrelation, or serial correlation, is present in the error term of the regression model.