Modeling the Clustering of Distribution Centers around Amsterdam Airport Schiphol

location endowments, economies of agglomeration, locked-in logistics and policy implications

Pim Martinus Jacobus Warffemius

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Modelleren van het clusteren van distributie centra rond luchthaven Schiphol: locatiekwaliteiten, agglomeratievoordelen, logistieke inertie en beleidsimplicaties

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Preface

This thesis deals with the explanation of why distribution centers cluster around Amsterdam Airport Schiphol. Airports represent important concentrations of economic activity. The explanation of why economic activities cluster around airports is important for location theory and location policy regarding airport regions. The amount and nature of economic activity located in the surrounding areas of airports is inevitably a prime concern for policy makers.

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Pim Warffemius

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Contents

1. Objectives and scope

1.1 Introduction

Amsterdam Airport Schiphol is the first airport in The Netherlands. In 2000, the year we collected our empirical data for this study, Schiphol was holding a fourth place among the top ten airports in Europe measured by passenger movements as well as by freight transport [Amsterdam Airport Schiphol, 2000]. These rankings change slightly from year to year but the overall pattern remains fairly constant. As a major European airport, Schiphol is part of an international transport network and an important hub for air transport of passengers and freight.

Airports essentially have four potential types of impact on the economy in their region [Button and Stough, 2000, p. 237-240]. Primary effects are the benefits to the region of the construction or expansion of the facility such as local employment required in the construction process and the work done by local contractors. Secondary effects are longer term effects and are associated with the local economic benefits of running and operating the airport. The employment in maintaining the facility, in handling the aircraft and passengers, in transporting people and cargo to and from the terminal and so on. Tertiary effects stem from the stimulus enjoyed by a local economy as the result of firms and individuals having air transport services at their disposal. Finally, there are perpetuity effects. The idea of perpetuity effects reflects an increasingly widely accepted school of thought that argues that economic growth, once started in a region, can become self-sustaining and may accelerate. The construction of a new airport or major enlargement of an existing facility may therefore act to set in progress a much larger and longer term development process in a region [see also:

Kramer, 1990, p. 16; Fujita et al., 2000, p. 4]. By initially attracting firms and activities to an area in sufficient numbers, airport development can lead to a favorable economic environment. The regional economy can feed on this and accelerate its growth. This type of dynamic economic impact of an airport has been little researched and is the focal point of this thesis.

Airports represent important concentrations of economic activity. The explanation of why economic activities cluster around airports is important for location theory and location policy regarding airport regions. The amount and nature of economic activity located in the surrounding areas of airports is inevitably a prime concern for policy makers.

This chapter outlines the objectives and scope of our study. First the problem definition and focal theory are discussed. Here we set the scene and limit the scope of our investigations. Then, the research goal and research questions are addressed. Finally, we outline the rest of this thesis.

1.2 The location allocation problem

Amsterdam Airport Schiphol represents an important concentration of distribution centers. The amount and nature of distribution centers located in the surrounding areas of Schiphol is a prime concern for Dutch policy makers because of two reasons. First, attracting distribution centers means attracting all kinds of goods flows, investments and employment. Second, distribution centers are space demanding while the amount of open space outside the airport is limited and earmarked for airport-dependent (or airport-related) firms. However, it is unknown whether:

- the right locations are allocated to the right warehouses;
- a bad location policy has long-lasting bad effects.

It is unknown whether the right locations are allocated to the right warehouses
Schiphol is a major European airport, handling an ever-growing number of passengers and freight. Demand for industry locations near Schiphol has grown accordingly. However, the total amount of enclosed or open space available outside the terminal that can be used for the building of maintenance facilities, hotels, offices, or warehouses is limited. To control economic development of Schiphol's surrounding areas, the Dutch government applies planning and zoning regulations on what can be built and on the uses to which the land may be put. This spatial policy is a combination of national government directives and specific policies of regional and local governments. The national government directives say that only airport-dependent (or airport-related) activities are permitted [Bouwens and Dierikx, 1997, p. 379] [Bureau PAU, 2000, p. 50]. The aim of the spatial policies of regional and local governments is to create a favorable economic environment and to strengthen Schiphol's market position through accommodating the growing demand for business parks in the

Schiphol area with as little negative impact as possible on the land use and airport accessibility [Provinciale Staten van Noord-Holland, 1986, section 2].

To control economic development of the Schiphol area, regional governmental authorities, local governmental authorities, and Schiphol founded the Schiphol Area Development Company or SADC in 1987. SADC performs four main tasks: (1) development of business parks in the Schiphol area, (2) to check that locations on those business parks are only allocated to Schiphol-dependent firms or in other words, keeping out non-Schiphol-dependent firms, (3) provide connecting roads from the SADC business parks to the highways and to Schiphol, (4) marketing and sales. In SADC, regional governments, local governments, and airport Schiphol work together and attempt to manage and control the clustering of firms around the airport through their responsibility for physical planning, including zoning and company location policy. In this thesis we focus on the SADC business parks. These business parks are situated in Schiphol's surrounding areas.

Uncontrolled economic development of Schiphol's surrounding areas can result in the allocation of scarce land just outside the airport to non-airport-dependent firms. As a consequence, later arriving airport-dependent firms might be confronted with completely occupied business parks forcing them to decide for a location near another but smaller Dutch airport, a non-airport location in The Netherlands, or a location near a major European airport in another country. Moreover, uncontrolled economic development can easily result in: overcrowded business parks; rising land costs; congested routes from the business parks to connecting roads and to the airport; and worsening airport accessibility.

Uncontrolled location allocation of warehouses:
From the literature however, we obtain the perspective that the location allocation of distribution centers around Schiphol is not in control. Buck Consultants International and Kuipers [BCI and NEI, 1997, p. 82] [Kuipers, 1999(a), p. 40] report that European Distribution Centers (EDCs) which rely heavily on road transport often are situated nearby airport Schiphol. While, near the airport we would expect to find EDCs relying heavily on air transport. Moreover, economists [Kramer and Zonnenberg, 1998] argue that for most of the firms that are settled near Schiphol an airport location is not a necessity. And Kuipers [1999(b)] points out that in general EDCs are non-Schiphol-dependent. Yet, the assumption that a significant amount of EDCs near Schiphol is non-Schiphol-dependent has never really been investigated in depth.

European Distribution Centers (EDCs):
In this thesis we focus on EDCs. Many international logistics companies have organized their European distribution network according to the concept of central European distribution. Within this concept, EDCs fulfill a main role. In an EDC, goods from mainly overseas production locations such as Japan or the USA are stored before being distributed throughout Europe, the Middle-East and Africa (EMEA-countries). In most cases, delivery lead times from the EDC to a customer somewhere in Europe range from 24 to 72 hours.

The Netherlands is an attractive location for EDCs. The well known slogan "The Netherlands, gateway for Europe", promotes The Netherlands as an optimal location for EDCs. In 1997,

approximately 550 EDCs -that is more than 50% of all EDCs in Europe- were located in The Netherlands [BCI, 1997, p. 39-54]. Research shows that the number of 550 rose to 650 EDCs in 2001 [NDL and BCI, 2001, p. 11-14]. Approximately 20% of the EDCs in The Netherlands, are located in the wider Schiphol region [NDL and BCI, 2001, p. 14].

Advantages and disadvantages of EDCs:
Attracting EDCs means attracting all kinds of international goods flows. On the one hand, attracting EDCs can bring investments and employment. On the other hand, EDCs are space demanding and rely heavily on road transport. To grasp the economic importance of EDCs we can look at jobs and income The Netherlands enjoys as the result of EDC activities. In 2002, the EDC sector contributed about 95,000 jobs (full time equivalents) and 1% of the gross national product (GNP) to the Dutch economy [Ernst & Young ILAS et al., 2002, p. 24-27]. The generated employment can be divided into 60,000 jobs required to maintain the EDC function and 35,000 jobs generated by the subsequent EDC-related activities. However, most of the jobs in EDCs relate to simple production work and do not require higher education [Ligt de, 1998, p. 109] [Ernst & Young ILAS et al., 2002, p. 47-48].

To grasp the disadvantages we look at the land use of EDCs expressed in square meters and at the transport modes used by EDCs. First, the land use. Recall that in the Schiphol area the amount of open space available outside the airport is limited. EDC activities are space demanding. They require on average 370 m^2 per employee whereas other economic activities require between 174- 267 m^2 per employee [Ernst & Young ILAS et al., 2002, p. 38]. The average size of EDCs differs per region. EDCs located close to seaport Rotterdam or Amsterdam Airport Schiphol have on average 13,000 m^2 , while EDCs located close to the German or Belgium border take up on average 40,000 m^2 [Ernst & Young ILAS et al., 2002, p. 38]. Second, the transport modes. In general, EDCs rely heavily on road transport [Ernst & Young ILAS et al., 2002, p. 43-44]. As a consequence, allocating land on a business park in the Schiphol area to an EDC contributes to congesting routes from that business park to connecting roads and to the airport.

It is unknown whether a bad location policy has long-lasting bad effects
An important question is how EDCs, once settled in the Schiphol area, will react to declining location conditions. We distinguish two types of declining location conditions. First, worsening conditions that mainly can be attributed to the growing EDC cluster around Schiphol. Examples are: rising land costs resulting in higher costs for renting or leasing warehouse space; congested routes from the business parks to connecting roads and to the airport; and growing demand for logistics staff resulting in higher recruitment costs. Second, worsening location conditions that only for a minor part can be attributed to the growing EDC cluster around Schiphol. Examples are: increasing road congestion in the wider Schiphol region; and increasing congestion at airport Schiphol (congested runways, congested terminals, and congestion in the air).

Effect of declining location conditions:
It is stated that EDC activities are becoming increasingly footloose and will easily relocate when location conditions are declining [Ernst & Young ILAS et al., 2002, p. 21]. In contrast, economic theory mentions the inertial effect of a firm's spatial structure what makes that firm

locations are not lightly abandoned [Pellenbarg, 1985, p. 94-96] [Dicken and Lloyd, 1990, p. 322] [Ligt de, 1998, p. 129-130] [Wintjes, 2001, p. 34-47].

Logistics adjustment possibilities:
Dicken and Lloyd [1990, p. 317] distinguish two broad types of adjustment possibilities available to firms in response to changes in their environment. First, in-situ changes. They represent making substantial on-site adjustments without changing the existing spatial network of the organization. Examples are: time shift to off-peak transportation; raise or lower the level of safety stock; or to make a modal shift for freight. Second, a location shift. This represents an increase or decrease in the number and location of units operated by the firm. Examples are: investment at a new location; disinvestments at an existing plant, closure or disposal; and relocation of the entire plant and equipment. In this thesis we look at all spatial-organizational changes, but we focus on the following two logistics adjustment possibilities of EDCs:

- making a modal shift for freight;
- moving the EDC facility away from the Schiphol area.

To and from the warehouses in the Schiphol area, freight can be transported by the following transport modes: airplane, truck, and train. In 2000, the year we collected our empirical data, options for freight transport by rail as well as options for a modal shift to rail were still in their infancy. Therefore, we focused on two modal shift options, namely: (1) shift from air to road, and (2) shift from road to air. We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking.

Locked-in logistics:
EDCs that are settled in the Schiphol area are confronted with increasing airport and road congestion. At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in: congestion of airspace and air traffic control delays; inadequate runway capacity; and congested terminals for passengers and freight. Furthermore, accessing Schiphol airport is becoming increasingly difficult as surface traffic congestion grows. In the wider Schiphol region, the road network suffers from heavy congestion. Transport speeds have fallen on the transport links with the airport as well as other national and international cities. Congestion is an important pressure to change, however, EDCs that are settled in the Schiphol area can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make pressures to change –such as declining location conditions or policy interventions- ineffective when it comes to modal shift or relocation.

From the viewpoint of the company location policy for the Schiphol area as developed by the Dutch government it is highly undesirable when non-Schiphol-dependent EDCs become locked into their Schiphol location. Moreover, a strategy that such EDCs –relying heavily on road transport- then may apply to cope with the fallen transport speeds as a result of

worsening road congestion in the wider Schiphol region, is to shift a part of their goods flows from road to air. In case the goods flows of non-Schiphol-dependent EDCs can be characterized as low value-weight and non-perishable we can say that this modal shift results in transporting traditional sea freight by air. An empirical illustration of locked-in logistics and its consequences is given in appendix 1.1. To gain insight in locked-in logistics and its threshold values, we focused on increasing airport and road congestion as a pressure to change.

1.3 Focal theory

Schiphol represents an important concentration of EDCs. Many studies have been carried out in order to address the location factors that attract EDCs into The Netherlands [BCI, 1997, p. 74] [BCI, 1998, p. 25-29] [Ligt de, 1998, p. 35-37, p. 137-142]. However, the explanation of why EDCs cluster around airport Schiphol seems to remain an unsettled question. The traditional answer is that EDCs are attracted to the airport due to the importance of having air transport services at their disposal. In other words, that they are attracted due to the specific airport endowments of Schiphol. However, this is only a partial answer. Economic theory shows that the other part of the answer is made up of so called economies of agglomeration.

New Economic Geography:
In recent years, economists have become increasingly interested in economies of agglomeration. By clustering in close spatial proximity to other activities, firms can benefit from a particular kind of economy of scale that is called economies of agglomeration. Three well known economies of agglomeration are: a large local market supporting efficient-scale suppliers of intermediate inputs; advantages of a thick labor market; the information exchange that takes place when firms in the same industry cluster together [Krugman, 1999, p. 50]. Economies of agglomeration are crucial in the formation of concentrations of economic activities. Economists [Fujita et al., 2000, p. 4] point out that industry clusters form and survive because of some form of economies of agglomeration in which spatial concentration itself creates the favorable economic environment that supports further concentration. This process can be self-sustaining and may accelerate. Airport development may act to set in progress such perpetuity effects [Kramer, 1990, p. 16] [Button and Stough, 2000, p. 239-240].

The analysis of economies of agglomeration is generally regarded as one of the most unsatisfactory aspects of traditional location theory [Chapman and Walker, 1991, p. 26-27]. Analyzing the role of economies of agglomeration has always posed difficulties for economic theorists and was an exception in economic theorizing [Krugman, 1999] [Fujita et al., 2000, p. 3] [Brakman et al., 2001, p. 56]. This statement no longer holds. Since the 1990s, with the rise of New Economic Geography, economies of agglomeration have become more a rule than an exception in modeling the clustering of economic activity.

A new model of the clustering of EDCs around airport Schiphol:
In this thesis we apply the theoretical framework of New Economic Geography. We develop a new model of spatial economic development of the Schiphol area in which the following location forces interplay in the making of the EDC cluster:

- location endowments;
- agglomeration economies;
- locked-in logistics.

Location endowments stress the location benefits of the Schiphol area due to differences in physical geography. For the Schiphol area –or an airport region in general- we introduce two types of location endowments. First, specific airport endowments. That are air transport services for passengers and freight. Examples are: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and landing fees; air fares; waiting time spent in terminals; and time and costs of getting to and from the airport. Second, non-airport endowments. Examples are: availability of fertile land; availability of natural resources; climate; access to the sea; labor costs; land prices; and transportation costs. Agglomeration economies stress the location benefits of the Schiphol area due to its concentrations of economic activity. There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. Location endowments and agglomeration economies attract EDCs into the Schiphol area, whereas locked-in logistics refers to the inertia of EDCs when they are settled in the Schiphol area.

To understand the clustering of EDCs near Schiphol, it is essential to know whether they are attracted due to the air transport services or due to economies of agglomeration. We therefore disentangle the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that region. The main message of our study is that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. We use our model to discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. These new steering options utilize the phenomenon of locked-in logistics.

1.4 Research goal and research questions

Research goal
The objectives of this thesis are: (1) to analyze and explain the clustering of EDCs around Amsterdam Airport Schiphol, (2) to examine the need and abilities of these EDCs to compensate for congestion impacts on their business operations, (3) to find additional options for governmental steering that can help to control the location allocation of EDCs in the Schiphol area.

Research question 1
What are the determinants and mechanisms that explain the clustering of EDCs in the SADC area?

Research question 2
What is the effect of increasing congestion on the EDC cluster in the SADC area in terms of firm relocation?

For those EDCs in the SADC area which do not relocate; What is the effect of increasing congestion on the composition and relative importance of the transport modes used?

Research question 3
Can we find additional options for governmental steering that can help to control the location allocation of EDCs in the Schiphol area?

1.5 Outline of the thesis

First, in chapter 2, we present and thoroughly study EDCs and their role in international supply chains. As a first step towards analyzing and explaining the clustering of EDCs near Schiphol, we searched the literature for reasons why EDCs are attracted into the Schiphol area and reasons why they are driven away. Furthermore, we construct a definition of "Schiphol-dependent EDCs". Then, chapter 3 addresses how regional governments, local governments and airport Schiphol work together in SADC and attempt to manage and control the allocation of scarce land -in the surrounding areas of Schiphol- to EDCs. We describe the goals and instruments of the EDC location policy from the start of SADC in 1987 until 2000.

The theoretical framework of this study is described in chapter 4 and 5. In chapter 4 the major approaches in Economic Geography are addressed. New Economic Geography and the crucial role of economies of agglomeration in the clustering of economic activity is discussed in greater detail in chapter 5. In that chapter we also present our new model of the clustering of EDCs near airport Schiphol. From the model we deduced generalizing statements in the form of testable hypotheses.

In order to assess the empirical relevance and explanatory power of our model we performed empirical research. The methods of data collection we applied are presented in chapter 6. We conducted a cross-sectional survey and collected data at the year 2000 over two populations:

- national-EDC-population;
- Schiphol-EDC-population.

The Schiphol-EDC-population is the warehouse cluster at the business parks of SADC. These business parks are situated in Schiphol's surrounding areas. The national-EDC-population consists of the warehouses that are located elsewhere in The Netherlands. The populations

have been compared and tested for similarities and differences. Survey results are presented in chapter 7 and 8. There we also discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. Finally, in chapter 9, we present conclusions, point out the limitations in our material and give suggestions on what new work is now appropriate.

2. The European Distribution Centers

2.1 Introduction

This thesis deals with the explanation of why EDCs cluster around airport Schiphol. The Netherlands is an attractive location for EDCs. Approximately half of all EDCs in Europe are located in The Netherlands [BCI, 1997, p. 39-54] [NDL and BCI, 2001, p. 11-14]. In 2002, the EDC sector contributed about 95,000 jobs (full time equivalents) and 1% of the gross national product (GNP) to the Dutch economy [Ernst & Young ILAS et al., 2002, p. 24-27]. Schiphol represents an important concentration of EDCs.

As a first step towards the explanation of why EDCs cluster around Schiphol, this chapter gives a review of the research and theory relating to the rise of EDCs, EDC location factors, and the in- and outbound logistics of EDCs. First we sketch the wider EDC context of logistics supply chains. Then we focus on the heart of European supply chains and address the EDC system of international distribution. Subsequently we present the reasons, as found in the literature, about why EDCs decide to establish themselves near Schiphol and why EDCs are driven away from the airport region. Finally, we construct a definition of Schiphol-dependent EDCs. This definition is linked to the use of air cargo for the in- and outbound EDC shipments.

2.2 Sketching the wider EDC context

Researchers [e.g. La Londe and Masters, 1994; Skjoett-Larsen, 2000; Goor van et al., 2003] identified and described the most important logistics strategies which have emerged in European and international logistics over the last decade and which will remain dominant well into the twenty–first century. In this section we outline the wider context of EDCs by examining these trends, including: Supply Chain Management; cycle time compression; Value Added Logistics; globalization; central European distribution; strategic partnerships and outsourcing; e-business; virtual logistics; and green logistics.

Supply Chain Management
Companies are usually part of a pipeline or supply chain that brings a product to the ultimate user. In its simplest context, the supply chain involves a company's vendors and direct customers. These parties are, in a sense, partners in bringing a product to the market. According to the logistics literature [Coyle et al., 1996] [Stock and Lambert, 2001] [Simchi-Levi et al., 2003] [Goor van et al., 2003] the underlying concepts for supply chain management are not new. They have evolved through several stages. During the 1960s and 1970s, many companies focussed attention upon physical distribution systems (or outbound logistics). They attempt to manage a set of interrelated activities such as: transportation; distribution; warehousing; finished goods; inventory levels; packaging; and materials handling. During the 1970s and 1980s, companies increasingly began to recognize the additional opportunities for savings by combining materials management (or inbound logistics) with physical distribution. Materials management encloses activities such as: demand forecasting; purchasing; production planning; and manufacturing inventories. The combining of the inbound side with the outbound side is described as business logistics (or the logistics system).

During the 1980s and 1990s, companies expanded their perspective on logistics processes to include all the firms and processes involved in ensuring that the final customer received: the right product, at the right costs, at the right time, in the right condition, and in the right quantity. This meant, including the vendors and channels of distribution. As this concept developed, it was referred to as the logistics pipeline or supply chain. Companies can be part of several supply chains. For example, a manufacturer of steel can be part of the supply chain for cars and bicycles. In a global sense, supply chains, instead of individual companies, compete with each other to deliver the best product at the best costs for the final consumer.

Cycle time compression
La Londe and Masters [1994] note that supply chain management and cycle time compression are two fundamental and closely related logistics strategies. Cycle time compression involves managing the flow of materials to minimize the time needed to respond to customer demands. Companies have long recognized that time is a strategic variable that affects competitive success in the marketplace [Muilerman, 2001]. Compression of logistics operations and time relates to more frequent shipments, faster inventory turnover rates, and smaller order sizes. Thus, a reduction in lead time in responding to customer orders can reduce inventories, storage costs and help to add value and customer service in the supply chain. Supply chain

management plays an important role in the ability to meet the needs of quick-response and Just-in-Time (JiT) strategies [Coyle et al., 1996, p. 19] [Simchi-Levi et al., 2003] [Goor van et al., 2003].

Value Added Logistics

Value Added Logistics is related to manufacturing and logistics systems that can respond quickly after an order is placed. These systems are referred to as mass-customization as opposed to the traditional systems where products are produced in advance of demand and stored in warehouses near the final customers [Hoek van, 1998]. Mass-customization means to deliver customized rather than mass-produced products. It is not a matter of infinite choices but about offering a number of standard parts that can be mixed and matched in many ways. To reduce both, inventory levels and delivery lead times, mass-customization demands that suppliers carry out final configuration as late as possible in the supply chain. Ballou [1992, p. 45-47] distinguishes four types of late configuration: labeling; packing; assembly; and manufacturing. A more extensive discussion of each type of late configuration is available in Van Hoek [1998]. Late configuration is performed in the distribution channel and is referred to as Value Added Logistics or VAL.

Globalization

An ever growing number of organizations adopt a global view of business, customers and competition. The companies may be headquartered in Europe, Asia, or North America but their markets are international. They have a significant and growing presence in resource and/ or demand markets outside their country of origin. Following an international distribution strategy results in a growing international dimension of the supply chain. Successful completion of the various logistics activities in international supply chains allows companies to held and expand overseas markets, despite of intense competition, due to reduced delivery costs and high levels of logistics services.

Central European distribution

The trend towards central European distribution started in the 1970s. The driving forces underlying this trend, as can be found in the literature [Skjoett-Larsen, 2000] [Goor van et al., 2003], are: removal of trade and transportation barriers between European Union (EU) countries; opening of new markets in Eastern Europe; acceptance of a single European currency; development of information technology and fast communication systems; and the emergence of pan-European Logistics Service Providers. Before the 1970s, companies operating in the European Union, usually needed to have plants and warehouses in each of the countries in which they wished to market their goods. Using a central European warehouse, instead of a series of national and regional warehouses, means shifting the main inventory location away from the final customer backwards into the distribution channel. Buck Consultants International [BCI, 1997, p. 34-35] found that the main reasons why companies switch to central European distribution are to lower total logistics costs and to improve inventory control. These are essentially the same arguments as mentioned by Van Goor et al. [2003, p. 19].

Strategic partnerships and outsourcing

Logistics theory [e.g. Coyle et al., 1996; Stock and Lambert, 2001; Simchi-Levi et al., 2003; Goor van et al., 2003] stresses the inter company nature of the supply chain. Successful supply chain management is based upon the coordination of the product-, information-, and cash flows among the network of companies. Strategic partnerships and alliances between manufacturing companies, suppliers, customers and Logistics Service Providers (or LSPs) play a vital role in providing the desired level of joint coordination.

With the emphasis on supply chain management, the use of third party logistics service providers (3PLs) is growing rapidly. Transportation, warehousing and other logistics activities have been outsourced to third parties for many years. Nearly every global organization uses the logistics services of an international freight forwarder (often called freight integrator). Forwarders can handle the movement of goods from the site of production to the customers location. They have an intimate knowledge of the transportation alternatives and can handle documentation responsibilities. Van Laarhoven et al. [2000] show that the most important reasons for shippers to outsource logistics activities to a logistics service provider are: reducing costs; reducing the amount of capital invested; service or quality improvement; the need for strategic flexibility; and a focus on core competencies. The first reason, cost reduction, is by far the most important one. Van Donselaar and Sharman [1997] note that shippers do not usually outsource their entire package of logistics activities.

One of the basic assumptions underlying the outsourcing of logistics operations is that a logistics service provider offers economies of scale[1]. Since the second half of the 1990s, third party logistics service providers tend to centralize their operations to benefit even more from economies of scale [MVA, 2000, p. 37]. In this process, the number of warehouse sites is reduced, while their size gets larger. The centralization is not only pursued within a single logistics service provider, but also through a consolidation of the entire sector.

E-business and virtual logistics

In general, information technology is an important factor for connectivity and transparency across all interfaces of the supply chain. This runs all the way from the use of barcodes, tracking and tracing systems, Warehouse Management Systems (WMS), the use of internet for selling (Electronic commerce or E-commerce), to Electronic Data Interchange (EDI) with suppliers. Faced with time-based competition, logistics firms are increasingly using information technology as a source of competitive advantage in an effort to reduce order cycle times, speed up responsiveness, and lower supply chain inventory [see Stock and Lambert, 2001; Simchi-Levi et al., 2003; Goor van et al., 2003]. In this connection Crowley [1998] indicates that it has become feasible for information to substitute physical inventory and that this substitution seems likely to continue. Traditionally, inventory was used to buffer against incompatibilities of adjacent links in the supply chain and against operational uncertainties. Information technology provides the opportunity to coordinate activities along the whole supply chain, and therefore to reduce uncertainty and the need for buffering between production stages.

[1] Economies of scale is the decline in unit costs which arise from savings to be made within the logistics operations of the service provider from purchasing, transportation and manufacturing at larger volumes.

In the era of E-business, the hollow and virtual corporations are a possible scenario for logistics companies [Stock and Lambert, 2001, p. 587]. In an electronic business environment, many activities traditionally performed in-house can be outsourced easily. This is the concept of the "virtual organization" in which a group of companies come together to develop, produce, sell and distribute a product or a service. They establish a very close working relationship which exists only for as long as the product or service is viable. Clarke [1998] notes that within virtual logistics operations, the ownership and control of resources is effected through internet applications rather than direct physical control. This makes that resources may be owned and utilized remotely. An example of a concept from a virtual logistics system is a virtual warehouse where the physical locations of the stock items held are scattered across the continent while the information about the stock is accessed from one central location.

Green logistics
Skjoett-Larsen [2000] points out that in the years ahead, environmental protection will increasingly come into focus and that "greening" will become an important parameter in supply chain management. In this connection he refers to the following logistics issues: a growing number of companies start to carry out life cycle analyses of their products and processes in order to reduce environmental impact on the total supply chain; a growing number of companies requires that their suppliers are certified based on environmental standards; the packaging area is faced with stricter requirements for reduction and recycling; due to the emphasis on recycling and re-using, an increasing importance of reverse goods flows or reverse logistics can be seen; because of the growing focus on traffic congestion on the highways, the transport area will be faced with changes and restrictions such as kilometer charges or time window restrictions.

2.3 The EDC system of international distribution

Multi-country system of international physical distribution
McKinnon [1989, p. 218-220] describes four systems of international physical distribution which are largely determined by the spatial organization of the stockholding functions. These are presented in figure 2.1 and discussed in greater detail below.

Direct system:
Stocks are centralized in the home country and deliveries are made directly to foreign agencies and final customers. Its main advantages are that it obviates the need for foreign warehousing and permits greater centralization of inventory. Supplying goods directly from the factory however, results in long lead times.

Transit system:
Exports are channeled through a non-stockholding, break-bulk point in a foreign market. Freight can then be transported more economically in greater bulk to the foreign market and disaggregated into individual orders much closer to the foreign customer.

Classical system:
Stocks are dispersed to national and regional warehouses in the foreign countries. Its main benefits are: orders can be delivered more rapidly from the foreign warehouses than the factory; the presence of readily available stocks in the foreign market can be reassuring for distributors and customers; and freight can be transported to the foreign market with less urgency, permitting the use of cheaper transport modes and offering greater scope for load consolidation. The classical system's main shortcoming is the expense of acquiring or renting storage space abroad and maintaining the higher level of stock required by a decentralized system.

Multi-country system:
Here, a single foreign warehouse supplies customers in several countries. By centralizing the foreign stockholding operation in fewer locations, exporters can reduce inventory costs and partially overcome the weakness of the classical system. This is achieved however at the expense of significantly increasing transport costs outward from the foreign warehouse. Furthermore, long transit times to peripheral parts of the international hinterland may jeopardize sales.

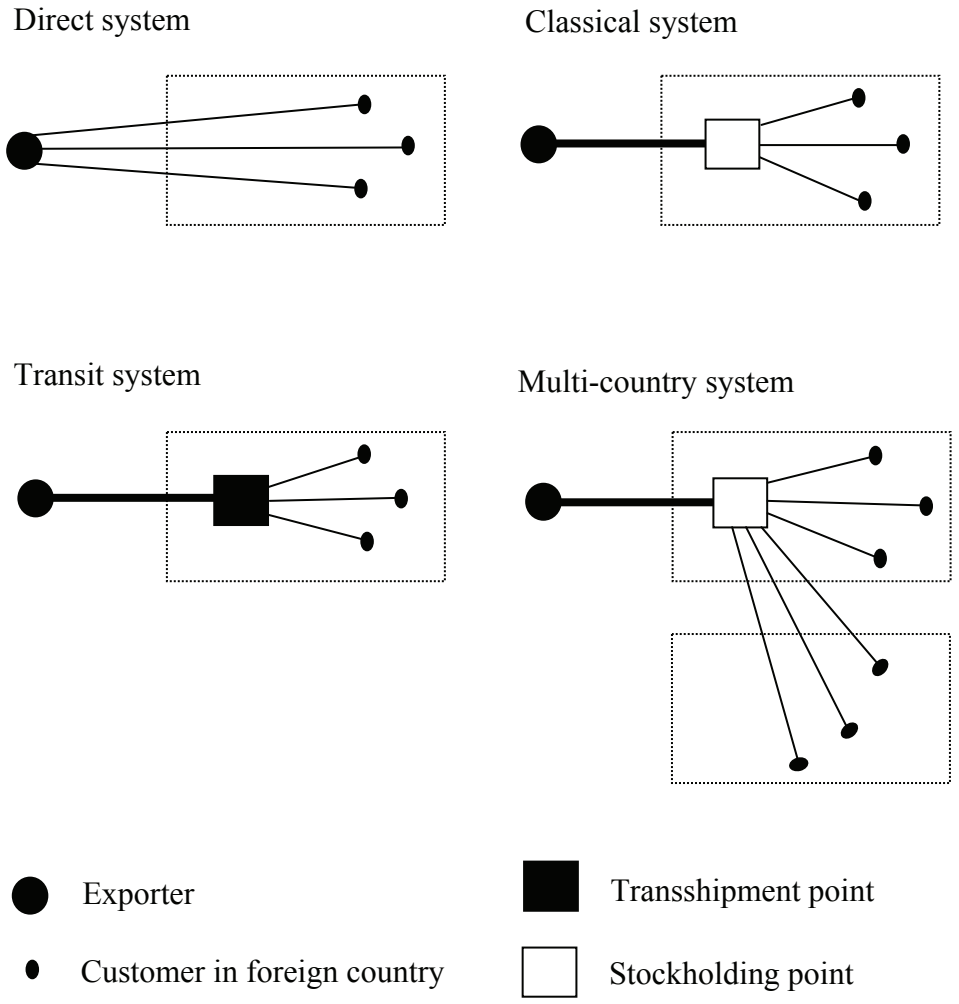

Figure 2.1: Systems of international physical distribution
Source: McKinnon, 1989, p. 218

It can be seen that the multi-country system is related to the concept of central European distribution [see also Ligt de, 1998, p. 33-34]. Following Holland International Distribution Council (or HIDC) [see BCI, 1997, p. 25], we define an EDC as follows:

> *A European Distribution Center (EDC) is: (1) a central European warehouse, or part of a central European warehouse, where goods are stored, (2) the point of origin of more than 50% of the inbound goods flows (by weight or units) is made up of production plants located in a different country than the warehouse, and (3) from the warehouse goods are distributed to customers in at least five different European countries*.

Stockholding point

EDCs are main stockholding points of European supply chains. Logistics theory [Stock and Lambert, 2001, p. 391] provides us with the following general reasons why the warehousing of inventories can be necessary: to achieve transportation economies; to achieve production economies; to take advantages of quantity purchase discounts and forward buys; to maintain a source of supply; to support the firm's customers service policies; to meet changing market conditions such as seasonality and demand fluctuations; to overcome time and space differentials that exist between producers and consumers; and to support Just-in-Time programs of suppliers and customers.

As a stockholding point, an EDC can be used to: mix products from multiple production facilities for shipment to a single customer; to break bulk or subdivide a large shipment of product into many smaller shipments to different customers; and to combine or consolidate smaller shipments of products into a higher volume shipment [Stock and Lambert, 2001, p. 391-394]. It can be seen that within EDCs a wide variety of warehousing tasks is performed, including: receiving and putting away; storage and inventory tracking; order picking; cross docking; processing return goods flows; value added logistics; and loading.

Private versus public warehousing

When a firm decides to store product in the field, it must choose whether to rent space, called public warehousing or to own or lease space, called private warehousing. Public warehousing is a form of outsourcing logistics operations to a third party logistics service provider. An other option is dedicated warehousing, a variation of public warehousing. Dedicated warehousing is a partnership arrangement between the user and provider of the warehousing service which provides unique and specially tailored warehousing and logistics services exclusively to one user. This warehouse classification is shown in figure 2.2.

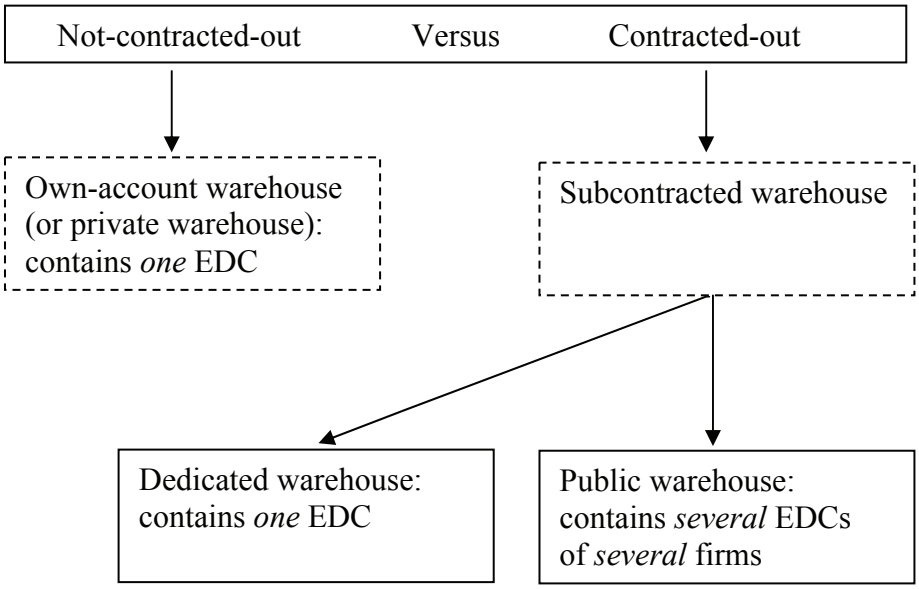

Figure 2.2: Classification of European Distribution Centers
Source: BCI, 1997, p. 32

Research shows that at the end of the 1990s, approximately 75% of the EDCs in The Netherlands were contracted out and that the use of public warehousing is still increasing [NDL and BCI, 2001, p. 11-14, p. 43-44] [Ernst & Young ILAS et al., 2002, p. 14]. From logistical theory [Stock and Lambert, 2001, p. 401-405] we obtain the following advantages that may be realized if a firm uses public warehousing rather than private warehousing: avoiding the investments in buildings, land and materials handling equipment, hiring and training personnel, as well as costs associated with starting up the operation; ability to increase warehouse space to cover peak requirements; economies of scale due to the fact that public warehouses handle the storage requirements of a number of firms at the same time; and flexibility if business conditions necessitate to change field warehouse locations.

The main advantage of private warehousing is that the firm exercises a greater degree of control over storage, handling, and management [Stock and Lambert, 2001, p. 404-405]. This allows the firm to integrate the warehousing function more easily in the companies total logistics system. The warehouse can be designed and operated to fit the specific needs of customers and the characteristics of the product.

Complementary logistics tactics
EDCs form the heart of European supply chains of international manufacturers. EDCs not only have a stock keeping responsibility, but also a prime responsibility for organizing the physical distribution into Europe, the Middle-East and Africa (EMEA-countries). Switching to central European distribution from holding inventories at national and regional warehouses can reduce inventory costs on the one hand but can increase delivery lead times from the warehouse to the customer on the other hand. However, by using central European

distribution combined with logistics tactics reducing order cycle time, logistics managers can significantly reduce inventories and improve customer service. Examples of such complementary logistics tactics are value added logistics and ICT developments creating new opportunities to optimize product flows and to streamline supply chain processes. Furthermore, the literature [McKinnon, 1989, p. 218-220] [HIDC, 2000, p. 9, p. 35-46] [NDL and BCI, 2001, p. 30-35] points at the following systems of physical distribution that increasingly are used alongside centralized European distribution: direct deliveries from manufacturer to consumer; regional distribution; and cross-docking.

We discuss cross-docking in greater detail. Cross-docking is a technique that eliminates the storage and order picking function of a warehouse. The idea is to transfer shipments directly from incoming to outgoing trailers without storage in between. Arriving shipments are immediately broken down and mixed in proper range and quantity for customer shipment. Technically, the product never enters the warehouse. For EDCs it has become very commonplace to cross-dock a part of the daily throughput [NDL and BCI, 2001, p. 30-35]. In most cases however, cross-docking on a large scale is quite difficult to arrange because of the high degree of coordination required [La Londe and Masters, 1994]. Examples of this required coordination are: the destination of the inventory must be known when it is received; the customers must be ready to receive the inventory immediately; and a stable and high demand of individual items [see also Stock and Lambert, 2001, p. 398-399]. A pure cross-docking operation avoids put-away, storage and order picking. In essence, a pure cross-docking operation means that the warehouse becomes a distribution mixing center without storage function. We stress that in this thesis, pure cross-docking operations are not counted as EDCs (see also our EDC definition).

2.4 Earlier research about EDC location factors

Attractiveness of The Netherlands

Within Europe, The Netherlands has a dominant market share of EDCs. Buck Consultants International [BCI, 1997, p. 39-54] shows that in 1997 nearly 550 EDCs –that is more than 50% of all EDCs in Europe- were located in The Netherlands. Research [NDL and BCI, 2001, p. 11-14] indicates that this number of 550 rose to 650 EDCs in 2001[2].

Many studies have been carried out in order to address the location factors that attract EDCs into The Netherlands instead of other European countries [BCI, 1997, p. 74] [BCI, 1998, p. 25-29] [Ligt de, 1998, p. 35-37, p. 137-142]. The most important location factors presented in these studies are: (a) transport infrastructure such as: seaport Rotterdam, Amsterdam Airport Schiphol (both are major European ports), and transport links with other cities and internationally; (b) due to its intermediate position between important European market areas, The Netherlands offers EDC locations which minimizes transportation costs; (c) access to

[2] In this study, EDCs are called European Logistics service Centers (ELCs) [NDL and BCI, 2001, p. 7] [see also Ernst & Young ILAS et al., 2002, p. 13-14], and pure cross-docking operations are counted amongst ELCs. Approximately 20% of the own-account ELCs and 15% of the subcontracted ELCs are pure cross-docking operations [NDL and BCI, 2001, p. 31]. To find the number of 650 EDCs in 2001, we subtracted the pure cross-docking operations from the population of ELCs.

logistics services and logistics know-how; (d) climate government creates for business through customs and tax policies; (e) languages spoken; (f) quality, quantity and costs of available labor.

Most EDCs in The Netherlands are North-American- or Japan based. Other important continents of origin of "parent companies" are: Taiwan; Korea; and Europe [NDL and BCI, 2001, p. 14-15]. The EDCs in The Netherlands cover the following industry sectors: high tech and electronics; life sciences (pharmaceuticals, biotech); automotive; consumer products (non-food); fashion and clothing; chemicals; and machinery [NDL and BCI, 2001, p. 19] [Ernst & Young ILAS et al., 2002, p. 16-17].

Traditionally, the most popular European countries for establishing EDCs are: France; the United Kingdom; Belgium; Germany; and The Netherlands [BCI, 1997, p. 76-77] [BCI, 1998, p. 25] [Cap Gemini Ernst & Young, 2003, p. 13-14]. However, in 2004, after the addition of 10 Eastern European countries into the European Union, the existing balance of local, regional and long-distance transport movements has begun to change. Already since the end of the 1990s, Eastern European countries experience a growing market share of EDCs while the market share of the United Kingdom and The Netherlands is declining [Cap Gemini Ernst & Young, 2003, p. 13-14] [see also Raad voor Verkeer en Waterstaat, 2003].

Attractiveness of the port regions in The Netherlands

Approximately 50% of all EDCs in The Netherlands are located around the two major European ports, Amsterdam Airport Schiphol and seaport Rotterdam [BCI, 1997, p. 51-59] [BCI, 1998, p. 25] [NDL and BCI, 2001, p. 14] [Ernst & Young ILAS et al., 2002, p. 16]. However, since the end of the 1990s, a shift of EDC location preferences from Schiphol and Rotterdam locations to locations near the German or Belgium border can be seen [BCI, 1997, p. 94] [Ligt de, 1998, p. 148-149] [Kuipers, 1999(b)] [NDL and BCI, 2001, p. 17]. These studies show that the main reasons why EDCs are driven away from the port areas are: price/ rent of warehouse or land; road congestion; distance to suppliers and markets; and costs of available labor.

Attractiveness of the Schiphol region

The wider Schiphol region is an attractive location for EDCs. Approximately 20% of all EDCs in The Netherlands is located there [NDL and BCI, 2001, p. 14]. Research shows [Technopolis, 1999, p. 23-35] that to understand why firms are attracted into the Schiphol region, not only logistics, transport or distribution factors must be taken into account but also factors such as: image-effect of being located near a major European airport and an international city (Amsterdam); presence of similar companies; and quality of life for employees due to proximity to an international city and an international school. From these location factors we can see that geographical preferences of EDCs for the Schiphol region may be partly attributed to the presence of early locators.

A major European airport

Over the period 1970-2000, the number of passengers and freight handled by airport Schiphol has grown sevenfold (see also chapter 3, figure 3.1 and 3.2). Schiphol is the first airport in The Netherlands. In 2000, the year we collected our empirical data for this study, Schiphol

was holding a fourth place among the top ten airports in Europe measured by passenger movements as well as by freight transport [Amsterdam Airport Schiphol, 2000]. These rankings change slightly from year to year but the overall pattern remains fairly constant.

A classification of airports by traffic mix, size and economic impacts is given in Kramer [1990, p. 20] and in Banister and Berechman [2000, p. 290]. Schiphol is a major European airport. Banister and Berechman [2000, p. 290] mention the following economic impact characteristics of such airports: attracts international company Head Quarters, distribution centers, large-scale retailing centers, and long-haul tourism; exercises economic influence nationally and internationally; and extensive off-airport influence.

It can be seen that it is insufficient to view Schiphol as one or more runways for aircraft together with associated buildings or terminals where passengers or freight transported by the aircraft are processed. Kramer [1990, p. 9-21] points out that major airports are complex industrial enterprises which act as a forum in which disparate elements and activities are brought together to facilitate the interchange between air and surface transport for passengers as well as freight. Within this overall airport umbrella, firms that are located at or very close to Schiphol offer a wide range of supporting services and facilities, such as: passenger and goods transfer; air traffic control services; meteorological services; police and security; fire and ambulance services; cleaning and maintenance; aircraft parking; aircraft handling and cleaning; cargo handling; logistics services; baggage handling; car-parking services; passenger check-in; flight information; ticketing; tourist services; fashion boutiques; duty-free shops; bars and restaurants; merchandising kiosks; car-hire; congressional services; hotels; banks; customs; consulting services to other airports; establishment of business parks; and real estate development. Together, the Schiphol agglomeration provides the so called “airport product” [Kramer, 1990, p. 15]. The business parks near Schiphol as well as the firms located there are part of the Schiphol agglomeration and contribute to the airport product.

Increasing congestion at airport Schiphol

Over the period 1970-2000, European air traffic (measured in passenger kilometers) has grown sevenfold, representing an average annual growth rate of almost 7% [MVA, 2000, p. 6]. Similarly to passenger air transport, the European air cargo market is expanding rapidly [MVA, 2000, p. 35]. Major European airports have grown accordingly. There is the prospect that air traffic in Europe continues to grow with no sign of abatement. This gives an indication of the increase in air transport capacity that the aviation sector is being called upon by the market to provide each year. Doganis [1992, p. 39] points out that shortage of runway capacity is the main problem facing many major European airports. Since the second half of the 1990s, the growth of airport Schiphol is heavily constrained by noise limits and airport slot availability [Bouwens and Dierikx, 1997, p. 375-398] [CPB, 1997]. However, the pressure of growth seems irresistible. At Schiphol restrictions on the volume of aircraft movements have been modified to accommodate around 6% growth per year [MVA, 2000, p. 7]. At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in airport congestion: congestion of airspace and air traffic control delays; inadequate runway capacity; and congested terminals for passengers and freight.

Increasing road congestion in the Schiphol region
Air transport movements ultimately involve accessing and leaving the air terminal or airport. However, accessing Europe's major airports is becoming increasingly difficult as surface traffic congestion grows [Button and Stough, 2000, p. 291]. In the wider Schiphol region, the road network suffers from heavy congestion [BCI and NEI, 1997, p. 84] [BCI, 1997, p. 94] [Ligt de, 1998, p. 148-149] [Kuipers, 1999(b)]. Transport speeds have fallen as the volume of traffic has continued to grow on all roads. EDCs that are settled near Schiphol are confronted with increasing congestion on the transport links with the airport as well as other national and international cities.

Rising land costs in the Schiphol regio
Since the second half of the 1980s, demand for industry locations near Schiphol increased rapidly. However, the total amount of enclosed or open space available outside the airport that can be used for the building of maintenance facilities, hotels, offices or warehouses is limited. Studies [BCI and NEI, 1997, p. 84] [BCI, 1997, p. 94] [Ligt de, 1998, p. 148-149] [Kuipers, 1999(b)] show that the wider Schiphol region is confronted with: lack of space for companies to locate; rising land costs resulting in higher costs for renting/ leasing warehouse or office space; and a growing demand for labor resulting in higher recruitment costs.

2.5 Schiphol-dependent EDCs and the role of air cargo

Transportation modes used for carrying air cargo
The definition of air cargo (or air freight) is given by the existence of an "air waybill". The air waybill serves as a contract of carriage between shipper and carrier. The air cargo market comprises four distinct segments [MVA, 2000, p. 35] [Button and Stough, 2000, p. 6-7], namely: (1) airfreight, which is generally containerized and is carried on passenger aircraft and freight aircraft (full freighters) operated by commercial airlines; (2) air express, which are small packages shipped by air express companies (for instance DHL, UPS, or FedEx) and which can be carried on own aircraft, chartered freighters, or commercial airlines; (3) niche operators, operating or leveraging specialized equipment and expertise in order to fill extraordinary requirements; (4) mail. The European air cargo market is expanding rapidly. This growth has been driven by decreasing air transport costs due to efficiency gains and more competition among air carriers and is accompanied by the growing internationalization of business [MVA, 2000, p. 35].

All four segments of air cargo can be carried on air waybills, with a flight number, by: airplane; road (often called airport trucking or road shuttle); and train [Wit de and Van Gent, 1998, p. 351-352] [MVA, 2000, p.35, p. 38-41] [Button and Stough, 2000, p. 293]. Airport trucking is extensively used in the express operators' service chain. Customers choose for the transport mode "air" however, air freight carriers (logistics service providers) then choose whether air or other modes actually are used on the basis of costs and transit time. In general, air cargo is carried from airport-to-airport. However, the airport trucking package can include door-to-door freight service [Wit de and Van Gent, 1998, p. 352]. Research [MVA, 2000, p. ii, p. 42] indicates that within Europe much of the air freight is trucked, not flown. For the

trucked part of the European air cargo market, the MVA Group indicates [MVA, 2000, p. 42] average growth rates of 15% (by weight) per annum after 2000. De Wit and Van Gent [1998, p. 351] note that within Europe, freight transport by air is increasingly substituted by road transport due to the following reasons: bellies of passenger aircraft are not always fit for handling standard air containers; flight schedules of passenger aircraft are tuned to passenger transport and not to the service levels demanded by air freight shippers; the flexibility offered by road transport -an appropriate truck is almost always available; and trucking is not restricted by night flight noise limits. We stress that in 2000, the year we collected our empirical data, options for freight transport by rail to and from the warehouses in the Schiphol area were still in their infancy.

Volumes shipped by airplane

Air cargo operations are a low volume and high revenue yield part of the freight transport market. Air cargo operations carry less than 1% of the freight ton-miles but represent approximately 40% of the value of the world's trade in manufactured goods [MVA, 2000, p. 35] [Herman and Van de Voorde, 2006]. It can be seen that freight flows through Schiphol can be measured by volume (weight or units) and by monetary value.

Switching to central European distribution from holding inventories at national and regional warehouses can result in an increase in delivery lead times from the warehouse to the customer. The use of air services can thereby help logistics managers to reconcile the conflicting objectives of centralizing stocks in the EDC and minimizing the risk of stock-outs in the international market areas. In general, higher transportation costs can easily be justified where the consequences of such contingencies are the disruption of foreign production for want of a spare or the erosion of customer loyalty. In this connection, we would expect that EDCs which established themselves very close to Schiphol receive and ship a significant part of their freight volumes via Schiphol by airplane. However, research indicates [BCI and NEI, 1997, p. 82] [Kuipers, 1999(a), p. 40] that EDCs which rely heavily on road transport often are situated nearby airport Schiphol. Moreover, economists [Kramer and Zonnenberg, 1998] argue that for most of the firms that are settled near Schiphol an airport location is not a necessity. And Kuipers [Kuipers, 1999(b)] points out that in general EDCs are non-Schiphol-dependent. Yet, the assumption that a significant amount of EDCs near Schiphol is non-Schiphol-dependent has never really been investigated in depth. This assumption will be addressed in this study. We define a Schiphol-dependent EDC as follows:

> *A Schiphol-dependent EDC is an EDC that meets the following criteria: (1) a significant part of the inbound goods flows (by weight or units) is received via Schiphol by airplane or, (2) a significant part of the outbound goods flows (by weight or units) is shipped via Schiphol by airplane*[3].

Characteristics of products shipped by air

From the logistics literature [Dicken and Lloyd, 1990, p. 121-132] [Ballou, 1992, p. 163-166] [Coyle et al., 1996, p. 323-335] [Stock and Lambert, 2001, p. 325-326] we obtain the

[3] What we mean by "significant" will be defined in chaper 7.

perspective that the product characteristics of the freight hauled, strongly determine the modes of transportation used (train, ship, truck, airplane, or pipeline). Following Grübler [Grübler, 1990, p. 167] [see also BCI and NEI, 1997, p. 80; Button and Stough, 2000, p. 267; and Stock and Lambert, 2001, p. 326], we define the product characteristics of traditional air freight and traditional sea freight as follows:

> *Traditional air freight meets the following requirements: (1) high value-weight ratio or, (2) perishable.*
>
> *Traditional sea freight meets the following requirements: (1) low value-weight ratio and, (2) non- perishable*[4].

Products that have high value-weight ratios have high storage costs but low movement costs as a percentage of their sales price. The traditional idea is that air freight usually cannot be cost-justified for low value items because the greater cost of air freight would represent too high a percentage of product cost. However, Button and Stough [2000, p. 267-268] show that during the 1990s logistics practice departed from this traditional viewpoint. As recently as in the late 1980s, air freight goods were perishables of all kinds (e.g. seafood; fresh fruit; newspapers; high-tech products with very short life cycles), urgent items (medicines; spare parts), or highly valuable goods (gold; jewels; computers; aerospace products). In contrast, in the late 1990s, the range of air transported products has widened. At the end of the 1990s, the most important air freight commodities (by weight) were: machinery parts; electronics; high tech instruments; cut flowers; live trees/ plants; fish; crustaceans; vehicle parts; plastic; consumer durables; apparel; and footwear. Overall, air transportation of lower-value goods, as well as their share in total air transportation, has reportedly increased since the beginning of the 1990s.

Already at the end of the 1980s, this trend was predicted by Grübler [1990, p. 167]. He noted that throughout the 1990s, air transport would not be confined to traditional high value or perishable goods but would enter into markets considered as unimaginable for air transport. Grübler [1990, p. 167] points out that the main reasons for this shift are the Just-in-Time (JiT) principle and the continuing request to reduce inventories. Both increase the importance of transport speed and flexibility. The high transport costs of air cargo (as compared to sea cargo) can be largely compensated for by: lower insurance costs; reduced damage during transport; no requirements for protective coating; and a considerable reduction of inventory costs due to higher transport speeds.

In summary, the perspective that the product characteristics of the freight hauled strongly determine the transport mode used is no longer valid for air transport. Therefore we did not include characteristics of the products shipped into our definition of a Schiphol-dependent EDC.

[4] We stress that the use of refrigerated or cold storage containers makes that sea transport is an important option for shipping perishable items such as fruits and vegetables.

2.6 Conclusions

One of the most significant changes in European distribution has been the use of fewer distribution points serving larger market areas. The spread of the central European distribution model has resulted from several mutually reinforcing developments such as: the creation of a single European market and therefore the streamlining of border crossings and customs requirements; increasing number of partnerships and strategic alliances; use of outsourcing and third parties; development of pan-European transport networks; and restructuring of logistics management.

EDCs form the heart of European supply chains of international manufacturers. EDCs not only have a stock keeping responsibility, but also a prime responsibility for organizing the physical distribution into Europe, the Middle-East and Africa. The Netherlands has a dominant market share of EDCs. Approximately one-half of all EDCs in Europe are located in The Netherlands. From the literature we obtained the following reasons why EDCs are attracted into The Netherlands instead of other European countries: (a) transport infrastructure such as seaport Rotterdam and Amsterdam Airport Schiphol (both are major European ports), and transport links with other cities and internationally; (b) due to its intermediate position between European market areas The Netherlands offers EDC locations which minimizes transportation costs; (c) access to logistics services and logistics know-how; (d) climate government creates for business through customs and tax policies; (e) languages spoken; (f) quality, quantity and costs of available labor. However, since the end of the 1990s, Eastern European countries experience a growing market share of EDCs while the market share of The Netherlands is declining.

Within The Netherlands, the Schiphol region is an attractive location for EDCs. Approximately 20% of all EDCs in The Netherlands is located there. Our review of earlier research shows that remarkably little attention has been paid to the driving forces underlying the clustering of EDCs around Schiphol. From the literature we obtained a first perspective on both, the reasons why EDCs are attracted into the Schiphol area and the reasons why EDCs are driven away from that area. We have seen that to understand why firms cluster around Schiphol not only logistics, transport or distribution factors must be taken into account but also factors such as: imago-effect of being located near a major European airport and an international city (Amsterdam); presence of similar companies; and quality of life for employees due to proximity to an international city or proximity to an international school. Studies show the following factors operating in the Schiphol region opposing the clustering of EDCs around the airport: worsening road congestion; airport congestion (congested runways, congested terminals, and congestion in the air); lack of space for company locations and therefore rising land costs; and growing demand for labor resulting in higher recruitment costs. It can be seen that a growing Schiphol agglomeration can yield not only economies that promote further clustering of EDCs around the airport but also diseconomies opposing such concentration.

We constructed a definition of Schiphol-dependent EDCs. This definition comprises criteria on volumes of air cargo shipped and the transport mode used. The definition does not include

criteria on the characteristics of the products shipped by air. We have seen that, since the second half of the 1990s, the importance of transport speed -instead of product characteristics- is the most important reason underlying the use of air transport. Air cargo can be carried on air waybills by: airplane; road (airport trucking); and train. Within Europe, much of the air freight is trucked, not flown.

3. The EDC location policy

3.1 Introduction

Since the second half of the 1980s, demand for industry locations near airport Schiphol increased rapidly. However, the total amount of enclosed or open space available outside the airport that can be used for the building of maintenance facilities, hotels, offices, or warehouses is limited. To control economic development of Schiphol's surrounding areas, the Dutch government applies planning and zoning regulations on what can be built and on the uses to which the land may be put. This spatial policy is a combination of national government directives and specific policies of regional and local governments. The national government directives say that only Schiphol-dependent activities are permitted [Bouwens and Dierikx, 1997, p. 379] [Bureau PAU, 2000, p. 50]. On the regional and local level, governmental authorities and Schiphol have a shared interest in formulating and implementing policies to accommodate the growing demand for business parks in the Schiphol area with as little negative impact as possible on the land use and airport accessibility [Provinciale Staten van Noord-Holland, 1986, section 2]. To realize this challenge, the Schiphol Area Development Company (SADC) was founded in 1987.

In this chapter we describe how regional governments, local governments, and Schiphol work together in SADC and attempt to manage and control the allocation of scarce land, just outside the airport, to EDCs. We focus on the period 1987 (the start of SADC) until 2000 (the year we collected our empirical data for this study through a cross sectional survey among EDCs). The chapter starts with addressing the debate on the limitations of public actors to influence or steer societal processes. Subsequently, the formal policy goals of the regional and

local governmental authorities who set the strategy of SADC are discussed. Then we turn to the policy instruments that have been used to attain these goals.

Most data for this chapter are collected through interviews with policy makers. A list of interviewed persons is presented in appendix 3.1. The interviews were conducted between November 2001 and February 2002. If in the text no specific reference is made, the information is derived from the interviews.

3.2 Limits of governmental steering

Governmental steering capacities
In the 1950s, public policy of Western governments grew out of a highly positivist orientation of planning and steering societal processes [Kooiman, 1993, p. 12] [Parsons, 1999, p. 74]. However, notwithstanding all knowledge available to policy makers, governments seemed to be unable to fully control and steer developments. In this connection, social theorists [Kooiman, 1993, p. 9-20] [Kickert et al., 1997, p. 3-5] address the debate on the limits of governmental steering. This debate started in the 1960s and 1970s due to a substantial number of governmental policies of Western governments that failed to meet their original targets. Policy implementation processes seemed to have their own dynamics whereupon numerous policy plans broke down. This disillusionment with government performance resulted in a lowering of ambitions. Social theory [Bruijn de and Ten Heuvelhof, 1991, p. 1-3] [Kickert et al., 1997, p. 3-5] [Dirven et al., 1998] [Teisman, 2001] refers to the imbalance between required and available governmental steering capacities that can be recognized in many policy fields. Since the first half of the 1980s, the general conclusion that capacities of governments to steer society are limited, is widely accepted [Bruijn de and Ten Heuvelhof, 1991, p. 1] [Kickert et al., 1997, p. 1] [Dirven et al., 1998, p. 1] [Teisman, 2001].

Criteria for success or failure of public policy
Against the background of disillusionment with the positivist and rational concept, a social constructionist framework of policy analysis developed. Social theory [Knaap van der, 1995] [Kickert et al., 1997, p. 7-10, p. 14-61] [Parsons, 1999, p. 67-77] provides us with three modes of thinking in policy analysis and evaluation in the public sector, namely: the rational perspective; the multi actor perspective; and the network perspective. Below we discuss these schools of thought in greater detail.

Rational perspective:
This perspective corresponds with the well established principle of rational objectivism. The starting point is the ambition and goal of the government which is seen as central actor being able to steer society. A policy theory constitutes the rational foundation of the policy programs and actions. Policy theory comprises relations between policy goals and policy instruments that are used to attain these goals, including relations established by: intuition; authority; statistics; observation; deduction; and guesses [Kickert and Van Vught, 1995, p. 91-94] [Bressers and Hoogerwerf, 1995, p. 61] [Nagel, 2002, p. 133, p. 136-137].

Policy making is approached from a strongly rational-technical point of view. However, it is recognized that given the limited time frames and limited information horizons policy makers do not enjoy complete knowledge of all relevant problems and all relevant solutions. Within these limits of bounded rationality policy makers look for satisfactory solutions.

The rational perspective assumes that policy making proceeds in stages. First, the policy maker analyses the problem and its alternatives. Then, scientific knowledge is used to find the "best" solution and to design an implementation program. After authoritative decision making, implementation is considered as a non-political, technical, and programmable activity. The criterion for success or failure is the attainment of the formal policy goals. Policy evaluation is concerned with the intended and unintended consequences of public policy for society. Data are gathered on the effectiveness of the policy theory and the efficiency of the policy instruments employed. The evaluation aims at the production of information that policy makers can use to improve the quality of their policy programs. The rational perspective suggests the following reasons for policy failure: incorrect assumptions about the causal relations between goals and means; limited effectiveness of steering instruments; resistance from implementing bodies or target groups for whom the policy is intended; unclear policy goals; and lack of monitoring and control of policy effects.

Multi actor perspective:
The role of institutional contexts as having an important influence on policy effects is emphasized in the multi actor perspective. Here the bottom-up approach is used, whereas the rational perspective is top-down. The multi actor perspective starts from the interests, strategies, capacities and resources of the implementing bodies and target groups regardless of whether they are governmental, quasi-governmental or private. The focus is on the extent to which central policies provide these local actors with resources and policy discretion to tackle the problems they encounter.

Policy making is regarded as a political process in which local actors assess whether their goals are met. Public policy is the result of interaction between various actors influencing the policy process into a direction which is favorable to themselves. Taking on board the knowledge, skills and goals of local actors in the policy design phase is considered as very important. Here, criteria to judge whether a public policy is successful are: does the policy contribute to local decision making; are local actors included in the policy process; are local actors provided with sufficient resources; and are local actors satisfied with the results.

Network perspective:
The network perspective considers policy making to take place in policy networks. Policy networks are stable patterns of social relations between interdependent actors which take shape around policy problems. Government is regarded as a multiform and non-central actor. Governments take part in policy networks just as all other actors. The focus is on the communicative processes between the actors in the networks.

Policy making is considered as the result of interactions among a variety of separate but interdependent actors each with own -and sometimes conflicting- interests, goals and strategies. Because of the interdependencies, actors need support, participation, or cooperation

from other actors. At the same time, actors try to steer the interaction and bargaining processes towards their own preferable outcomes. The network perspective assumes that there is no single actor who has enough power to steer the actions of all other actors. The fact that actors are mutually dependent and are able to understand each other, does not necessarily mean that their particular images of the "world" correspond sufficiently to allow collective action. The contrary is often the case. That is, each actor has a different worldview and multiple versions of "reality" exist in the form of multiple mental constructions.

The idea is that reality is "socially constructed" and given meaning by people in interaction processes rather than "objectively determined". In this light, policy analysis is not longer seen as positivist business. Within the network perspective, there is no a priori policy goal or "right solution" in the form of consequences for society which can be used as criterion to measure success or failure of policy. A basic assumption of the network perspective is that if actors seek joint interests, instead of adhering to one's own goals, advantageous win-win situations can be achieved. The advantage lies in the surplus value of the solution achieved jointly compared to the outcome that will be reached when actors operate in isolation. The most important criterion for measuring success of public policy is whether joint action or cooperation is achieved on policy problems within the network. According to the network perspective, policies fail because of the lack of incentives to cooperate and blockades in the interaction processes between actors in the policy network.

It can be seen that there is a broad spectrum of viewpoints in the field of policy analysis and evaluation. At the one end of the spectrum we find the positivist concept of knowledge. That is, the world is a knowable place, facts are "out there", costs and benefits can be calculated and performance can be measured. At the other end, policy analysts are working in the context of a social constructionist framework taking the view that there are no such things as objective facts "out there". Parsons [1999, p.73] points out that no one of these modes of thinking is adequate to explain the total complexity of policy activity.

Causal relations between public policy and its effects

A main reason for policy failure, as suggested by the rational perspective, is incorrect assumptions about the causal relations between policy goals, means and effects. Important questions are to what extent the effects can be attributed to the policy, and which part of the policy contributed to which effect. Or more specifically, how has the EDC location policy for the Schiphol area impacted the clustering of EDCs near the airport? In general, it is difficult to answer what effects policy has because it is hard to fully determine the causal relations between a public policy and its effects. Bressers and Hoogerwerf [1995, p. 28, p. 56-59] explain this difficulty as follows:

- usually a public policy is embedded in a wider set of policies affecting each others impact on the target group for whom the policy is intended;
- the effects of a public policy on its target group are not only affected by other public policies but also by individuals, interest groups, and organizations in the policy environment.

The general idea that causal relations between a public policy and its effects on the members of the target group are highly complex and can not be fully determined applies to the EDC location policy for the Schiphol area. The EDC location policy is embedded in a wider set of policies, all affecting the EDC location behavior and thus strengthening or weakening the EDC location policy. Examples of those policies are: spatial policy; transport policy; environmental policy; economic policy including customs policy, tax policy and trade policy. Furthermore, EDC location behavior is also affected by interest groups such as Holland International Distribution Council and by the trends in European and international logistics (see chapter 2).

3.3 Goals of the EDC location policy (period 1987-2000)

In 1987, the "Schiphol Convenant" was signed by the Province of North-Holland, the city of Amsterdam, the city of Haarlemmermeer and airport Schiphol [Provinciale Staten van Noord-Holland, 1986]. This contractual agreement is the official start of the joint cooperation between regional governmental authorities, local governmental authorities and airport Schiphol on formulating and implementing spatial policy for economic development of the Schiphol area. The Schiphol Convenant [Provinciale Staten van Noord-Holland, 1986, section 2] formulates this challenge as follows: "To create a favorable economic environment and to strengthen Schiphol's market position through accommodating the growing demand for business parks in the Schiphol area with as little negative impact as possible on the land use and airport accessibility". The Schiphol Convenant specifies this broad challenge by three policy goals[5]:

- Consistency with the long term planning needs of airport Schiphol in terms of planning and zoning of adjacent lands;
- Provision of high quality business parks for the location of Schiphol-dependent firms;
- Development of a sustainable attractive economic environment for Schiphol-dependent activities.

Consistency with the long term planning needs of airport Schiphol
Over the period 1970-2000, European air traffic (measured in passenger kilometers) has grown sevenfold, representing an average annual growth rate of almost 7% [MVA, 2000, p. 6]. Similarly to passenger air transport, the air cargo market is expanding rapidly. Major European airports have grown accordingly. From the figures 3.1 and 3.2 we can see that Schiphol handles an ever-growing number of passengers and freight. It is anticipated that this trend will continue. However, since the second half of the 1990s, the growth of airport Schiphol is heavily constrained by noise limits and airport slot availability [Bouwens and Dierikx, 1997, p. 375-398].

[5] The policy goals have not been changed over the period 1987 – 2000.

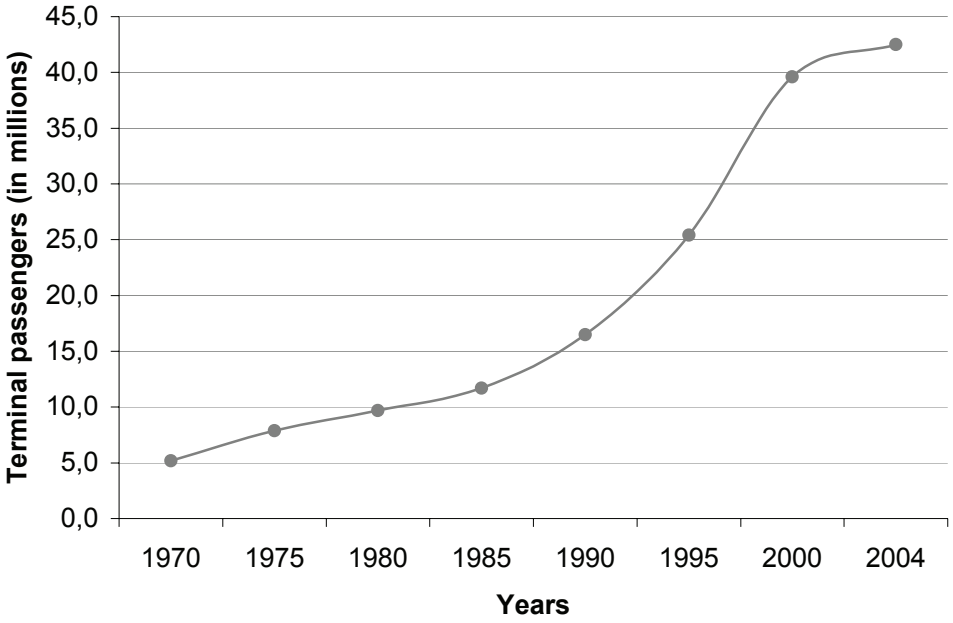

Figure 3.1: Amsterdam Airport Schiphol: Growth in passengers handled
Source: Bouwens and Dierikx, 1997, p. 247, p. 365; Amsterdam Airport Schiphol, 2000; Schiphol Group, 2004

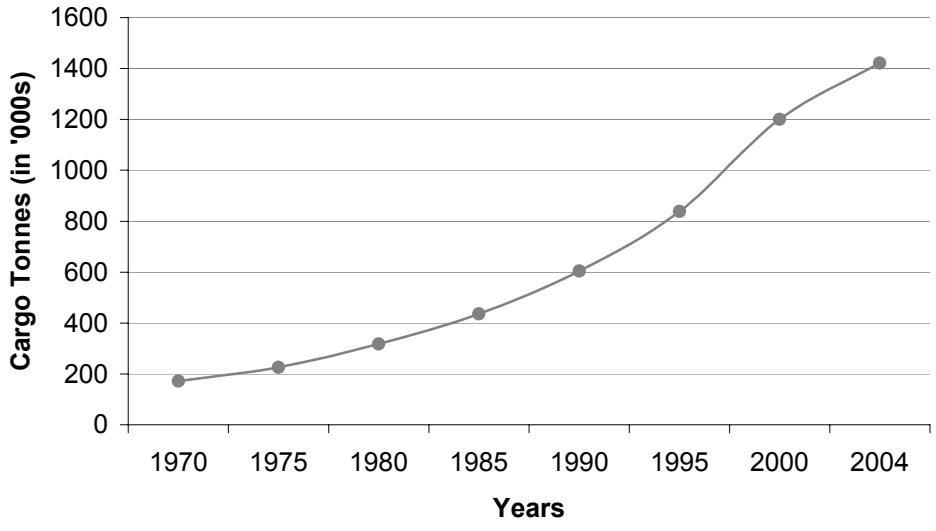

Figure 3.2: Amsterdam Airport Schiphol: Growth in freight handled
Source: Bouwens and Dierikx, 1997, p. 264, p. 374; Amsterdam Airport Schiphol, 2000; Schiphol Group, 2004

An important starting point for the Schiphol Convenant is the Schiphol study of the "Commission Van der Zwan" [Commissie Van der Zwan, 1986]. The Commission found that the rapidly growing demand for air transport would outstrip the supply of Schiphol's infrastructure and surface access. Congested airspace, airport runways, terminals and surface transport provisions can result in frequent and lengthy delays for passengers and freight, especially at peak periods. The commission pointed out that airport development and additional surface transport provisions were needed to meet the expected increase in demand for air transport. By the end of the 1980s, firm projects on airport development were planned for Schiphol, such as: building of additional apron space; new terminals; and the construction of a fifth runway. At the same time, road and rail (for passenger transport, not freight) projects were planned to improve Schiphol's surface accessibility.

Planning and zoning for extensions at the existing airport site such as new terminals and aprons is very much under the control of Schiphol. When it comes to planning and zoning outside the airport, Schiphol's control is limited. The Schiphol Convenant secures that the development of business parks in the Schiphol area is consistent with Schiphol's long term planning needs in terms of planning and zoning of adjacent lands.

Provision of high quality business parks

In its 1986 Schiphol study, the Commission Van der Zwan [Commissie Van der Zwan, 1986] pointed out that the embarking of Schiphol on the further cycle of expansion would not automatically result in the migration of firms to the Schiphol area. The commission stated that to realize the potential of Schiphol as point of crystallization for companies and to benefit from employment effects and other economic impacts, two important development programs were needed. First, the development of a marketing and sales strategy. We stress that in attracting companies, Schiphol competes with other countries and major European airports. Second, the development of business parks in the Schiphol area. Direct availability of high quality business parks is an important asset for the marketing and sales strategy. In this connection, the Commission concluded that regional governments, local governments, and Schiphol should work together and establish an organization for the development, marketing, and sales of such business parks in the Schiphol area for Schiphol-dependent firms.

The underlying idea is that it is insufficient to view airport Schiphol as several runways for aircraft together with associated buildings or terminals where passengers or freight transported by the aircraft are processed. Schiphol is a complex industrial enterprise in which many activities are brought together to facilitate the interchange between air and surface transport for passengers and freight. Within this overall airport umbrella, firms that are located at or very close to Schiphol offer a wide range of supporting services and facilities. Together, the Schiphol agglomeration provides the so called "airport product" [Kramer, 1990, p. 15]. The business parks near Schiphol as well as the firms located there are part of the Schiphol agglomeration and contribute to the airport product.

Development of a sustainable attractive economic environment

Demand for industry locations in the Schiphol area increased rapidly since the second half of the 1980s. However, the total amount of enclosed or open space available outside the airport that can be used for the building of maintenance facilities, hotels, offices, or warehouses is

limited. Controlled development of the business parks in the Schiphol area is needed to realize a sustainable favorable economic environment that not only supports the attraction of firms into the area "today" but also in the future.

To control economic development of the Schiphol area, governmental authorities (national, regional, local) apply planning and zoning regulations on what can be built and on the uses to which the land may be put. The national government directives say that only Schiphol-dependent activities are permitted [Bouwens and Dierikx, 1997, p. 379] [Bureau PAU, 2000, p. 50]. And the aim of the spatial policies of regional and local governments is to create a favorable economic environment and to strengthen Schiphol's market position through accommodating the growing demand for business parks in the Schiphol area with as little negative impact as possible on the land use and airport accessibility [Provinciale Staten van Noord-Holland, 1986, section 2].

Uncontrolled economic development of the Schiphol area can result in the allocation of scarce land, just outside the airport, to non-Schiphol-dependent firms. As a consequence, later arriving Schiphol-dependent firms might be confronted with completely occupied business parks forcing them to decide for a location near another but smaller Dutch airport, a non-airport location in The Netherlands, or a location near a major European airport in another country. Moreover, uncontrolled economic development can easily result in: overcrowded business parks; rising land costs resulting in higher costs for renting/ leasing warehouse or office space; congested routes from the business parks to connecting roads and to the airport; and worsening airport accessibility.

Above, we described declining location conditions that mainly can be attributed to uncontrolled growth of the cluster of firms located at the business parks in the Schiphol area. However, we can also find worsening location conditions that only for a minor part can be attributed to the growing cluster of economic activities at these business parks. Examples are: increasing road congestion in the wider Schiphol region; and increasing congestion at airport Schiphol (congested runways, congested terminals and congestion in the air).

3.4 Instruments of the EDC location policy (period 1987-2000)

The intended and unintended effects of a policy depend strongly on the policy instruments that are used and how they are used. Saying that policy makers choose from a toolkit of policy instruments by comparing them in terms of their ability to contribute to the realization of previously determined policy goals is too simplistic. Social theorists consider the selection and use of policy instruments as the result of interactions among a variety of actors, goals, and instruments [Bruijn de and Ten Heuvelhof, 1991, p. 5-8] [Bressers and Hoogerwerf, 1995, p. 139-141, p. 146-150] [Kickert et al., 1997, p. 121]. The availability of an instrument may not only facilitate the realization but also the formulation of goals. Values, norms, and perceptions of the actors involved affect the selection process of policy goals and instruments. We stress that decision making processes and the question how specific decisions on policy goals and instruments actually happened is beyond the scope of this thesis.

The broad number of policy instruments can be classified into three families [Bruijn de and Ten Heuvelhof, 1991] [Kickert et al., 1997, p. 121] [Bruijn de and Ten Heuvelhof, 1999], namely:

- legal family consisting of regulations;
- family of economic instruments or financial incentives;
- family of communicative instruments focused on bringing about a change in perceptions, values, and norms.

Within each family, three characteristics of policy instruments can be distinguished [Kickert et al., 1997, p. 124-132]. The first characteristic is whether the instrument is aimed at actors or aimed at relations between actors. Instruments aimed at actors can affect their: number, variety, interests, power, or size. Instruments aimed at relations can create new relations and dependencies between actors. The second characteristic is whether the instrument is used for direct or indirect steering. When an instrument is aimed directly at the actor to be steered, the term direct steering is used. Indirect steering means that the actor to be steered is approached through other actors. The third characteristic is whether the instrument is used to govern generically, whereby all actors to be governed are approached in an identical manner, or non-generically, whereby the instrument is tailored to the specific sensitivities of individual actors. We follow this classification to describe the instruments of the EDC location policy for the Schiphol area.

Regulatory instruments: Governing Body Schiphol

The signing of the Schiphol Convenant in 1987, forms the official start of the joint cooperation between regional governmental authorities, local governmental authorities and airport Schiphol on formulating and implementing policies for the development of business parks in the Schiphol area. In the Schiphol Convenant [Provinciale Staten van Noord-Holland, 1986, section 3], this cooperation is formalized by the creation of two new actors, namely:

- Governing Body Schiphol (Bestuursforum Schiphol);
- Schiphol Area Development Company (SADC).

The Governing Body Schiphol is the political-administrative platform responsible for outlining the policy whereas SADC is responsible for the policy implementation. The area that falls within the jurisdiction of the Governing Body Schiphol is referred to as Schiphol area (or Schiphol zone). The actors that signed the Schiphol Convenant (Province of North Holland, city of Amsterdam, city of Haarlemmermeer, airport Schiphol) work together in the Governing Body Schiphol. The Province of North Holland is chairman. From the start in 1987 until 2000, the main agenda items of the Governing Body Schiphol have been: acquisition of land around Schiphol for the development of business parks; selection of Schiphol-dependent (or Schiphol-related) firms; controlled economic development to accommodate the growing demand for business parks in the Schiphol area with as little negative impact as possible on the land use and airport accessibility. The latter includes the development of criteria to

distinguish Schiphol-dependent firms from non-Schiphol-dependent firms and directives about timing, place and size of new development programs for business parks and real estate.

The business parks falling within the jurisdiction of the Governing Body Schiphol are earmarked for the location of Schiphol-dependent firms. The criteria to select Schiphol-dependent firms are developed by the Governing Body Schiphol and implemented by SADC. They differ for offices and warehouses. In this thesis we focus on warehouses, not on offices. Over the period 1987-2000, the warehouse selection criteria have been changed twice. These changes were required due to the need to adapt the strategy of the Governing Body Schiphol to changes in the economical-political environment. The warehouse selection criteria are given in appendix 3.2. From these criteria it can be seen that the definition of a Schiphol-dependent EDC as used by the Governing Body Schiphol and SADC is wider than our definition (see chapter 2).

Regulatory instruments: Schiphol Area Development Company (SADC)
SADC is a land development company, not real estate, and is responsible for the implementation of the policy outlined by the Governing Body Schiphol [Provinciale Staten van Noord-Holland, 1987]. SADC is a public-private company. From its start in 1987 until 2000, SADC's shareholders were: the province of North Holland (public, 16.7%); the city of Amsterdam (public, 16.7%); the city of Haarlemmermeer (public, 16.7%); airport Schiphol (private, 25%); and NIB Capital Bank (Nationale Investeringsbank; private, 25%). We can see that one half of the shares (50%) is owned by public actors and that the other half is owned by private actors. The NIB Capital Bank provided the venture capital. SADC performs four main tasks:

- development of high quality business parks in the Schiphol area;
- to check that locations on those business parks are only allocated to Schiphol-dependent firms or in other words, keeping out non-Schiphol-dependent firms;
- provide connecting roads from the SADC business parks to the highways and to Schiphol;
- marketing and sales.

Development of high quality business parks
The first SADC task is the development of high quality business parks in the Schiphol area. SADC can buy the land needed for the development of business parks, or SADC can start business park development programs in cooperation with a public or private land owner. The latter means that the land owner has to comply with the SADC regulations and the Schiphol Convenant. Furthermore, SADC provides park management services such as: area surveillance, waste management, and maintenance. Figure 3.3 shows the picture of existing and future business parks in the Schiphol area in the year 2000. In the figure, the existing SADC business parks are marked with an arrow. They are described below.

Business parks "Oude Meer" and " Sky-Park"
Development of Park Oude Meer and Sky-Park began in 1988. Park Oude Meer is directly adjacent to Schiphol's freight areas. It offers facilities specially tailored for large logistics operations. Sky-Park is suitable for small and medium sized logistics companies and offices. The EDC cluster we study in this thesis is located at these two business parks.

Business park "Schiphol-Rijk":
Park Schiphol-Rijk is a high-end office location. Since 1988, many large international companies have established themselves there.

Business park "Lijnden":
Real estate development at Lijnden started in 2000 and is focused on small scale and medium sized logistics activities and offices.

Business park "Amsterdam Osdorp":
In 2004 the site has been prepared for building. Just as Lijnden, this business park is focused on small and medium sized logistics activities and offices.

Business park "Schiphol Logistics Park":
Schiphol Logistics Park is a new location for large-scale logistics activities. Preparation of land and infrastructure started in 2005. By reserving land for a possible sixth airport runway, land surrounding the business areas is presently devoted to a green environment. The site is part of the comprehensive "Werkstad A4" development aimed at the area south of Schiphol near the A4 motorway.

Business park "Riekerpolder":
This business park is specially designed for offices and is an extension of Amsterdam's office park named South Axis. At Riekerpolder, office development started in the second half of the 1990s.

In the second half of the 1990s, airport Schiphol started its own land and real estate development company named "Schiphol Real Estate" (SRE). The scope of SRE's activities is not limited to the site of Schiphol. SRE develops land and real estate at and around Schiphol and at/ around other airports. In some cases, SRE competed with SADC on the acquisition of land. This shows that the partners of the Schiphol Convenant (Province of North Holland, city of Amsterdam, city of Haarlemmermeer, airport Schiphol) do not only work together but also compete. Next to competition about land, there can also be competition about firms. The important question is whether to locate a Schiphol-dependent firm at the SADC business parks or at a business park of one of the individual partners.

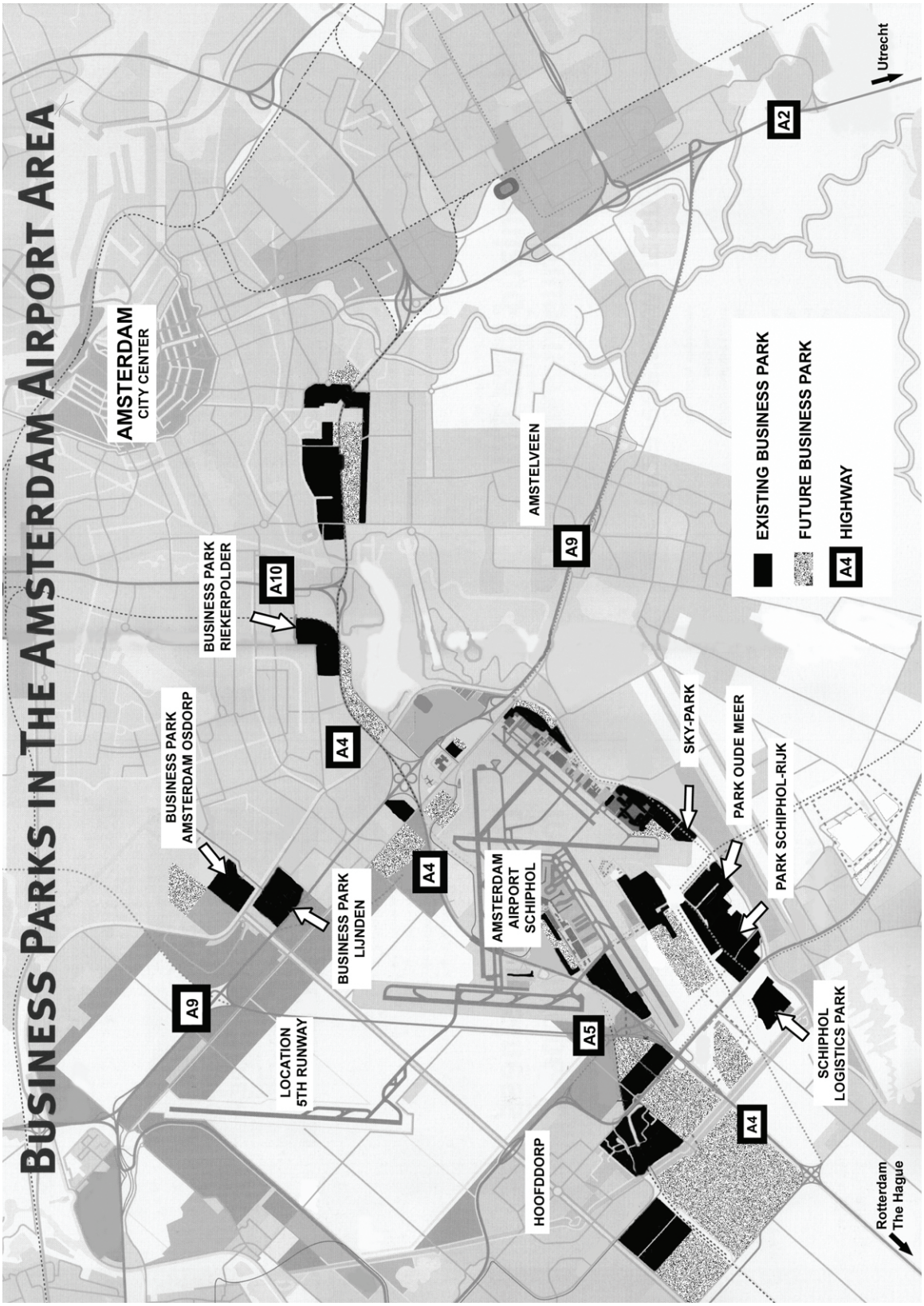

Figure 3.3: ***Business parks in the Schiphol area***
Source: ***Adapted from "Amsterdam Airport Area" (AAA), 2001***

Check that SADC sites are only allocated to Schiphol-dependent firms
This is the second task of SADC. At the SADC business parks, only Schiphol-dependent firms are permitted. SADC assesses whether a firm is Schiphol-dependent or non-Schiphol-dependent by the selection criteria as developed by the Governing Body Schiphol (for the warehouse selection criteria, see appendix 3.2).

Provision of connecting infrastructure
One of SADC's responsibilities is the provision of infrastructure between the business parks in the Schiphol area, airport Schiphol, and the highways, including: secondary roads, bridges, bus lanes, and telecommunication network facilities.

Marketing and sales
Here we discuss the marketing and sales responsibility of SADC. At the end of the 1980s, SADC's marketing strategy was aimed at attracting airport-dependent activities from firms headquartered in the Far East (mainly Japan) and the USA. In the second half of the 1990s, SADC expanded the scope of its marketing activities. Since then, the marketing strategy is also aimed at firms in European countries such as Germany and Scandinavia. A main component of the marketing strategy is to organize international business trips to promote the business climate of Amsterdam, the Schiphol area and the wider Schiphol region. On the marketing side, SADC works closely together with: the Netherlands Foreign Investment Agency (NFIA, department of the Dutch ministry of Economic Affairs); the city of Amsterdam; Holland International Distribution Council (HIDC); and Amsterdam Airport Area (AAA or Triple-A). The aim of AAA is to coordinate the international marketing activities for the Schiphol area. AAA was founded in the second half of the 1990s. Within AAA the following actors work together: the province of North Holland; the city of Amsterdam; the city of Haarlemmermeer; SADC; Schiphol Real Estate (SRE); Royal Dutch Airlines (KLM); and Kantoren Fonds Nederland (KFN, Dutch real estate development company). SADC is chairman and coordinator of AAA.

Regarding the sales responsibility, SADC is a land development company, not a real estate developer. Land development includes: planning and zoning; landscaping; arranging necessary permits; and building infrastructure. Once the land is prepared, SADC sells off or leases out (long-term lease) parcels of land. However, this selling/ leasing is not total or unconstrained. SADC land can only be bought or leased for the building of real estate (warehouses or offices) that is used for Schiphol-dependent activities. In case an owner of SADC land sells his site, the constraint that only Schiphol-dependent activities are permitted is transferred to the new owner. Figure 3.4 shows the three options for a Schiphol-dependent firm (end-user) to buy or lease business space at the SADC business parks. In case an end-user buys or leases land directly from SADC, he can join forces with a project developer for the building of the warehouse or office he desires.

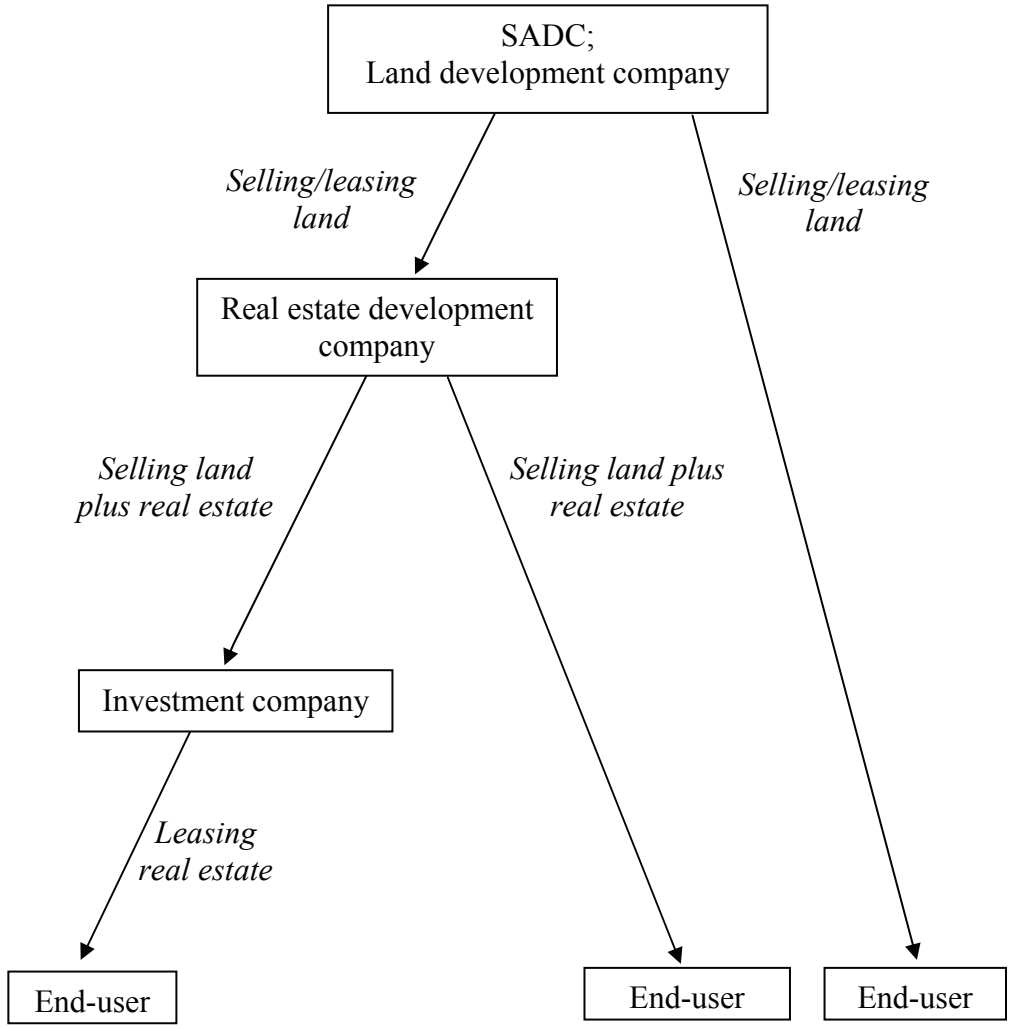

Figure 3.4: The three options for a Schiphol-dependent firm (end-user) to buy or lease business space at the SADC business parks

Financial instruments

SADC prepares sites and then sells off or leases out parcels of land to project developers and also directly to end-users (see figure 3.4). Pricing policy is determined by SADC, not by the Governing Body Schiphol. SADC bases its price setting on market demand and price sensitivities, cost estimates, and prices offered by competitors. In case SADC sells or leases land to a project developer, prices for end-users are set by the developer.

The buying decision process of a project developer can be characterized by three stages. First, the developer estimates the sales revenues of the project. Second, he estimates the total project costs and adds a markup for profit and risk. Finally, revenues minus costs, including the markup, set the ceiling of the land price that can be charged. Thus, for project developers the land price balances the budget.

Communicative instruments
For the communicative instruments, the reader is referred to the marketing responsibility of SADC which we have discussed earlier.

3.5 Conclusions

In this chapter we described how regional governments, local governments, and airport Schiphol work together in SADC and attempt to manage and control the allocation of scarce land, just outside the airport, to EDCs.

We stress that, in general, capacities of governments to steer societal processes are limited. A main reason for this is that causal relations between a public policy and its effects are highly complex. This is also true for the EDC location policy for the Schiphol area. The EDC location policy is embedded in a wider set of policies all affecting EDC location behavior, such as: spatial policy; transport policy; environmental policy; economic policy including customs policy, tax policy, and trade policy. Furthermore, the EDC location behavior is also affected by interest groups and trends in European and international logistics. We conclude that a causal relation between the EDC location policy and its effect on the clustering of EDCs around Schiphol can not be fully determined. The official goals of the company location policy for the Schiphol area are:

- Consistency with the long term planning needs of airport Schiphol in terms of planning and zoning of adjacent lands;
- Provision of high quality business parks for the location of Schiphol-dependent firms;
- Development of a sustainable attractive economic environment for Schiphol-dependent activities.

Evidently, this location policy aims at controlled economic development of the Schiphol area. The policy instruments used to attain the policy goals are the following:

- planning and zoning regulations;
- directives on timing, place, and size of new development programs for business parks, real estate, and infrastructure;
- criteria to select Schiphol-dependent firms;
- marketing and sales activities;
- land prices.

There are legal constraints on the uses to which the SADC business parks in the surrounding areas of Schiphol may be put. Only Schiphol-dependent activities are permitted. However, from the SADC selection criteria (see appendix 3.2) it can be seen that the SADC definition of a Schiphol-dependent EDC comprises a wide range of warehouses. At the one end of the range we find EDCs according to our definition of a Schiphol-dependent EDC (see chapter 2).

At the other end, we find a Schiphol-dependent EDC defined as being a subsidiary of an international company.

4. Approaches to the study of industrial location

4.1 Introduction

Our model of the clustering of EDCs near airport Schiphol is based on a specific model from New Economic Geography, namely the model of industry location of Arthur [Arthur, 1994, p. 49-67, p. 99-110]. Arthur argues that concentration of firms may arise for two reasons:

- endowments of a geographical location;
- economies of agglomeration.

The first reason for concentration, location endowments, is the existence of comparative advantages of a region due to differences in geography such as: availability of fertile land; availability of natural resources; climate; access to the sea; availability of an airport; labor costs; land prices; proximity to markets; and transportation costs. The second reason, agglomeration economies, stresses the benefits of being close to other firms or concentrations of industry. These may be due to: the existence of specialized suppliers and large local markets; the existence of a large pool of labor; the opportunities of interaction, learning, creativity and innovation; or access to community infrastructure (e.g. energy, communication and transportation). As industry in an agglomeration grows, diseconomies of agglomeration may also emerge such as: congestion; rising land costs; and high demand for labor in relation to its supply. Economies of agglomeration tend to promote spatial concentration of economic activity whereas diseconomies of agglomeration promote spreading.

The idea that spatial configuration of economic activities is the outcome of a process involving location endowments and agglomeration economies, agrees with early work in economic geography. These early contributions are discussed in this chapter. We will highlight the main contributions. It is beyond the scope of this chapter to give a complete survey of the literature. Early work in economic geography is widely addressed in textbooks and other publications [e.g. Paelinck and Nijkamp, 1975; Webber, 1986; Dicken and Lloyd, 1990; Chapman and Walker, 1991; Harrington and Warf, 1995; Hayter, 1997; Lambooy et al., 1997; Brakman et al., 2001]. In economic geography several theoretical perspectives have emerged. How to classify these perspectives is open to some debate. The most common starting point is to distinguish between the normative, behavioral, and structural approach [Dicken and Lloyd, 1990, p. 9-12] [Chapman and Walker, 1991, p. 18-31] [Harrington and Warf, 1995, p. 9-10] [Hayter, 1997, p. 5]. We follow this classification.

This chapter starts with the normative approach or neoclassical location theory. This strand of thinking studies ways in which firms should make location decisions to minimize costs or maximize revenues and profits. Then, the behavioral approach is discussed. This approach came into being as a reaction to the unrealistic assumptions in neoclassical location theory and is focused on how location decisions are actually made. The emphasis of the normative and behavioral approach is firmly placed upon location decisions from a managerial point of view. The structural approach produced a significant shift in emphasis away from the managerial perspective towards the impact of industry location upon the social environment. Examples of such societal impacts are: changes in employment opportunities due to shifts in economic activity; differences between prosperous and less prosperous regions; how these inequalities between regions are perpetuated; and how to influence the forces responsible for the uneven spatial distribution of economic development. New Economic Geography is addressed within this broader perspective of the structural approach.

4.2 Normative approach

The normative approach -or neoclassical location theory- studies ways in which firms should make location decisions rather than which decisions actually happen in reality. Hayter [1997, p. 6] describes three general characteristics of the neoclassical explanation of industrial location. First, it focuses solely on economic variables such as transportation costs and labor costs. History, political influences and social processes are largely ignored. Second, the economic factors are analyzed in an abstract deductive manner to derive generalizations as to where industry should locate. The theory so derived provides a normative yardstick to compare with actual location behavior. Third, neoclassical location theory interprets the firm as an “economic man” who has the perfect information and perfect rationality to compute an optimal location in the sense of minimizing costs or maximizing profits. Authors [e.g. Harrington and Warf, 1995, p. 18, p. 40; Hayter, 1997, p. 111] distinguish two lines of neoclassical location theory, namely: (1) minimizing the costs of operating the facility and

selling the product, and (2) maximizing the profit from the fixed investment[6].

Locating to minimize costs

Least cost location theory rests upon the work of Weber (1909) [cited in e.g. Paelinck and Nijkamp, 1975; Webber, 1986; Dicken and Lloyd, 1990; Chapman and Walker, 1991; Harrington and Warf, 1995; Hayter, 1997; Lambooy et al., 1997]. Weber considered transportation costs, classified into procurement costs and distribution costs, to be the most important general principle of location. The first step in Weber's approach is to assess the effect of transportation costs on location. Subsequently the effect of economies of agglomeration and labor is taken into account. The best location is the one at which costs of transport and production are minimized.

Transportation costs:

Weber suggested that transportation costs are determined by the weight of the materials and the distances over which the materials and products have to be moved. By combining these two elements, Weber came up with a simple index of costs, the ton-mile. The key on transportation costs is to find the site that accumulates the lowest total of ton-miles for assembling materials and getting the product to the market. The sources of input (or raw materials) as well as the market centers exert a pull on location. Furthermore, Weber classified inputs as either ubiquitous or localized. Ubiquitous materials are available everywhere at similar costs whereas localized materials are only available at specific locations. Within Weber's approach, localized materials are a form of location endowments that are not uniformly distributed across locations and therefore exert a specific influence on location. Localized materials that do suffer a loss of weight in the process of manufacture have the ability to attract industries to their source. A widely quoted example of this is the manufacture of sugar from sugar beets [Dicken and Lloyd, 1990, p. 86]. The weight of sugar extracted by this process is only one-eight of the raw material that goes into the process.

Thus, in activities that utilize localized inputs which lose weight, procurement costs are more significant than distribution costs. Accordingly, the sources of these inputs exert a stronger pull on location than the location of markets. Conversely, in activities that utilize localized inputs which gain weight, distribution costs are more significant than procurement costs. Consequently, the location of markets exerts a stronger pull on location than the sources of input. The resultant value represents the so called "center of gravity" [see Stock and Lambert, 2001, p. 414; Goor van et al., 2003, p. 177-182]. That is the point or location of a distribution center that minimizes transportation costs for products moving between manufacturing plants (production centers) and markets (consumption centers). It can be seen that even under highly simplified conditions, location matters in terms of minimizing transportation costs. In other words, "distance to suppliers and markets" (the center of gravity) is a form of location endowments.

[6] The neoclassical location theories as discussed in this chapter, are also widely addressed in logistics textbooks and articles [e.g. Hagdorn-van der Meijden, 1996; Stock and Lambert, 2001, p. 410-417; Goor van et al., 2003, p. 177-186]. They form the basis for the location analysis and site selection techniques for distribution centers as used in logistics.

Economies of agglomeration and labor costs:
Agglomeration economies and cheap labor locations are the other key elements contributing to the location decision. Weber recognized that by clustering in close spatial proximity to other activities firms may benefit from a particular kind of external economy of scale. Without necessarily raising their own scale of production, their spatial association and functional linkage with the larger agglomeration permits firms to derive cost economies from scale factors operating outside themselves. Weber named these cost economies "economies of agglomeration" [Dicken and Lloyd, 1990, p. 208]. Weber also recognized that there may be a point at which an expanding agglomeration becomes incapable of maintaining its efficiency and where problems such as congestion, clogged transportation arteries, soaring land prices, pollution, and administrative overload begin to transform economies into diseconomies of agglomeration. However, Weber failed to probe sufficiently deeply into the nature of (dis)economies of agglomeration [Dicken and Lloyd, 1990, p. 208].

Labor costs vary by location, based on a series of factors such as: housing costs; number and rate of increase of potential workers; or level of industrialization of the region. Labor costs can thus be seen as a location endowment. Weber recognized that the location which minimizes labor costs or maximizes economies of agglomeration may not be the same as the minimum transportation cost location. If so, the optimal location is determined via an iterative fashion. The starting point is the minimum transportation cost location. When savings in labor costs are more than the increases in transport costs, the firm should move to the location that minimizes labor costs. Similarly, if a firm is faced with a choice between the minimum transportation cost location and the location that maximizes economies of agglomeration. Here, Weber neglected the inertial effect of a firm's spatial structure and adopted a highly simplistic view of the mechanism of relocation [Dicken and Lloyd, 1990, p. 208].

Locating to maximize revenues and profits
Weber took no account of the potential effect of the location of competitors upon sales [Chapman and Walker, 1991, p. 19]. In Weber's analysis, demand and prices are held constant and it is assumed that the manufacturer can sell all his products regardless of the actions of his competitors. Given these conditions, it is reasonable to regard the least cost location as the optimal location. Authors from the profit-maximizing location school (e.g. Hotelling, Hoover, Isard, and Moses) introduced the concern of spatial competition and internal economies of scale.

Spatial competition:
One of the most famous statements of competitive location relative to a market was published by Hotelling (1929) [cited in e.g. Paelinck and Nijkamp, 1975; Dicken and Lloyd, 1990; Harrington and Warf, 1995; Hayter, 1997; Lambooy et al., 1997]. He allowed demand to vary and recognized that decision makers react to competitors as the best location changes according to the strategy of others. Hotelling's assumptions are crucial to his analysis and his outcome [Paelinck and Nijkamp, 1975, p. 141] [Dicken and Lloyd, 1990, p. 209-211] [Harrington and Warf, 1995, p. 45]. These assumptions are:

- The market is a limited one dimensional line, for instance a limited stretch of beach;

- The set of customers is evenly spread along the beach;
- Two producers serve the market, for instance two sellers of ice cream;
- Each ice cream costs one monetary unit (for instance 1 US Dollar) at the point of sale to which must be added the cost of the customer's travel to the point of sale;
- Each customer is prepared to buy one ice cream, no matter what the price may be, but each will buy from the seller with the lowest total price;
- The two sellers are spatially mobile and can move along the beach without costs.

Given these assumptions, the amount purchased from each ice cream seller depends on their relative prices and locations. They compete for the location that will give them the largest volume of sales. It can be seen that if both sellers were located at the same end of the beach, a move by one seller to the next location on the beach would produce a large advantage for that seller. However, this is an highly unstable situation because the other seller would then retaliate by relocating. Given the potential retaliations, the stable position for each seller will be the center of the beach. In other words, to agglomerate. Hotelling shows how spatial competition can draw producers towards clustering. Hotelling made an important comment about this result [see Paelinck and Nijkamp, 1975, p. 143; Harrington and Warf, 1995, p. 45]. The total costs of transportation paid by all the customers would be minimized if the two sellers were located at the quartiles of the beach. If the sellers are in competition, however, this is not a stable condition. Therefore, the competitive equilibrium does not maximize the welfare of the consuming public.

Internal economies of scale:
Internal economies of scale is the decline in unit costs which arise from savings to be made within a plant from purchasing, producing and transporting at larger volumes. One of the acknowledged weaknesses of early location theory is its tendency to neglect scale [Dicken and Lloyd, 1990, p. 202]. Hoover (1937) [cited in e.g. Dicken and Lloyd, 1990; Lambooy et al., 1997] took internal economies of scale into account and showed the way in which reductions in unit costs with increasing scale reduced the delivered price of the goods for an established firm. This extended the firm's market area over a wider range than would be the case with the assumption that there are no internal economies of scale. The underlying idea is that total transport costs will rise as the product is shipped to more customers who are farther away. Compensating for this, a rise in the volume of output will lower the unit costs of production. If the fall in costs due to the additional sales volume exceeds the additional shipment charges, the firm can carry on expanding. Isard (1956) [cited in e.g. Dicken and Lloyd, 1990; Lambooy et al., 1997] showed how this works for two competing producers. The competitor that can achieve greater scale economies in production is able to increase its market area at the expense of the other firm.

Hoover and Isard showed that scale of production is linked with the level of demand available to a producer. However, the starting point for both is the prior assumption that the firm is already located. Their analyses neglect the fact that the optimal location, that is the point of maximum profits, may vary according to the scale of production [Dicken and Lloyd, 1990, p. 204]. Moses (1958) [cited in e.g. Dicken and Lloyd, 1990; Lambooy et al., 1997]

demonstrated that the optimal combination of inputs (raw materials and labor) and the optimal location of the plant may change as the scale of output changes. The technical possibilities in production will vary with the scale of output to be produced. A small operation may need far more labor in relation to materials, while a bigger one may demand more materials and less labor. It may be expected that when the scale of production increases new combinations of inputs become optimal. As a consequence, location endowments such as availability of raw materials and labor costs will exert a different pull on location. Thus, as the scale of output changes so does the optimum location.

4.3 Behavioral approach

The behavioral approach is focused on how location decisions are actually made as opposed to neoclassical location theory which is focused on how they should be made. The actual location choice of a firm may differ from the outcome given by neoclassical location models. In other words, the possibility of "sub-optimal" location decisions must be recognized. The behavioral approach came into being largely as a reaction to two unrealistic behavioral assumptions in neoclassical location theory [Webber, 1986, p. 38-39] [Dicken and Lloyd, 1990, p. 11] [Hayter, 1997, p. 137-138]. First, neoclassical location theory is focused solely on economic variables. The behavioral approach also recognizes the importance of history, political influences, social processes and personal considerations. Second, neoclassical location theory interprets the firm as an "economic man". In the behavioral approach, firms are characterized as "satisfying man". Given the limited time frames and limited information horizons, firms do not enjoy complete knowledge on all relevant aspects. Within these limits of bounded rationality, firms look for satisfactory decisions. The behavioral approach is focused on decision making processes within the firm.

The location of firms as a decision making process:
The key to behavioral explanations of industrial location is how firms perceive, code and evaluate information and the factors which influence cognitive and choice processes [Hayter, 1997, p. 140]. In Pred's (1967) classic study [cited in e.g. Chapman and Walker, 1991; Hayter, 1997; Lambooy et al., 1997], the complex range of factors affecting how firms process information and make location choices are summarized in terms of a behavioral matrix. In this matrix, a firm with a high ability to use information and a high availability of information would be in a better position to make a "good" location choice. Pred's idea of the "best" location is close to the neoclassical optimum. Within his matrix, Pred draws attention to the importance of learning and the past experience of decision makers (ability to use information) as well as to uncertainty (availability of information). A complementary idea is that location preferences can incorporate biased information and reflect subjective perceptions of location endowments and (dis)economies of agglomeration operating in a region [see Pellenbarg, 1985; Meester, 1999].

4.4 Structural approach

The emphasis of neoclassical and behavioral location theory is firmly placed upon location decisions from a managerial perspective. The structural approach recognizes that studies of industrial location should have a greater awareness of the societal implications of shifts in industrial activity [Chapman and Walker, 1991, p. 29]. Examples of such societal implications are: changes in employment opportunities due to shifts in economic activity; differences between prosperous and less prosperous regions; how these inequalities between regions are perpetuated; and how to influence the forces responsible for the uneven spatial distribution of economic development. According to the structural approach, industry location and the development of spatial patterns of firms should not be examined by restricting ourselves solely to location decisions from a managerial perspective. Among this broader perspective of the structural approach, we count the following lines of enquiry: Geography of enterprise; Regional economic development; and New Economic Geography.

Geography of enterprise
Within the neoclassical and behavioral location theory the small single-plant firm is the point of departure in attempts to explain the location of industry [Chapman and Walker, 1991, p. 18]. This premise largely ignores the growth of large global enterprises. Large corporations, particularly multinational corporations, are at the core of the enterprise approach. This approach recognizes that the location of individual firms can often only be understood in relation to the wider corporate systems to which they belong. Factory location is explained in terms of the factors that influence strategy formulation. In particular, emphasis is placed on how the geography of corporate strategies is guided by internal long-term motivations, accumulated expertise, established corporate structures and by the external strategies and structures of other business organizations such as: rivals, consumers, suppliers, labor organizations, and governments [Hayter, 1997, p. 161]. Closely related to this point has been the recognition that many essentially non-spatial business decisions have geographical consequences [Dicken and Lloyd, 1990, p. 290] [Chapman and Walker, 1991, p. 25]. For example, the introduction of a new technology may result in a change in the ratio of skilled to unskilled jobs at the different manufacturing sites. For this reason, the corporation may decide to close or relocate one or more of its plants.

Imperfect competition:
Galbraith (1967) [cited in e.g. Chapman and Walker, 1991; Hayter, 1997] expressed a growing awareness of and concern with the power of large industrial corporations. This power is exercised in various ways, for example in bargaining processes with other firms, labor and governments. For large corporations, location endowments and economies of agglomeration are not simply given data. Wage levels, transportation rates, land prices, taxation levels, or supply of infrastructure can be subject to negotiation and bargains [Chapman and Walker, 1991, p. 24-25] [Hayter, 1997, p. 161]. This assertion of market power implies that the market structure must necessarily be one of imperfect competition [see Hayter, 1997, p. 161]. Perfect competitive forces exercised by “invisible hands” are replaced by oligopolistic or monopolistic forms of competition.

Regional economic development

Whereas normative location theory is essentially static, models of regional economic development encourage the adoption of an evolutionary perspective [Chapman and Walker, 1991, p. 26]. Economic landscapes evolve or change over time. Existing location patterns of firms are regarded both, as derivates of former conditions and as major influences upon future location patterns.

Regional economics has long been dominated by the view that operating market forces would result in the equalization of economic development across regions [Dicken and Lloyd, 1990, p. 240-241] [Hayter, 1997, p. 125-126] [Fujita and Thisse, 2002, p. 6]. According to this view, in regions where firms and investments are concentrated (core regions) demand for labor and wage levels increase. As a result, firms are encouraged to seek locations in peripheral regions where there are available labor supplies and where wage rates are lower. In addition, movements of labor from peripheral to core regions reduce pressures on wage levels in core regions but increase pressures on wage levels in peripheral regions. This equilibrium view is based on the idea that capital flows from regions where it is abundant to regions where it is scarce until capital rents are the same across regions, or regional wage differences push and pull workers until the equalization of wages between regions is reached. In other words, this model is based on perfect mobility of capital and labor, both moving freely from regions with low returns (interest and wages) towards regions with high returns up to the point at which capital and labor are equalized across all regions.

Critiques [see Dicken and Lloyd, 1990, p. 241; Hayter, 1997, p. 126; Fujita and Thisse, 2002, p. 6-7] pay particular attention to two unrealistic assumptions of the equilibrium view. First, it ignores the unevenness in the spatial distribution of labor costs and other location endowments. On labor costs, Hayter [1997, p. 126] [see also Webber, 1986, p. 73-77] points out that it is unrealistic to assume infinite labor mobility because the mobility of workers is inevitably constrained by social and family commitments and a highly localized knowledge of opportunities. Second, while continued investments in core regions are likely to increase pressure on wages, they are also likely to reinforce agglomeration economies. In other words, the regional pattern of economic development may not equalize across regions but result in polarized development. This idea has been at the heart of the work of Myrdal (1957) [cited in e.g. Dicken and Lloyd, 1990; Chapman and Walker, 1991; Hayter, 1997; Lambooy et al., 1997] on circular and cumulative causation.

Circular and cumulative causation:

Myrdal argued that once the development process of an established area is under way, a number of features have a strong tendency to reinforce further growth. This process is circular and cumulative. Below we discuss the process of circular and cumulative causation by reference to figure 4.1 [Chapman and Walker, 1991, p. 173-175]. In this figure, four cycles can be seen giving the circular and cumulative aspects of the process, namely:

- The effect of increased income, via new wages, on local opportunities in business and on community wealth. The rising local markets encourage more firms making it possible to create new jobs. There is a so-called multiplier effect (one job in the original sector creates others elsewhere). This new wealth also provides more income

in the community for the public provision of infrastructure and community services. All of this, makes the area more attractive to manufacturers in the next period.

- New jobs in the industry usually increase the pool of trained labor. Local people are trained or others are brought in from elsewhere; either way the community benefits. With time and job turnover, the number of qualified workers increases and educational institutions do their part to improve even more. Firms in later periods can see a larger, more qualified labor force which may be an important location factor.
- Some industries require many raw or semi-finished materials, components or a variety of business services. If a company locates in an area then it may be an attraction for linked suppliers of intermediate inputs to also locate there.
- Agglomeration economies derived from the build-up of a supply industry are also strengthened by the general improvement of business services in the area.

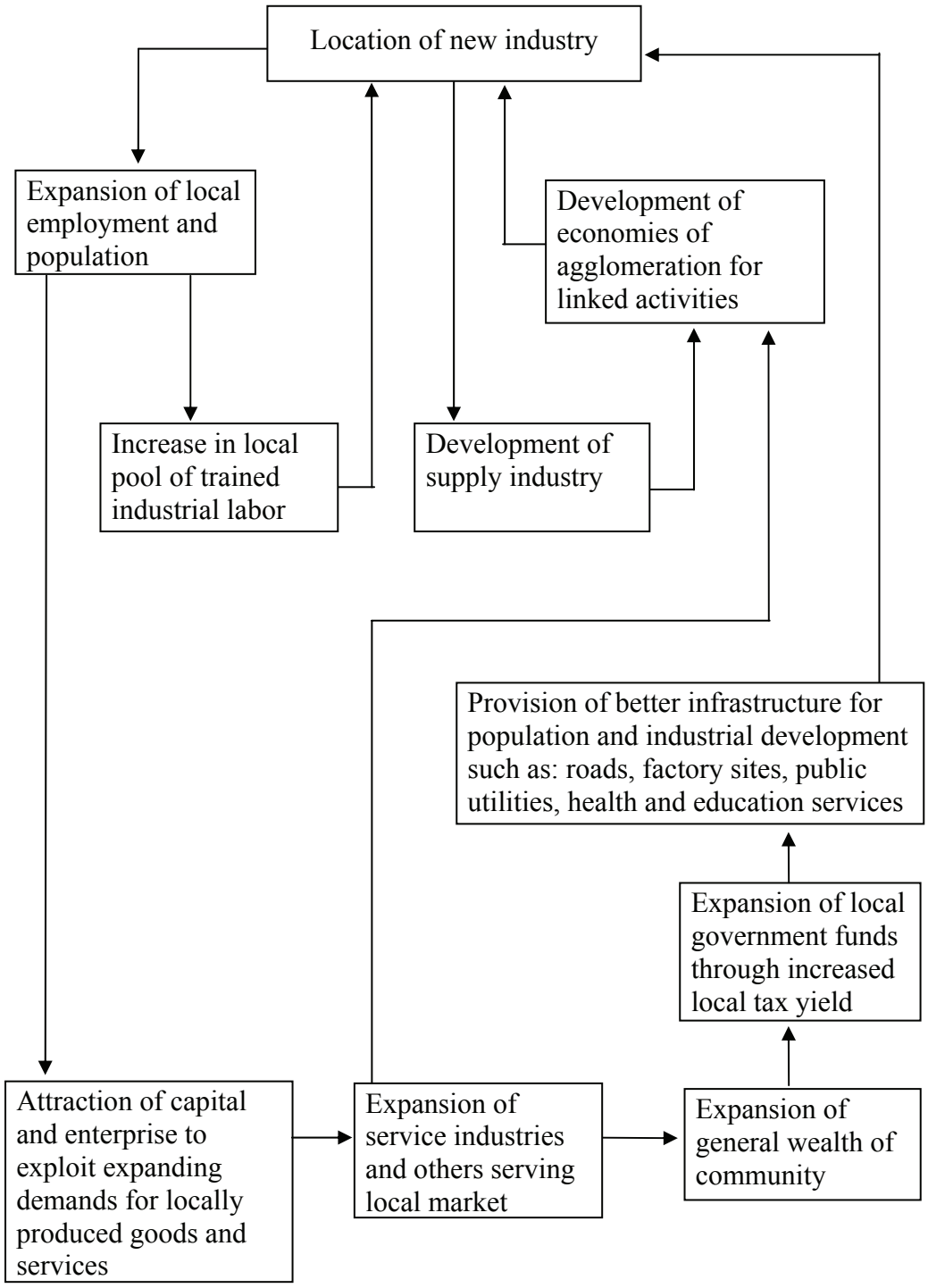

Figure 4.1: Myrdal's process of circular and cumulative causation
Source: Chapman and Walker, 1991, p. 174

Myrdal describes the sustainability of core-periphery patterns of economic development. However, he does not so much emphasize the conditions under which a region may start a process of economic development. He stated that the power of attraction today of a center has its origin mainly in the historical accident that something once started there and not in a

number of other places where it could equally well or better have started [Dicken and Lloyd, 1990, p. 220].

Linkages and propulsive industries:
An important and influential strand of thinking about key triggers to cumulative growth has been the work of Perroux (1955) [cited in e.g. Dicken and Lloyd, 1990; Chapman and Walker, 1991; Lambooy et al., 1997]. The term growth pole was adopted by Perroux to refer to a group of what he called propulsive firms or industries. Not only do such industries experience rapid growth, but they also induce further growth in related sectors. Thus, growth becomes manifest at the poles and it spreads from there through different channels with variable terminal effects on the whole economy. This propulsive effect is based upon a high intensity of input-output relationships or linkages with other industries. The propulsive industries positively influence others which depend upon them for a high proportion of their inputs and/ or outputs. We stress that in Perroux's terms growth poles are industries or firms, not restricted geographic locations. Kramer [1990] points out that airport Schiphol, together with the firms located at and very close to the airport, can be seen as a growth pole.

New Economic Geography
In the early models of regional economic development, agglomeration economies were merely assumed and taken as the point of departure for analyzing patterns of economic development. The early theories provided a description rather than an explanation of the forces steering the spatial configuration of economic activities [Krugman, 1999] [Fujita et al., 2000, p. 4]. Since the 1990s, a new group of models has been developed. Often, they are based on the paper of Krugman [1991] and aimed at deriving the pattern of spatial configuration from economic reasoning. That is, they seek to explain the spatial structure from the economic rationale of individual economic agents. This group of models is generally named New Economic Geography models [Fujita et al., 2000, p. 3] [Brakman et al., 2001]. The main theoretical vehicles used by these models to address the causes for the formation of the various types of economic agglomerations include: increasing returns to scale; externalities; and imperfect competition [Fujita and Thisse, 2002, p. 5].

Agglomeration and increasing returns to scale:
The average costs per unit of output of a firm vary with the scale of production. Here, three situations can be distinguished. First, increasing returns to scale (or economies of scale). This refers to the situation in which an increase in the level of output produced implies a decrease in the average costs per unit of output. It translates itself into a downward-sloping average cost curve. Second, when average costs do not vary with the level of output we are in a situation of constant returns to scale. Third, diminishing returns to scale (or diseconomies of scale) refers to a situation where average costs rise as more units are produced.

To identify the sources of increasing returns to scale, Scitovsky (1954) [cited in e.g. Brakman et al., 2001; Fujita and Thisse, 2002] distinguished between internal and external economies of scale. Internal economies of scale arise from the savings to be made within an individual plant from producing at larger volumes. In contrast, external economies of scale are savings that a plant or firm gains from its connections (or linkages) with other firms. Here, the

decrease in average costs comes about through an increase of output at the level of the industry as a whole. The average costs per unit is seen as a function of industry-wide output.

One source of external economies of scale is explicitly spatial, namely economies of agglomeration [Dicken and Lloyd, 1990, p. 208]. Within New Economic Geography, basically two levels of aggregation are distinguished on which increasing returns to scale might occur [Fujita et al., 2000] [Brakman et al., 2001] [Fujita and Thisse, 2002]:

- Economies of scale within a firm;
- Economies of agglomeration or scale economies internal to a cluster of firms.

Economists have long recognized that theories about clustering of economic activities cannot do without some type of increasing returns to scale [Brakman et al., 2001, p. 26] [Fujita and Thisse, 2002, p. 7]. Fujita et al. state [2000, p. 2] that the dramatic spatial unevenness of the economy –the disparities between densely populated manufacturing belts and thinly populated farm belts; between congested cities and desolated rural areas; between the spectacular concentration of particular industries in the Silicon Valleys and Hollywood's– is surely the result not of inherent differences among locations but of some set of cumulative processes necessarily involving some form of increasing returns whereby geographic concentration can be self-reinforcing.

Analyzing the role of increasing returns have always posed difficulties for economic theorists and was an exception in economic theorizing [Krugman, 1999] [Fujita et al., 2000, p. 3] [Brakman et al., 2001, p. 56]. In the 1970s, in the field of industrial organization, theorists began for the first time to develop models of competition under increasing returns. Subsequently, these new analytical tools were applied to the fields of international trade, economic growth theory, and economic geography. The latter led to the emerge of New Economic Geography.

Agglomeration and externalities (or external effects):
Formally, externalities exist when the activities of one group (either consumers or producers) affect the welfare of another group without any payment or compensation being made [Button, 1993, p. 93]. There are external benefits as well as costs. Following Scitovsky (1954) [cited in e.g. Brakman et al., 2001; Fujita and Thisse, 2002], it is now customary to consider two categories of externalities: pecuniary and technological externalities. The formal difference between these two categories of externality is that when the latter effects occur in production (or consumption), they must appear in the production (or utility) function while this is not the case with pecuniary externalities [Button, 1993, p. 93].

An example can help to clarify this difference. The formation of an agglomeration of economic activity may create a large local market that supports the build-up of specialized input services and internal economies of scale. Thus, promoting a high level of efficiency in the operations of workers and machines. The fact that this directly enters the production function of the individual firms in the cluster means it is a technological externality. If the

internal economies of scale are passed on from a supplying firm to a purchasing firm by the market through price effects, then the lower purchasing costs are a pecuniary externality. This indirectly enters the production function, namely through changes in the prices charged. Technological externalities are real resources of benefits or costs whereas pecuniary externalities have important distributional implications [Button, 1993, p. 94]. The fact that there are pecuniary externalities does not increase the total benefits or costs in an aggregated sense but reveals that there are economic adjustments which influence who is to enjoy the gains and who is to suffer the costs.

Through externalities, the sources of increasing returns to spatial concentration can be modeled. They capture the idea that an agglomeration is the outcome of a "snowball effect" in which a growing number of firms want to congregate to benefit from a larger diversity of activities and a higher specialization [Fujita and Thisse, 2002, p. 8]. However, the technological externalities of spatial concentration remain hard to model in any explicit way. To a large extent they are often black boxes that aim at capturing the crucial role of complex non-market institutions whose role and importance are strongly stressed by geographers and spatial analysts [Fujita et al., 2000, p. 5] [Fujita and Thisse, 2002, p. 9] [see also Storper and Venables, 2002; Oort van, 2004].

Agglomeration and imperfect competition:
Recall that within New Economic Geography two levels are distinguished on which increasing returns to scale might occur, namely: the individual firm and a cluster of firms. On both levels of aggregation, increasing returns to scale imply market power or monopolistic power. If firms produce under internal economies of scale, the largest firm has the lowest average costs per unit of output and is able to push the smaller competitors off the market. If clusters of firms can benefit from economies of agglomeration, the cluster that gets ahead in number of firms is able to increase its lead. This shows that, the market structure underlying increasing returns to scale must necessarily be one of imperfect competition and that the perfect competition paradigm is unable to cope with the emergence and growth of economic agglomerations [see Arthur, 1994, p. 1-12; Fujita et al., 2000, p. 5-6; Brakman et al., 2001, p. 26-28; Fujita and Thisse, 2002, p. 7]. Therefore, the market structure in the New Economic Geography models is characterized by monopolistic competition. The equilibrium equations of these models are non-linear. This means that small changes in parameters do not always produce the same effects. Sometimes effects are small, sometimes they are large. This makes New Economic Geography models very different to standard neoclassical location models. We can distinguish four main distinctive characteristics of New Economic Geography models [Brakman et al., 2001, 61-62] [see also Arthur, 1994; Fujita et al., 2000; Fujita and Thisse, 2002]:

- First, there is the concept of cumulative causation. If, for some reason, one location has attracted more firms than the other, a new firm has an incentive to locate where the other firms are. This means that the location decision of a single firm might not change the spatial pattern of economic agglomerations but it could have dramatic consequences. It is possible that the location decision of a single firm triggers a process of cumulative causation resulting in a dramatic change of the location pattern.

- Second, we stress that under increasing returns to scale, multiple stable equilibrium points of market shares of agglomerations (expressed as a percentage of all firms) are possible. However, we can not determine beforehand where agglomeration will occur. Once a location gets a head-start, the process of cumulative causation starts working. Initially small differences between locations can evolve over time to large differences in the long-run equilibrium.
- Third, an equilibrium might be stable or unstable. If the equilibrium is unstable and if a single firm decides to relocate to a new location, that location will immediately become more attractive for all other firms. This can trigger a snowball effect. All firms may follow the pioneer.
- Fourth, a stable equilibrium can be non-optimal for the economy as a whole.

4.5 Conclusions

We have seen that the idea that spatial configuration of economic activities is the outcome of a process involving location endowments and economies of agglomeration has its roots firmly in early work of economic geography.

Location endowments are the comparative advantages of a region due to differences in geography such as: availability of fertile land; availability of natural resources; climate; access to the sea; availability of an airport; labor costs; land prices; proximity to markets; and transportation costs. We have paid special attention to three location endowments: transport costs; labor costs; and land prices. First, transport costs. We have seen that a main reason why transport costs vary over space is that the sources of input needed for production (raw materials) as well as the market exert a pull on location in terms of minimizing the transportation costs. The resultant value represents the so called “center of gravity”. That is the point or location of a distribution center that minimizes transportation costs for products moving between manufacturing plants (production centers) and markets (consumption centers). We conclude that location matters in terms of minimizing transportation costs. In other words, “distance to suppliers and markets” (the center of gravity) is a form of location endowments. Second, labor costs. We have seen that spatial variations in wage rates arise between growing areas that need to attract labor and depressed regions that have a surplus of labor. Furthermore, it seems that infinite mobility of labor and capital is a feature sometimes used in economists’ models but not of real life. We are led to the conclusion that the regional pattern of economic development does not equalize across regions but results in polarized development. In sum, spatial variations in wage rates persist and therefore labor costs can be counted among the location endowments. Third, land prices. There are enormous persisting variations in the prices of land between regions where firms and investments are concentrated and peripheral regions. The reason is the same as for the persisting spatial variations in wage rates, namely the polarized economic development.

Economic activity is not distributed randomly over space. Clustering of firms is the rule, not the exception. By clustering in close spatial proximity to other activities, firms may benefit from savings in production costs referred to as economies of agglomeration. We have seen

that theories of clustering can not do without some type of increasing returns to scale unless strong spatial differences in location endowments are assumed. We distinguish two levels of aggregation on which increasing returns to scale might occur, namely:

- Economies of scale within a firm;
- Economies of agglomeration or scale economies internal to a cluster of firms.

Increasing returns to scale imply market power and an underlying market structure of imperfect competition. Modeling the spatial pattern of industry location under increasing returns to scale means that the location of a single firm can trigger a process of cumulative causation resulting in a dramatic change of the location pattern as a whole. Moreover, on forehand it can not be determined where agglomeration will occur or which region will become the center of production. We stress that, to a large extent, the sources of economies of agglomeration often are black boxes that remain hard to model in any explicit way.

5. Modeling location endowments, economies of agglomeration and locked-in logistics

5.1 Introduction

This thesis deals with the explanation of why EDCs cluster around Amsterdam Airport Schiphol. In this chapter we construct our model of spatial economic development of the Schiphol area in which the following location forces interplay in the making of the EDC cluster:

- location endowments;
- agglomeration economies;
- locked-in logistics.

In the real world, economic activity is not distributed randomly over space. Clustering of firms is the rule, not the exception. Economies of agglomeration are crucial in the formation of concentrations of economic activity. The analysis of economies of agglomeration is generally regarded as one of the most unsatisfactory aspects of traditional location theory [Chapman and Walker, 1991, p. 26-27]. In this thesis we apply the theory of New Economic Geography. Different from traditional location models, New Economic Geography models hinge crucially on the role of economies of agglomeration. The main thrust of the New Economic Geography literature is to give a micro-economic foundation for the effect of economies of agglomeration by modeling the self-reinforcing character of spatial

concentration. Our model of the clustering of EDCs near airport Schiphol is based on a specific model from New Economic Geography, namely Arthur's model of industry location [Arthur, 1994, p. 49-67, p. 99-110].

This chapter starts with an extensive discussion of the sources of economies of agglomeration. Then, we address Arthur's model of industry location. The core models of New Economic Geography focus on economies of agglomeration, thereby often assuming that space is homogeneous. This means that differences in location endowments are not taken into consideration. In Arthur's model both determinants of industry location (location endowments and economies of agglomeration) are combined. That is an important model characteristic. To understand the clustering of economic activity in airport regions, it is essential to know whether the firms are attracted into the region due to its location endowments or due to the economies of agglomeration operating in the region. Therefore, we aim to disentangle these two location forces.

Two important phenomena about the clustering of EDCs near Schiphol are not addressed by Arthur's model. First, the model tends to neglect governmental policy. However, the Dutch government plays a prominent role as a multi-actor in the process of economic development of Schiphol's surrounding areas. Second, Arthur assumes in his model that firms will not migrate. After a firm has chosen a particular location it stays there. In other words, within Arthur's model all firms become locked into their location. The Schiphol agglomeration yields not only economies but also diseconomies of agglomeration. An important question is how EDCs, once settled in the Schiphol area, will react when they are confronted with declining location conditions. In this thesis we look at all spatial-organizational changes, but we focus on two logistics adjustment possibilities of EDCs, namely: making a modal shift for freight, and relocation of the entire EDC facility.

Consequently, we arrived at our model by extending Arthur's model in two directions. First, we included the Dutch government explicitly as a multi-actor. Second, we incorporated the fact that established EDCs can make logistics adjustments in response to changes in their business environment. Generally speaking, we model pressures to change on one hand and resistance to change on the other hand. The latter refers to threshold values and threshold effects. Once the pressures to change cross the threshold, EDCs will change. Thresholds produce inertia that can make pressures to change ineffective. Here we introduce the concept of locked-in logistics that refers to very high thresholds. Our model provides the theoretical framework to address the research questions as presented in chapter 1.

5.2 Sources of economies of agglomeration

Agglomeration economies remain a key attraction factor

Economies of agglomeration are savings that a firm gains from being located in close spatial proximity to other activities. An important question is whether clustering in close spatial proximity remains important in this age of declining transportation and communication costs, increasing availability of high-speed transportation infrastructure, and fast growing

developments of new information/ communication technology[7]. It can be seen that such developments can create connections (or linkages) between firms through which externalities can be transmitted without the need for spatial proximity. In other words, they have a potential "distance shrinking" character. This can culminate in the "death of distance" scenario where: the force of economies of agglomeration gradually fade; firms become increasingly footloose and easily relocate; economic activities increasingly disperse; and clusters of firms vanish. However, researchers [e.g. Storper and Venables, 2002; Fujita and Thisse, 2002, p. 4; Geenhuizen van and Nijkamp, 2005] state that the force of economies of agglomeration remains a key attraction factor for economic activities even though transportation and communication costs continue to decline.

Defining economies of agglomeration

Following Arthur [1994, p. 51-52], we define economies and diseconomies of agglomeration as follows:

> *There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location.*
>
> *There are diseconomies of agglomeration if the benefits of being in a location together with other firms decrease with the number of firms in that location.*

Localization and urbanization economies:

To identify the sources of economies of agglomeration, conventionally a distinction is made between localization economies and urbanization economies. This distinction is linked to the work of Hoover (1937) [cited in e.g. Dicken and Lloyd, 1990, p. 211-212; Chapman and Walker, 1991, p. 59-60; Harrington and Warf, 1995, p. 37; Hayter, 1997, p. 91-92]. Localization economies of scale are gained by firms in a single industry, or a set of closely related industries, at a single location through the overall enlarged output of the industry as a whole at that location. Localization economies are most obviously revealed in specialized districts of related businesses or so-called "industrial districts". Well-known examples of industrial districts are: Toyota Town in Japan that produces cars; the production of shoes in northern Italy; the production of cutlery in Solingen, Germany; the semiconductor sector in Silicon Valley, USA; and the financial district in the City of London.

Whereas localization economies apply to firms in the same industry, urbanization economies apply to firms in all industries at a single location. Urbanization economies embrace scale advantages that benefit a wider group of businesses and refer to the advantages of locating in a larger city (a mix of diverse industries) rather than in a smaller one. As one industry sector grows not only firms from that specific sector but also firms from other sectors at that location can benefit from urbanization economies. Therefore, urbanization economies encourage sector diversity to a much greater degree than do localization economies [see also Jacobs, 1985].

[7] These are long-term trends that seem to continue.

However, a real distinction between localization and urbanization economies is often difficult to establish [Dicken and Lloyd, 1990, p. 212]. Both, localization and urbanization economies may arise due to: the existence of specialized suppliers and large local markets; the existence of a large pool of labor; the opportunities of interaction, learning, creativity and innovation; access to community infrastructure such as energy, communication, and transportation.

Pecuniary and technological externalities:
Formally, externalities exist when the activities of one group (either consumers or producers) affect the welfare of another group without any payment or compensation being made [Button, 1993, p. 93]. There are external benefits as well as costs. The term "agglomeration economies" is used for all externalities that foster geographical concentration of economic activities. Within New Economic Geography, it is customary to consider two categories of sources of economies of agglomeration: pecuniary and technological externalities [Brakman et al., 2001, p. 27-28] [Fujita and Thisse, 2002, p. 8]. The formal difference between these two categories of externality is that when the latter effects occur in production (or consumption), they must appear in the production (or utility) function while this is not the case with pecuniary externalities [Button, 1993, p. 93].

The formation of an agglomeration of economic activity may create a large local market that supports the build-up of specialized input services and internal economies of scale. Thus, promoting a high level of efficiency in the operations of workers and machines. The fact that this directly enters the production function of the individual firms in the cluster means it is a technological externality. If the internal economies of scale are passed on from a supplying firm to a purchasing firm by the market through price effects, then the lower purchasing costs are a pecuniary externality.
This indirectly enters the production function, namely through changes in the prices charged. Technological externalities are real resources of benefits (or costs) whereas pecuniary externalities have important distributional implications [Button, 1993, p. 94]. Technological externalities are also called "spillovers" [Fujita and Thisse, 2002, p. 8]. We can say that they spill over for third parties to exploit.

Technological externalities that foster geographical concentration (external benefits) are the sources of economies of agglomeration whereas externalities that foster geographical spreading (external costs) are the sources of diseconomies of agglomeration. This will be pursued below.

Four principal sources of economies of agglomeration
The example of agglomeration economies as given above, dates back to Marshall [Marshall, 1920, p. 267-277] [see also Hayter, 1997, p. 330; Banister and Berechman, 2000, p. 212; Fujita et al., 2000, p. 4-5; Brakman et al., 2001, p. 27-28; Storper and Venables, 2002; Fujita and Thisse, 2002, p. 7-8]. Marshall pointed out that externalities are crucial in the formation of economic agglomerations and suggested the following classification of externalities as sources of economies of agglomeration:

- linkages (or input-output relationships) between firms associated with: large local markets, the build-up of specialized input services, and internal economies of scale;

- thick markets allowing the formation of a highly specialized labor force;
- knowledge spillovers;
- existence of modern infrastructure.

The literature often centers on the concept of these so called "Marshallian externalities" as principle reason for why economic activities concentrate in geographical space. We follow this line and use the Marshallian externalities as a general framework to describe the sources of economies of agglomeration.

Backward and forward linkages:
An important basis of agglomeration economies is the connections or linkages between economic activities. These linkages are of two main types: backward and forward linkages [Centraal Planbureau, 1975, part 2, p. 3-4] [Dicken and Lloyd, 1990, p. 211] [Harrington and Warf, 1995, p. 85] [Banister and Berechman, 2000, p. 212] [Brakman et al., 2001, p. 179]. Backward linkages are the connections (or input-output relationships) of firms with their suppliers of production inputs such as: raw materials, components, or services. Forward linkages are the interactions of firms with their customers. The central idea is that firms, upstream and downstream in the supply chain, can benefit from each other. For example, if the production of the supplying industry is characterized by increasing returns to scale, an increase in demand for its products induces the supplier to produce at a more cost efficient level of production. And if the lower costs of the supplying firm are passed on by the market through price effects they become part of the costs of the purchasing firm, making the purchasing industry more cost efficient.

If firms produce under increasing returns to scale, backward and forward linkages induce economic activities to cluster in groups to reduce both, production costs and transaction costs [see Fujita et al., 2000; Brakman et al., 2001; Fujita and Thisse, 2002]. In the simplest version, increasing returns to scale arise internally in firm or plant level production and transaction costs are defined as transportation costs. It can be seen that there is a trade-off between increasing returns to scale in production and transaction costs. Internal economies of scale mean that firms seek to concentrate production in a few locations while transaction costs mean that the most profitable locations will be those close to suppliers of production inputs and markets. A location that already has a concentration of firms offers a good local supply of production inputs as well as a large local demand for intermediate and final goods. Due to backward and forward linkages, such a location allows individual firms to create internal economies of scale and to reduce transaction costs. Thus, a spatial concentration of production, once established, creates economies of agglomeration and may tend to persist.

Backward and forward linkages and the interaction between internal economies of scale and transaction costs are particularly important for firms that are highly specialized in a particular trade [Storper and Venables, 2002]. These firms specialize in the production of a good or service to a degree that promotes a high level of efficiency in the operations of workers and machines. However, a specialized industry needs many clients to operate at a scale large enough to do the job efficient. Also the procurement of specialized production inputs is

complex. Highly specialized trades under separate ownership exploit a complex constellation of linkages to each other, often replicating in this way the characteristics found under single ownership in a multi-plant firm. As a consequence, specialized industries tend to be found in places with relatively large local markets.

Apart from the transaction costs benefits of close spatial proximity, an other advantage associated with firms keeping their linkages within a closely confined area is economies of large scale purchasing [Dicken and Lloyd, 1990, p. 213]. The advantages of large scale purchasing of a single large firm, obtaining favorable rates on bulk purchase of supplies and services, may also be available to a cluster made up of firms of all sizes. In the case of transportation, for example, firms that individually ship small quantities can share the services of freight forwarders. Dealing with a large number of spatially concentrated firms, the freight forwarder can combine shipments to make full-truckloads and may pass on some of the resulting economies to its customers.

Clustering of workers:
Large agglomerations of economic activities offer a wide range of skilled and unskilled labor. Such a common pool of labor, offers workers and firms the possibility of rapid and efficient search and (re)hire in an environment of high turnover [Storper and Venables, 2002]. Through these search and matching dynamics sudden shifts in services and goods production, for instance because of fluctuating markets, can be met. Here, agglomeration is encouraged by responses to uncertainty in the business environment [Storper and Venables, 2002].

Not only sudden fluctuations in the demand of labor but also sudden shifts in the demand of materials, floor space, and machine capacity can more easily be met at the level of an industrial agglomeration than at the level of a single firm [Webber, 1986, p. 78-79] [Dicken and Lloyd, 1990, p. 212-213] [Chapman and Walker, 1991, p. 60] [Hayter, 1997, p. 330]. Sudden increases in demand at one firm may take up slack capacity at another firm that is part of the same agglomeration making the overall usage more efficient. As a consequence, far less capital needs to be immobilized in back-up inventories and capacity.

Knowledge spillovers:
Agglomerations of economic activities are increasingly conceived as repositories of knowledge and places where knowledge exchanges are facilitated, resulting in the creation of new knowledge, learning, creativity and innovation [Storper and Venables, 2002]. In both, specialized districts of related businesses (industrial districts) and diversified agglomerations (cities), investments in innovation and knowledge spills over for third parties to exploit. Economists and geographers [e.g. Storper and Venables, 2002; Fujita and Thisse, 2002, p. 9; Boschma and Frenken, 2003; Oort van, 2004; Geenhuizen van and Nijkamp, 2005] acknowledge that considerable progress has been made in the development of theories about knowledge spillovers as an important force behind agglomeration but that the theories still do not fully explain how geographical concentration fosters knowledge spillovers.

Three important strands of thinking in explaining the advantages of physical proximity for the development of knowledge spillovers are: local competition; local diversity; and face-to-face contacts. The first strand can be found in the work of Porter [1985]. According to Porter,

rivalry stimulates innovation and most competition occurs among competitors who are geographically concentrated. Jacobs [1985] advanced the idea that cities enjoy an economic advantage because of their local diversity. This diversity, highly packed into a limited space, can facilitate the creation of new knowledge and innovation. Clustering of economic activity facilitates and stimulates face-to-face contacts. The importance of face-to-face contacts as a vehicle for the production and communication of ideas, knowledge and information is described in detail in the paper of Storper and Venables [2002].

Existence of modern infrastructure:
Another important economy of agglomeration is formed by the savings to the individual firms from the use of common infrastructure facilities –that are paid for and maintained not by any individual firm but by the community at large- such as: energy, communication, and transportation. The broader perspective of societal infrastructure includes further items, such as: schools, universities, libraries, knowledge centers, hospitals, shopping centers, banks, business park development, and all kinds of governmental functions [Webber, 1986, p. 80] [Hayter, 1997, p. 92]. Some of these items are publicly owned, others are privately owned. All, however, offer a shared use to customers. As an agglomeration grows, it provides more income in the community and a higher level of demand necessary for the provision of economically viable infrastructure and community services. This can result in cumulative processes whereby spatial concentration can be self-reinforcing.

Sources of diseconomies of agglomeration
At some stage, an expanding agglomeration may become incapable of maintaining its efficiency. At that point, diseconomies of agglomeration set in. Economies of agglomeration tend to promote spatial concentration of economic activities whereas diseconomies of agglomeration promote dispersion. From the literature [Dicken and Lloyd, 1990, p. 215] [Chapman and Walker, 1991, p. 62] [Arthur, 1994, p. 52] [Harrington and Warf, 1995, p.37] [Hayter, 1997, p. 92] [Brakman et al., 2001, p. 188] we obtain the following sources of diseconomies of agglomeration:

- congestion and clogged transportation arteries;
- soaring land prices;
- pollution;
- administrative overload;
- labor market reflects the growing demand for labor (increasing recruitment, turnover and training costs);
- increases in the costs of living;
- crime;
- competition becomes “cut-throat”.

5.3 Modeling location endowments and economies of agglomeration

Our model of the clustering of EDCs near airport Schiphol is based on a specific model from New Economic Geography, namely the model of industry location of Arthur [Arthur, 1994, p.

49-67, p. 99-110]. The main theoretical building blocks underlying the group of New Economic Geography models are: increasing returns to scale; externalities; and imperfect competition (see chapter 4). These building blocks are also used in Arthur's model. Therefore, we count this model among the umbrella of New Economic Geography models. However, Arthur's model can also be labeled as "Evolutionary Economics" [Boschma and Frenken, 2003]. The model includes an evolutionary approach. Existing location patterns of firms are regarded as derivates of former conditions and as major influences upon future location patterns.

Two important differences between Arthur's model and the core models of New Economic Geography can be seen. First, although all four Marshallian externalities (linkages; pool of labor; knowledge spillovers; and community infrastructure) are clearly operating in the real world, core models of New Economic Geography focus on the role of linkages. They have generally downplayed the other Marshallian externalities, essentially because they are hard to model in any explicit way [Fujita et al., 2000, p. 5]. Arthur's model applies to all Marshallian externalities [Boschma and Frenken, 2003]. Second, core models of New Economic Geography focus on economies of agglomeration, thereby often assuming that space is homogeneous [Brakman et al., 2001, p. 54]. This means that differences in location endowments are not taken into consideration. In Arthur's model both determinants of industry location (location endowments and economies of agglomeration) are combined.

This thesis deals with the explanation of why EDCs cluster around Amsterdam Airport Schiphol. To understand the clustering of economic activity in airport regions, it is essential to know whether the firms are attracted into the airport region due to its location endowments or due to economies of agglomeration operating in the region. Therefore, we aim to disentangle the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in the region. For this reason we do not work with a core model of New Economic Geography but with Arthur's model. The methodology underlying Arthur's model can also be seen in the work of Ellison and Glaeser on the concentration of manufacturing industries in the USA [Ellison and Glaeser, 1997] [Ellison and Glaeser, 1999] [see also Fujita and Mori, 1996].

Structure of the model

Within Arthur's model of industry location [Arthur, 1994, p. 49-67, p. 99-110] geographic concentration of firms is based upon two determinants:

- endowments of a geographical location;
- economies of agglomeration.

Both forces affect the geographical preferences of firms and are combined in the model. The first force, location endowments, stresses the benefits due to differences in physical geography such as: availability of fertile land; availability of natural resources; climate; access to the sea; availability of an airport; labor costs; land prices; and transportation costs. In other words, some locations are preferred by nature or man-made phenomena over other locations.

These locations tend to be natural centers of economic activity. The second force, economies of agglomeration, stresses the benefits of being close to other firms or concentrations of industry. These benefits may arise due to: the existence of specialized suppliers and large local markets; the existence of a large pool of labor; the opportunities of interaction, learning, creativity and innovation; and access to community infrastructure. The sources of economies of agglomeration are referred to as Marshallian externalities. We can say that under the force "economies of agglomeration" geographical preferences of firms are affected by the location decisions taken by other firms whereas under the force "location endowments" geographical preferences of firms are affected by differences in geography.

It can be seen that, in Arthur's model, the pay-off to a firm for locating in a particular region results from the location endowments of that region and the economies of agglomeration operating in that region. This pay-off can be written as:

$$R_L^F = E_L^F + A(y_L) \tag{5.1}$$

Where:
R_L^F are the returns to firm F for locating in location L,
E_L^F are the benefits to firm F due to the endowments of location L and,
$A(y_L)$ are the benefits to firm F due to economies of agglomeration of location L from having y_L firms already located.

Where the agglomeration function $A(y_L)$ is increasing, economies of agglomeration are operating. In contrast, a decreasing agglomeration function shows diseconomies of agglomeration.

Arthur assumes that each firm is well informed and calculates its pay-off for each possible location. However, we stress that these location preferences can incorporate bounded rationality, biased information and reflect subjective perceptions of location endowments and economies of agglomeration [see Boschma and Frenken, 2003]. Each firm locates in its maximum return location. After a firm did choose for a particular location, it stays there. Arthur assumes in his model that firms will not migrate.

Arthur works with computer simulations to study the effect of economies of agglomeration. He uses a population of firms and N possible regions for firms to locate in. At the start of the model run, zero firms are located in the regions. Then, firms enter one by one in random order. We can think of them as arriving in a random sequence in the economy and then making their location choice. The location preferences of early firms are mainly based on location endowments. Subsequently, later firms might be attracted to the same regions, however not because of the location endowments but by the presence of the early locators. Still later firms might be attracted in turn by their presence.

The four main distinctive characteristics of New Economic Geography models (see chapter 4) apply to Arthur's model of industry location. First, the concept of cumulative causation. If, for some reason, one location has attracted more firms than the other, a new firm has an incentive to locate where the other firms are. This means that the location decision of a new entering firm might not change the spatial pattern of economic agglomerations but it could have dramatic consequences. It is possible that the location decision of a single firm triggers a process of cumulative causation resulting in a dramatic change of the location pattern. Second, multiple stable equilibrium points of market shares of agglomerations (expressed as a percentage of all firms) are possible. However, we can not determine beforehand where agglomeration will occur. Once a location gets a head-start, the process of cumulative causation starts working. Initially small differences between locations can evolve over time to large differences in the long-run equilibrium. Third, an equilibrium might be stable or unstable. If the equilibrium is unstable, the location decision of a new firm can make a region more attractive for other entering firms. This will trigger a snowball effect. All new firms will suddenly choose for that region. Fourth, a stable equilibrium can be non-optimal for the economy as a whole. The economic agglomerations are generated over time as the collective result of the decisions of many firms rather than the deliberate actions of any one firm, and can be seen as the unintended consequence of decisions by firms on other firms [cf. Hayter, 1997, p. 91].

To better understand the working of Arthur's model and to show how it can be useful to analyze and explain the clustering of EDCs near Schiphol, two further issues are addressed below. First, we examine the model's long-run equilibrium under bounded and unbounded economies of agglomeration. Second, because some important phenomena about clustering of EDCs near Schiphol are not addressed by the model we discuss refinements and extensions that are needed to arrive at our model.

Bounded economies of agglomeration:
Suppose, economies of agglomeration are absent, thus $A(y_L)= 0$. Then, equation (5.1) takes the form:

$$R_L^F = E_L^F \tag{5.2}$$

Under $A(y_L)= 0$, the concept of cumulative causation is absent. Geographical preferences of firms are not affected by the location decisions taken by other firms. Therefore, at the start of the model run, final concentrations of firms in the various regions are known, no matter what the sequence of arrival of firms will be. Firms that are alike will choose the same maximum return location. This shows that economies of agglomeration are not a necessary condition for spatial clustering of firms.

Now, suppose that $A(y_L)$ will increase by additions of firms and is bounded by an upper limit. Here, location decisions of firms are affected by the location decisions taken by other firms. In other words, location preferences of firms are interdependent. Early firms, arriving by "historical accident" or "chance event" (because firms arrive in random order), might settle

down in locations because of their endowments. These firms can create economies of agglomeration and in turn attract later firms. Finally, firms might end up clustered in the early chosen places. An alternative run of the model will result in a different long-run equilibrium of locations sharing the industry. It can be seen that a different sequence of entry of firms, caused by chance events, will steer the location pattern into a different outcome. Therefore, final concentrations of firms in the various regions are not predictable beforehand. The final location pattern depends very much on the order of entry of early locators.

Unbounded economies of agglomeration:
Suppose that by additions of firms $A(y_L)$ will increase and that, in the model, economies of agglomeration are allowed to increase without ceiling. Here, location decisions of firms are interdependent, a different sequence of entry of firms will lead to a different location pattern, and final concentrations of firms in the regions are not predictable beforehand. Moreover, under unbounded economies of agglomeration there is a high probability that monopoly of the industry by a single region will occur. As firms are added to the regions, one region might gain enough firms to offer sufficient advantages to shut all other regions out. In that case, a critical threshold is passed and suddenly all entering firms will opt for this one region to profit from the higher agglomeration economies. This region becomes a so called dominant region. When the number of firms in the model run becomes large, the share of firms located in the dominant region can tend towards 100%. It can not be determined beforehand which of the possible regions will become dominant.

Refinements and extensions:
Arthur's model of industry location provides a theoretical framework for studying industrial location under economies of agglomeration. However, two important phenomena about the clustering of EDCs near airport Schiphol are not addressed by this framework, namely:

- Arthur's model tends to neglect governmental policy. Concerning economic development around Schiphol, the Dutch government is a prominent actor. In chapter 3 we described how regional governments, local governments and Schiphol work together in SADC and attempt to manage and control the allocation of scarce land, just outside the airport, to EDCs.
- Arthur assumes in his model that firms will not migrate. After a firm has entered the economy, it chooses a particular location and stays there. In other words, within Arthur's model all firms become locked into their location. The Schiphol agglomeration yields not only economies but also diseconomies of agglomeration. An important question is how EDCs, once settled near Schiphol, will react when they are confronted with declining location conditions. In this thesis we look at all spatial-organizational changes, but we focus on two logistics adjustment possibilities of EDCs, namely: making a modal shift for freight and moving the EDC facility away from the Schiphol area.

Consequently, we arrive at our model by extending Arthur's model of industry location in two directions. First, we include the Dutch government explicitly as a multi-actor. Second, we

incorporate that established EDCs can make logistics adjustments in response to changes in their business environment. This second extension is pursued below.

5.4 Locked-in logistics

Survey evidence suggests that spatial-organizational change is considered only when various internal and external pressures upon a firm become too great to resist [Chapman and Walker, 1991, p. 55]. Sometimes this change is of major magnitude and has far reaching effects throughout the organization, for instance the complete physical relocation of an entire plant. More frequently, it consists of relatively minor adjustments. However, we always need to consider internal and external pressures to change on the one hand and resistance to chance on the other hand. Resistance to change refers to threshold values and threshold effects. Once the internal and external pressures cross some threshold, the firm will change. An example of internal pressure is pressure related to growth in output. In this thesis, we concentrate on external pressures that relate to diseconomies of the growing Schiphol agglomeration. We categorize these diseconomies as follows:

- Worsening location conditions that mainly can be attributed to the growing EDC cluster at the business parks in the Schiphol area. Examples are: overcrowded business parks; rising land costs resulting in higher costs for renting or leasing warehouse space; congested routes from the business parks to connecting roads and to the airport; and growing demand for logistics staff resulting in higher recruitment costs.
- Worsening location conditions that only for a minor part can be attributed to the growing EDC cluster around Schiphol. Examples are: increasing road congestion in the wider Schiphol region; and increasing congestion at airport Schiphol (congested runways, congested terminals, and congestion in the air).

Two broad types of spatial-organizational change can be identified: in-situ change and location shift [Dicken and Lloyd, 1990, p. 317-318]. To adjust in-situ means making on-site adjustments without changing the existing spatial network of the organization. Examples are: time shift to off-peak transportation; raise or lower the level of safety stock; or make a modal shift for freight. A location shift consists of changes in the number and location of units operated by the firm. Examples are: investment at a new location; disinvestments at an existing plant, closure or disposal; and relocation of the entire plant and equipment. In this thesis we look at all spatial-organizational changes, but we focus on the following two logistics adjustment possibilities available to EDCs that are established near Schiphol:

- making a modal shift for freight;
- relocation of the entire EDC facility.

However, it is an open question whether the EDCs that are established near Schiphol will make logistics adjustments when they are confronted with worsening location conditions such

as diseconomies of the growing Schiphol agglomeration. Thresholds produce inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to modal shift or relocation. Consequently, we can define two lock-in logistics situations for individual EDCs which refer to very high threshold values:

> *An EDC is locked into its transportation mode if the pressure to make a modal shift for freight is sufficiently great to feel forced to adapt but a modal shift is not considered.*
>
> *An EDC is locked into its location if the pressure to relocate the facility is sufficiently great to feel forced to adapt but migration is not considered.*

Lock-in regarding transportation mode:
It is an open question whether the EDCs that are settled in the Schiphol area will change their mode of transportation when they are confronted with pressures to make a modal shift for freight. In this thesis we focus on the following pressures:

- worsening road congestion in the Schiphol region;
- worsening airport congestion (congested runways, congested terminals, and congestion in the air).

We examine the need and abilities of the individual EDCs to compensate for congestion impacts on their business operations. If EDCs can not be induced to make a modal shift for freight, the allocation of transport modes may not only be locked-in on the level of the individual EDCs but also on the level of the EDC cluster.

To and from the warehouses in the Schiphol area, freight can be transported by the following transport modes: airplane, truck, and train. In 2000, the year we collected our empirical data for this study, options for freight transport by rail as well as options for a modal shift to rail were still in their infancy. Therefore, in this thesis, we study two modal shift options, namely:

- shift from air to road;
- shift from road to air.

We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking.

Lock-in regarding warehouse location:
It is an open question whether the EDCs that are settled in the Schiphol area will be driven away when they are confronted with pressures to relocate the facility. In this thesis we focus on the following pressures:

- worsening road congestion in the Schiphol region;

- worsening airport congestion (congested runways, congested terminals, and congestion in the air).

It is stated that EDC activities are becoming increasingly footloose and will easily relocate when location conditions are declining [Ernst & Young ILAS et al., 2002, p. 21]. An EDC is footloose if its long-run profitability is the same for any location in the economy [see Geenhuizen van and Nijkamp, 2005]. In contrast, economists mention the inertial effect of a firm's spatial structure what makes that firm locations are not lightly abandoned [Pellenbarg, 1985, p. 94-96] [Dicken and Lloyd, 1990, p. 322] [Harrington and Warf, 1995, p. 148] [Ligt de, 1998, p. 129-130] [Wintjes, 2001, p. 34-47]. These authors mention the following main sources of "location inertia": large fixed prior capital investments of an organization in its operations in a particular place; a local work force with specialized knowledge and skills has been assembled; the total labor force outside the organization is understood; supply and distribution networks are location specific and expensive to modify (for example due to: large fixed capital investments; long term contracts and commitments between local buyers and suppliers; or high degrees of cooperation to share risk and innovation between local firms); large local base of buyers and suppliers; long-standing relationships with the local business community (for example: local banks and credit agencies; specialized technical expertise; and local government); political pressure; and risk avoiding behavior of the organization's executives.

It can be seen that many sources of location inertia relate to economies of agglomeration. Marshall [1920, p. 271] already recognized that economies of agglomeration can generate something like a lock-in effect [see also Fujita and Mori, 1996; Fujita and Thisse, 2002, p. 7]. Following Pellenbarg [1985, p. 54] we distinguish three forces that steer firm migration:

- push-out factors: forces that contribute to declining location conditions of a particular location and therefore push settled firms out of that location;
- pull-out factors: forces that attract established firms to other possible locations;
- keep factors: forces that keep established firms glued to their location.

Keep factors refer to threshold values and threshold effects. Keep forces produce inertia that can make push-out and pull-out forces ineffective when it comes to relocation. Consequently, we can say that if an individual EDC is locked into its location, keep forces win over push-out and pull-out forces [adapted from Pellenbarg, 1985, p. 96].

Regional governments, local governments and Schiphol work together in SADC and attempt to manage and control the allocation of scarce land, just outside the airport, to EDCs (see chapter 3). From the viewpoint of the company location policy for the Schiphol area as developed by the Dutch government it is highly undesirable when non-Schiphol-dependent EDCs become locked into their Schiphol location. Moreover, a strategy that such EDCs then may apply, to cope with the fallen transport speeds as a result of worsening road congestion in the wider Schiphol region, is to shift a part of their goods flows from road to air. In case the

goods flows of non-Schiphol-dependent EDCs can be characterized as low value-weight and non-perishable we can say that this modal shift results in transporting traditional sea freight by air.

5.5 Our conceptual model

Based on the above discussion, we now present our model of the clustering of EDCs near airport Schiphol [we also presented this model in Warffemius and Van der Hoorn, 2000; Warffemius, 2000; Warffemius and Van der Hoorn, 2003]. The model is shown in figure 5.1.

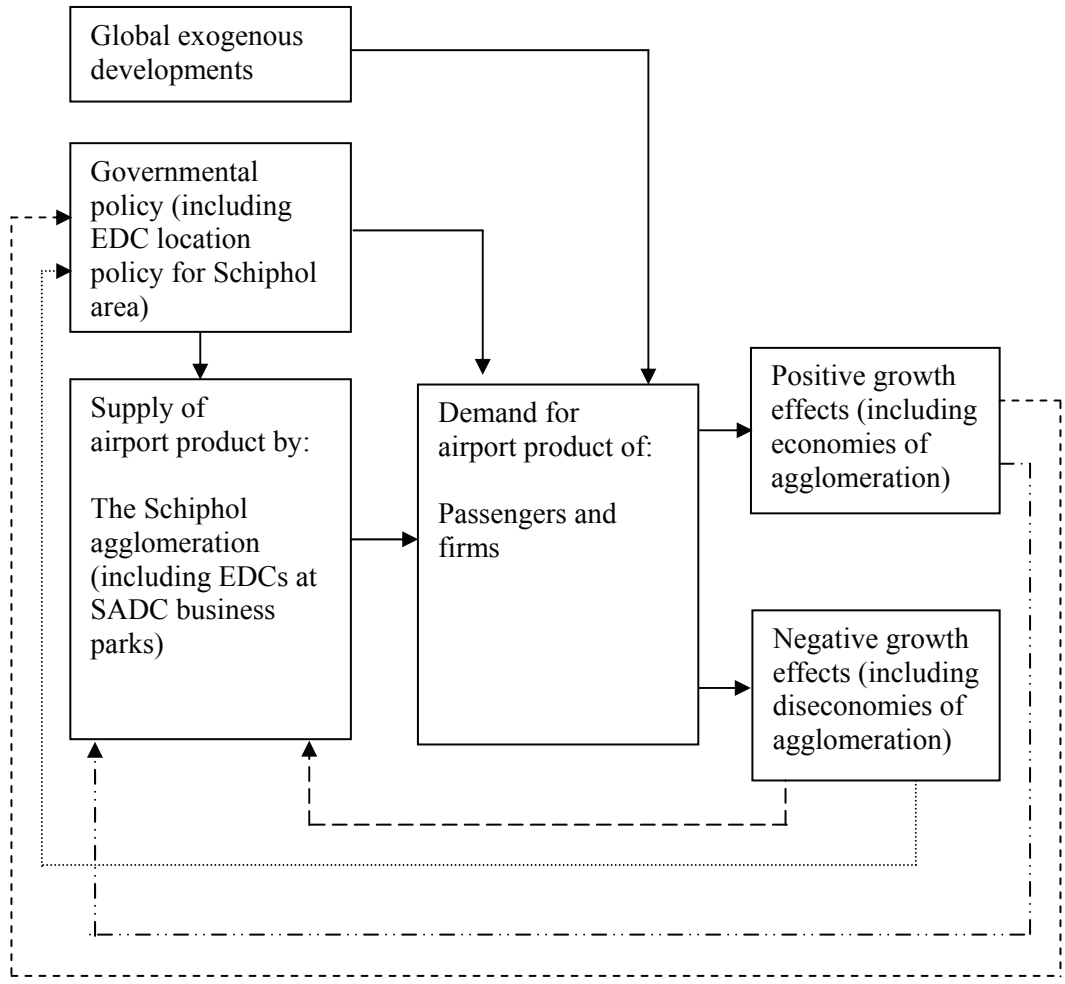

Figure 5.1: ***Conceptual model***
Object of research: ***Clustering of European Distribution Centers near Amsterdam Airport Schiphol***

Supply of airport product:
It is insufficient to view airport Schiphol as several runways for aircraft together with associated buildings or terminals where passengers or freight transported by the aircraft are processed. Schiphol is a complex industrial enterprise in which many activities are brought together to facilitate the interchange between air and surface transport for passengers and freight. Within this overall airport umbrella, firms that are located at or very close to Schiphol offer a wide range of supporting services and facilities, such as: passenger and goods transfer; air traffic control services; meteorological services; police and security; fire and ambulance services; cleaning and maintenance; aircraft parking; aircraft handling and cleaning; cargo handling; logistics services; baggage handling; car-parking services; passenger check-in; flight information; ticketing; tourist services; fashion boutiques; duty-free shops; bars and restaurants; merchandising kiosks; car-hire; congressional services; hotels; banks; customs; consulting services to other airports; establishment of business parks; and real estate development. Together, the Schiphol agglomeration provides the so called "airport product" [Kramer, 1990, p. 15]. The SADC business parks as well as the EDCs that are located there are part of the Schiphol agglomeration and contribute to the airport product.

In this thesis we focus on a specific part of the airport product, namely the location factors offered by the Schiphol region. We aim to disentangle the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that region. We investigate the EDCs that are settled at the SADC business parks. Fore those EDCs, equation (5.1) can be written as:

$$R_{SPL}^{F} = E_{SPL}^{F} + A(y_{SPL}) \tag{5.3}$$

Where:
R_{SPL}^{F} are the returns to firm (or EDC) F for locating in Schiphol location SPL,
E_{SPL}^{F} are the benefits to firm F due to the endowments of Schiphol location SPL and,
$A(y_{SPL})$ are the benefits to firm F due to economies of agglomeration of Schiphol location SPL from having y_{SPL} firms already located.

There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. We define the principal sources of economies of agglomeration in conformity with the Marshallian externalities. Furthermore, we distinguish between two types of location endowments of the Schiphol region, namely:

- Specific airport endowments, such as: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and landing fees; air fares; waiting time spent in terminals; and time and costs of getting to and from the airport.

- Non-airport endowments, such as: availability of fertile land; availability of natural resources; climate; access to the sea; labor costs; land prices; and transportation costs.

To understand the clustering of EDCs in the Schiphol area, it is essential to know whether the EDCs are attracted into the airport region due to the specific airport endowments or due to economies of agglomeration. The issue of locked-in logistics can be found within the box "Supply of airport product". Regarding locked-in logistics we investigate whether EDCs, once settled in the SADC area, become locked into their Schiphol location and/ or transport mode.

Demand for airport product:
It can be seen that the airport product must be conceived as a broad product or service package. In other words, the Schiphol agglomeration is a multi-product provider. Demand for one or more of the products or services provided by the Schiphol agglomeration comes from individual passengers and firms.

In this thesis we focus on a specific part of this total demand, namely the demand of EDCs for industry locations near Schiphol. To be more specific, we investigate whether EDCs, that are settled in the SADC area, were attracted into that area due to its location endowments or its agglomeration economies.

Global exogenous developments:
Examples of important exogenous developments affecting the demand for the airport product are: international and national economy growth; inflation; growth of world trade; exchange rate of the US Dollar; oil price; liberalization and deregulation of the US and European air transport market; rise of low cost airlines; construction of infrastructure for High-Speed Trains; Just-In-Time logistics and the continuing request to reduce inventories; and the switch to central European distribution from holding inventories at national and regional warehouses.

Governmental policy:
In a wide variety of ways, different levels of the Dutch government affect the supply of and demand for the airport product. Examples are: airport privatization; customs policies; Schiphol's infrastructure and surface access; aviation safety and security; restrictions on the volume of aircraft movements; noise limits; night flight regime; restrictions on runway slots; and industry location conditions around the airport.

In this thesis we focus on the EDC location policy for the Schiphol area. To formulate and implement this policy, regional governments, local governments and Schiphol work together in SADC (see chapter 3). We stress that the EDC location policy is embedded in a wider set of policies, all affecting the nature of the SADC location conditions and the EDC location behavior. Examples of those policies are: spatial policy; transport policy; environmental policy; and economic policy including customs policy, tax policy and trade policy. Thus, other policies can strengthen or weaken the EDC location policy. To manage and control the allocation of scarce SADC sites to EDCs, the compounded wider policy environment must achieve joint action and cooperation.

Positive growth effects:
Airports essentially have four potential types of impact on the economy in their region [Button and Stough, 2000, p. 237-240]. Primary effects are the benefits to the region of the construction or expansion of the facility such as local employment required in the construction process and the work done by local contractors. Secondary effects are longer term effects and are associated with the local economic benefits of running and operating the airport. The employment in maintaining the facility, in handling the aircraft and passengers, in transporting people and cargo to and from the terminal and so on. Tertiary effects stem from the stimulus enjoyed by the local economy as the result of firms and individuals having air transport services at their disposal. Finally, the construction of a new airport or major enlargement of an existing facility may act to set in progress a much larger and longer term development process in the airport region [see also Kramer, 1990, p. 16]. By initially attracting firms and activities into the airport region in sufficient numbers, airport development can lead to a favorable economic environment. The regional economy can feed on this and accelerate its growth.

In this thesis we focus on the latter type of dynamic economic impact of airport Schiphol. To be more specific, we investigate the clustering of EDCs at the SADC business parks. We aim to disentangle the location forces exerted by the location endowments and the agglomeration economies of the Schiphol region. A growing Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration. This can start a process of circular and cumulative causation. In this chapter, economies of agglomeration have been discussed extensively. Below we address benefits in terms of specific airport endowments that can result from airport development.

As an airport increases its traffic throughput, three economies can be distinguished: scale, density and scope [Button et al., 1998, p. 269-270] [Button and Stough, 2000, p. 233]. There are economies of scale in airport operations. As an airport increases its traffic throughput, the costs per unit of traffic fall sharply and flatten out as traffic grows beyond a certain level. Doganis [1992, p. 49-50] mentions that there is no evidence that in the long term there are any significant internal diseconomies of scale which would push up unit costs when airports start to get very large. Furthermore, not only Schiphol but also the airlines that serve the airport can enjoy economies of scale as the airport grows. These cost savings are termed economies of density and scope. They come from the airline's ability to feed high volumes of traffic through a large airport on banks of flights from a variety of origins and with passengers and freight destined for a variety of other cities. Traffic density economies imply that, given aircraft capacity, the costs per unit of traffic will decrease when traffic density on routes served increases. In general, more passengers and freight on a route imply greater load factors and a better fleet utilization. Moreover, higher levels of traffic density enable the use of larger size aircraft, thereby reducing associated costs of operations. Scope economies imply that the airline's total costs of providing services separately on each individual route is greater than the costs of joint production of services. Here, the economies are synergies resulting from the bundling of different traffic flows. The use of a major airport, through which traffic is funneled, introduces conditions of joint production which can intensify scope economies.

The scale, density and scope economies have a major effect on the choice of an airline network structure. As Schiphol increases its traffic throughput, it induces airlines to choose for Schiphol as a node or hub in their network structure. It can be seen that attracting airlines serving Schiphol can lead to favorable specific airport endowments which, in turn, support further growth of Schiphol's traffic throughput.

We stress that economies of density and scope are specific forms of scale economies that not only can be applied to airports but also to EDCs. As an EDC increases its throughput, warehousing and transport operations can gain economies of scale, density and scope.

Recall that within New Economic Geography basically two levels of aggregation are distinguished on which increasing returns to scale might occur. First, economies of scale within a firm. Second, economies of agglomeration or scale economies internal to the cluster of firms. Schiphol and the EDCs are firms within the Schiphol agglomeration that can enjoy economies of scale, density and scope.

Negative growth effects:
Increasing demand for the airport product can lead to diseconomies in terms of location endowments and agglomeration effects of the Schiphol region. Diseconomies of agglomeration have already been discussed and illustrated in this chapter. Now, we address diseconomies in terms of specific airport endowments that can result from airport development.

As an airport increases its traffic throughput, airport congestion (congested runways, congested terminals, and congestion in the air) may also increase. Especially the banking of flights at an airport can result in periodic congestion at the airport as well as at the roads to and from the airport. Moreover, when the number of banks per day is relatively small it can lead to considerable periods of idle time where ground staff and other resources are left with little to do and aircraft are used much less effectively [Button and Stough, 2000, p. 234].

An other important economic characteristic of airports is that major development programs push up costs per unit of traffic [Doganis, 1992, p. 50-51]. Airports by their very nature require relatively large indivisible investments in additional terminals or runways. Where airports undertake major expansion and development programs which are too large in relation to immediate traffic needs or which are undertaken too soon, the short term and medium term effect is that unit costs rise significant. This is not only because the airport's depreciation and other capital costs go up but also because operating costs rise. For example, a major new terminal has to be heated, lighted, cleaned, maintained and staffed even if the number of passengers using it is well below the design capacity. Airports having undertaken major expansion schemes often find themselves losing money. It is in the longer term, when traffic builds up to make better use of the expanded facilities, that profitability is restored.

Furthermore, a concentration of traffic at an airport can lead to safety issues. It also means environmental intrusion for those living in the region. The Dutch government applies restrictions on noise and runway slots. At Schiphol, the governmental restrictions combined with the high growth of air traffic can easily result in airport congestion (congested runways,

congested terminals, and congestion in the air). In general, the worsening of specific airport endowments can make that airlines decide to withdraw their services from the airport.

In this thesis, we concentrate on diseconomies of the growing Schiphol agglomeration that create worsening location conditions for the EDCs that are settled in the SADC area. We categorize these diseconomies as follows:

- Worsening location conditions that mainly can be attributed to the growing EDC cluster at the SADC business parks. Examples are: overcrowded business parks; rising land costs resulting in higher costs for renting or leasing warehouse space; congested routes from the business parks to connecting roads and to Schiphol; and growing demand for logistics staff resulting in higher recruitment costs.
- Worsening location conditions that only for a minor part can be attributed to the growing EDC cluster at the SADC business parks. Examples are: increasing road congestion in the wider Schiphol region; and increasing congestion at airport Schiphol (congested runways, congested terminals, and congestion in the air).

Policy implications:
Researchers demonstrate that New Economic Geography models have a number of properties that makes policy analysis very different compared to standard neoclassical location models [Fujita and Mori, 1996] [Baldwin et al., 2003, p. 227-232]. Our model exhibits four of such properties yielding important implications for the EDC location policy:

- non-linear effects in the process of attracting EDCs;
- quasi-permanent EDC location effects;
- quasi-permanent EDC transport mode effects;
- non-linear effects in the process of pushing-out EDCs.

Non-linear effects in the process of attracting EDCs:
A growing Schiphol agglomeration can lead to economies in terms of location endowments and economies of agglomeration. Attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering a self-reinforcing growth process. Below the threshold, a small variation in location policy can result in a small effect on the growth rate of the EDC cluster. From that, policy makers may conclude that the clustering of EDCs is not much affected by policy changes. However, a marginal policy variation can have non-linear effects when the thresholds are crossed. The possibility of non-linear responses makes it much more difficult to forecast the effect of a given policy change. It implies that the same intervention can have different impacts the first and second time it is applied. Unless policy makers are aware of the non-linearity, estimates based on historical data may provide a very misleading indication of what future policy changes will do [see also Baldwin et al., 2003, p. 227-232].

Quasi-permanent EDC location effects:
EDCs, once settled at the SADC business parks, can become locked into their location. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to relocation. From the viewpoint of the company location policy for the Schiphol area as developed by the Dutch government it is highly undesirable when non-Schiphol-dependent EDCs become locked into their Schiphol location. It can be seen that a bad EDC location policy, even when it is temporary, may have long-lasting bad effects. Moreover, reversing these effects may be difficult and may require a policy reform that is much larger than the policy change that led to the initial effect. In other words, the impact of the policy need not be reversed when the policy is reversed [see also Baldwin et al., 2003, p. 227-232].

Quasi-permanent EDC transport mode effects:
A small policy intervention that is ineffective in terms of relocation of EDCs can, however, result in a modal shift for freight. The policy intervention may have long-lasting effects if EDCs become locked into their new transport mode. The impact of the policy need not be reversed when the policy is reversed.

Non-linear effects in the process of pushing-out EDCs:
EDCs, once settled in the SADC area, can become locked into their location making small policy interventions ineffective when it comes to relocation. However, once the level of the policy instrument crosses some threshold –that is, when push-out and pull-out forces outweigh keep forces- EDCs will move. And as EDCs start to locate away from the Schiphol agglomeration, the size of its agglomeration economies decreases, making the location even less attractive. The outcome can be a massive relocation of EDCs [see also Baldwin et al., 2003, p. 227-232].

5.6 Conclusions

In this chapter we have constructed our model of the clustering of EDCs near airport Schiphol. It is based on New Economic Geography insights and provides the theoretical framework to address the research questions as presented in chapter 1. In our model the following location forces interplay in the making of the EDC cluster:

- location endowments;
- economies of agglomeration;
- locked-in logistics.

We started out by separating the location endowments into non-airport endowments and specific airport endowments. The latter are location factors such as: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and

landing fees; air fares; waiting time spent in terminals; and time and costs of getting to and from the airport. To understand the clustering of EDCs in the Schiphol area, it is essential to know whether they are attracted into the airport region due to the specific airport endowments or due to economies of agglomeration. Therefore, we disentangle the location forces exerted by the location endowments and the economies of agglomeration.

There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. From the New Economic Geography literature we obtained four principal sources of economies of agglomeration that are clearly operating in the Schiphol region, namely: (1) linkages (or input-output relationships) between firms associated with large local markets, the build-up of specialized input services, and internal economies of scale; (2) thick markets allowing the formation of a highly specialized labor force; (3) knowledge spillovers; (4) existence of modern infrastructure. These are the so called "Marshallian externalities". The literature often centers on the concept of these externalities as principle reason for why economic activities concentrate in geographical space. We follow this line and use the Marshallian externalities as a general framework to define and describe the sources of economies of agglomeration.

We model pressures to change on the one hand and resistance to change on the other hand. Resistance to change refers to threshold values and threshold effects. Once the pressures to change –such as policy interventions or worsening location conditions- cross some threshold, EDCs will change. Thresholds produce inertia. We introduced two situations of logistics inertia -or locked-in logistics- for EDCs that refer to very high threshold values. First, an EDC can become locked into its transportation mode. Second, an EDC can become locked into its Schiphol location.

In our model, the clustering of EDCs has a self-reinforcing character. That is, attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering the self-reinforcing growth process. Furthermore, due to locked-in logistics our model exhibits phenomena of irreversibility.

We applied the theoretical framework of New Economic Geography to develop a new model of spatial economic development of the Schiphol area. Our model has a number of properties that makes policy analysis very different to standard neoclassical location models. These properties arise because of the threshold effects in the model. This yields important implications for the EDC location policy. Our model explains that marginal policy interventions may have no impact on the growth rate of the EDC cluster as long as the level of the policy instrument remains below a threshold value but that the same policy intervention can have a large effect when the threshold is crossed. The possibility of such non-linear responses makes it much more difficult to forecast the effects of EDC location policy.

6. Designing the survey to assess our model

6.1 Introduction

In chapter 5 we have presented our model of the clustering of EDCs near airport Schiphol. It is based on New Economic Geography insights and provides the theoretical framework to address the research questions as presented in chapter 1. In order to assess the empirical relevance and explanatory power of our model we performed empirical research. From the model we deduced hypotheses that have been tested. We conducted a cross-sectional survey and collected data at the year 2000 over two populations:

- national-EDC-population;
- Schiphol-EDC-population.

The Schiphol-EDC-population is the warehouse cluster at the business parks of the Schiphol Area Development Company (SADC). These business parks are situated in Schiphol's surrounding areas. The national-EDC-population consists of the warehouses that are located elsewhere in The Netherlands. The populations have been compared and tested for similarities and differences. In this chapter we address the methods of data collection we applied. Moreover, we examine how we ensured validity and reliability of the data. On validity and reliability we followed the definitions as given in Stopher and Jones [2003, p. 241-242]. Validity of the data collected is defined as the extent to which the instrument measures what it is supposed to measure. Reliability refers to whether the measure will yield the same results on different occasions assuming no real change in what is to be measured.

This chapter starts with the presentation of the testable hypotheses. Subsequently we address our survey design, that is: selection of the survey method; defining the EDC populations and the sampling unit; selection of respondents; the obtaining of responses; validity of the survey data; and questionnaire design. Here we clearly describe how and what data have been collected, and which constructs, definitions and measurement scales have been used.

6.2 The testable hypotheses

In order to assess the empirical relevance and explanatory power of our model we performed empirical research and hypothesis testing. From our model we deduced the following generalizing statements in the form of testable hypotheses:

H1: The EDCs that are located at the SADC business parks have been attracted into the area mainly because of economies of agglomeration operating in the Schiphol region.

There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. We define the principal sources of economies of agglomeration in conformity with the Marshallian externalities (see chapter 5). If hypothesis 1 is true -that is, if we are led to the conclusion that the specific airport endowments of Schiphol are not the main location factors- the question arises whether the EDC population in the SADC area differs from the EDC population located elsewhere in The Netherlands. These considerations lead to the following hypotheses:

H2: With respect to general warehouse characteristics, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.

H3: With respect to location factors on which the choice of location is based, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.

H4: With respect to the proportion of warehouses that are locked into their location, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.

H5: With respect to origin and destination of goods flows, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.

H6: With respect to the use of air cargo, the EDC population in the SADC area differs from the EDC population located elsewhere in The Netherlands.

EDCs, once settled at the SADC business parks, can become locked into their transport mode and/ or their location. In the Schiphol area, we expect to find very high threshold values producing inertia that can make pressures to change –such as

worsening location conditions or policy interventions- ineffective when it comes to making a modal shift for freight or relocation of the EDC facility. In this thesis we focus on increasing congestion as a pressure to change. These considerations lead to the following hypotheses:

H7: The EDCs in the SADC area will not react to increasing congestion by relocating the EDC facility.

H8: For those EDCs in the SADC area which do not relocate; They will not react to increasing congestion by changing the composition and relative importance of the transportation modes used.

In order to test these hypotheses, we need to clarify how and what data have been collected, and which constructs, definitions and measurement scales have been used. This is addressed in the rest of the chapter.

6.3 Selection of survey method

Selection of survey time frame
The data collection method we applied is survey research. One basic decision which must be made for all surveys is the choice of time frame for the data collection effort. It is possible to collect data from a cross-sectional survey or a time-series survey [Richardson et al., 1995, p. 34-42]. A cross-sectional survey involves the collection of data at one point in time over a large number of identifiable groups which constitute a fraction of the total population. Whereas a time-series survey involves the collection of data using the same survey method at a number of successive points in time. We conducted a cross-sectional survey and collected data at the year 2000.

The survey data we collected were subjected to testing whether correlations exist between variables. However, cross-sectional surveys can not explain why observed correlations between variables exist. The question whether an correlation exists is about statistical significance, while the question why this correlation exists is about causality. Van Dalen and De Leede [2000, p. 22-23] point out that causality comes from subjective interpretations. Thus, whereas significance is objective, causality is subjective. Statistical theory [Dalen van and De Leede, 2000, p. 23-24] provides us with two approaches to handle the problem of causal interpretation of correlations, namely: a priori and a posteriori causality. A priori causality starts with making the expected causalities explicit. Then, it is tested whether the assumptions are supported by statistical significance. We follow this approach. A posteriori causality starts with the determination of statistical significant correlations. Causality is then found through interpretation of these correlations.

Selection of survey mode
There is an increasing diversity of techniques available for collecting survey information. The literature [Richardson et al., 1995, p. 42] [Stopher and Jones, 2003, p. 242] essentially mentions four different data collection methods or survey modes, namely: postal self-completion surveys; face-to-face interviews; telephone surveys; and internet (web) surveys. Each data collection technique has its own peculiar survey errors and limitations. Stopher and Jones [2003, p. 243-250] [see also Richardson et al., 1995, p. 42-71] have compared the performance of the different survey modes across the following attributes: coverage; response rate; data quality; suited to situations where there are many different languages spoken; does the mode permit complex or in-depth questions to be asked; costs; data verification and consistency; and specific cultural issues. Face-to-face interviews perform well on most attributes, except costs. Telephone surveys also do well on most attributes, however coverage is less than complete. In postal self-completion surveys issues of data quality can be a concern. Whereas in internet surveys sample coverage and selectivity bias place limits on the utility of the data unless other response options are also provided.

Many surveys are effectively a hybrid of two or more of the primary methods of data collection [Stopher and Jones, 2003, p. 242]. For example, surveys that are primarily collected by postal methods may include telephone follow-up interviews to verify responses or to obtain data that may have been omitted. We adopted two survey modes for the gathering of data. For the national-EDC-population we used postal self-completion questionnaires. Whereas for the Schiphol-EDC-population we used structured face-to-face interviews.

6.4 Defining the sampling unit and population

Defining the sampling unit and unit of analysis
About 75% of the EDCs that are located in The Netherlands are contracted out to a Logistics Service Provider or LSP (subcontractor). The warehouse of an LSP can contain one or more EDCs.

> *Therefore, we used the following construct as being sampling unit and unit of analysis: "warehouses that contain one or more EDCs". Thus, warehouses instead of individual EDCs form the sampling unit as well as the unit of analysis. This is illustrated in figure 6.1.*

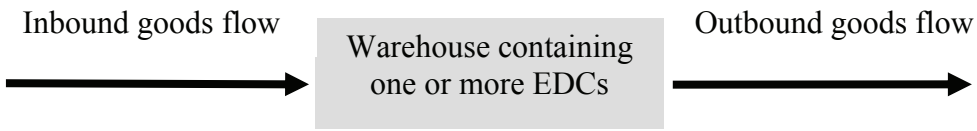

Figure 6.1: Warehouses are sampling unit and unit of analysis

Defining the population
We conducted a cross-sectional survey and collected data at the year 2000 over two populations: the national-EDC-population and the Schiphol-EDC-population. Consequently, we defined both populations as follows:

> *The national-EDC-population consists of own account as well as subcontracted warehouses that contain one or more EDCs and are located in The Netherlands.*
>
> *The Schiphol-EDC-population consists of own account as well as subcontracted warehouses that contain one or more EDCs and are located at the SADC business parks.*

The Schiphol-EDC-population is a subset of the national-EDC-population. For gathering data from the national-EDC-population we used the national-EDC-survey. For the Schiphol-EDC-population we used the Schiphol-EDC-survey. The surveys are addressed below.

6.5 National-EDC-survey: sample design

Selection of respondents and obtaining the responses
Here we participated in a larger EDC research project [see Koster de and Warffemius, 2005]. For gathering data from the national-EDC-population, we used postal self-completion questionnaires. In cooperation with Holland International Distribution Council (HIDC) we composed a list of addresses. This council organizes regular survey research among EDCs in The Netherlands. We aimed at a full 100% sample or "census". Every warehouse of the population had an equal probability of being selected for the sample. In other words, we used the simplest form of sample, namely the random sample.

Before the data collection phase the questionnaire was subjected to a pilot test that was carried out among a small group of logistics professionals. The test provided: an estimate of the time needed for responding to the questionnaire; comments on perceived ambiguities in the questions; and recommendations on additional questions.

In October 2000, we sent the questionnaire together with an introductory letter (see appendix 6.1) to approximately 400 warehouses by mail. We addressed the questionnaire to logistics managers because we may expect that they have a thorough knowledge of, and insight in, all logistics aspects on warehousing and distribution. To maximize the response rate, the introductory letter included: the goal of the survey; information on the usage of the survey results; the importance of participating; assurance of respondent anonymity; an incentive for participation; and a postage-paid return envelope. Logistics managers who did not respond were re-contacted by telephone. It turned out that these telephone calls were crucial in the process of obtaining response.

In cooperation with Holland International Distribution Council, responses were scrutinized for completeness and errors. If necessary, response validation was obtained by re-contacting logistics managers whose answers appeared inconsistent or unusual. For response validation we re-contacted about 10% of the respondents. Finally, we collected 63 well filled out questionnaires. The respondents (that are 63 warehouses) are listed in appendix 6.2. They represent 128 EDCs. In 2001 the number of EDCs in The Netherlands was 650. Thus, our response rate is about 20%. Muilerman [2001, p. 104-106] shows that logistics surveys using postal self-administered questionnaires have low response rates in general. The question whether our sample is truly representative is addressed below.

Estimating the validity of the survey data

In 1997, Buck Consultants International (BCI) presented an extensive study on the EDC population in The Netherlands [BCI, 1997]. We tested our sample for validity through comparing our sample with the BCI sample on the variables that are present in both samples. The comparison is presented in table 6.1.

Table 6.1: Testing for the difference between proportions from the two samples using the chi-square test

	Percentage of EDCs in sample		Chi-square test α= 0.05
Variables	BCI sample (N= 553 EDCs)	Our sample (N= 128 EDCs)	Difference between proportions
EDCs contracted out to a Logistics Service Provider (LSP)	78	73	Not significant $\chi_1^2 = 1.34$ p-value= 0.25
Self operated (own-account) EDCs	22	27	Not significant $\chi_1^2 = 1.34$ p-value= 0.25
EDCs contracted out to a dedicated LSP	5	6	Not significant $\chi_1^2 = 0.09$ p-value= 0.75
EDCs contracted out to a public LSP	73	67	Not significant $\chi_1^2 = 1.95$ p-value= 0.20
Asian own-account EDCs	8	15	Significant $\chi_1^2 = 5.07$ p-value= 0.025
North American own-account EDCs	13	9	Not significant $\chi_1^2 = 0.95$ p-value= 0.40
European own-account EDCs	1	3	Minimum expected frequency< 5

Note: Data on the BCI sample are taken from BCI, 1997

As can be seen from table 6.1, for each variable we tested whether there is evidence of a difference between proportions through a two-way contingency table indicating frequencies. Here, the test statistic is chi-square with 1 degree of freedom. Because of this 1 degree of freedom we applied the Yates Correction on calculating chi-square. The critical value of the chi-square distribution for $\alpha = 0.05$ and 1 degree of freedom is 3.841. The null hypothesis of equality was rejected when the computed value of the test statistic is greater than the critical value. Then, the p-value (or observed level of significance) is smaller than α. The chi-square test assumes that there are at least five theoretical frequencies in each cell of the contingency table. This assumption is important particularly for the 2 x 2 contingency table which has only 1 degree of freedom. The assumption is not met for the variable "European own-account EDCs".

The table shows that, in comparison with the BCI study, our sample is slightly biased with respect to the warehouse origin and that it is not biased between own-account and outsourced EDCs. In sum, we conclude that our database is sufficiently representative to draw meaningful conclusions.

6.6 National-EDC-survey: questionnaire design

The questionnaire is given in appendix 6.3. Recall that we participated in a larger EDC research project. Therefore the questionnaire also covers topics and questions beyond the scope of this thesis. In the questionnaire, the questions related to this thesis are printed in Italic and include the following topics: general warehouse characteristics; location factors on the choice of the warehouse location; lock-in regarding warehouse location; origin and destination of goods flows; and the use of air cargo. The topics are addressed in greater detail below.

General warehouse characteristics
We measured the following variables on general warehouse characteristics:

- warehouse location: city where the warehouse is located,
- warehouse classification: own-account; subcontracted; dedicated; public,
- number of main EDCs in the warehouse,
- Value Added Logistics (VAL) provided in the warehouse: yes; no,
- warehouse sector, such as: ICT and computers; photo and film industry; pharmaceutical products; aviation industry; automotive; fashion and clothing,
- number of employees: full-timers plus part-timers,
- size of the warehouse: less than 1000 m^2; 1000-3000 m^2; 3000-5000 m^2; 5000-10,000 m^2; 10,000-20,000 m^2; more than 20,000 m^2,
- capital invested in the warehouse building: less than 2 million Euro; 2-5 million Euro; 5-10 million Euro; 10-15 million Euro; 15-25 million Euro; 25-40 million Euro; 40-60 million Euro; more than 60 million Euro,

- capital invested in logistics systems within the warehouse: less than 2 million Euro; 2-5 million Euro; 5-10 million Euro; 10-15 million Euro; 15-25 million Euro; 25-40 million Euro; 40-60 million Euro; more than 60 million Euro,
- region of origin of the "parent company" of the warehouse: Asia; USA; Europe; other regions.

Location factors on the choice of the warehouse location

Here we apply the idea that location decisions may involve the sequential consideration of location factors at successively more limited geographical scales [e.g. Chapman and Walker, 1991, p. 50; Hagdorn-van der Meijden, 1996; Hayter, 1997, p. 147; Stock and Lambert, 2001, p. 415; Goor van et al., 2003, p. 183-185]. First we asked the logistics managers why The Netherlands was chosen for the establishment of the warehouse instead of other European countries. Then we asked the logistics managers to express why the specific warehouse location within The Netherlands was chosen. Both questions on location factors are open questions in which up to four location factors can be mentioned.

Lock-in regarding warehouse location

EDCs can become locked into their location. That is, high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to relocation. We can say that if an EDC is locked into its location, keep forces win over push-out and pull-out forces. We searched the literature for existing measures that accurately and completely capture the concept of location lock-in. An extensive discussion of measures used in logistics research can be found in Keller et al. [2002]. Because we did not found relevant existing measures, we had to develop a new tool to measure the concept. In order to test the individual warehouses for location lock-in we used the following questions:

- First we asked the logistics managers: "Imagine that you can choose a new location for the establishment of your warehouse; Would you decide for the current location or would you decide differently?". The answer categories are: current location; different location.

- Then we asked: "Will your warehouse operations move to a new location within a period of 2 years?". The answer categories are: no; very unlikely; unlikely; likely; very likely; yes.

- If the following conditions were met we indicated that a warehouse was locked into its location: the answer to the first question is "different location" and the answer to the second question is "no", "very unlikely", or "unlikely".

The two questions on location lock-in relate to stated behavior. A disadvantage of questions relating to stated behavior is that one can not be entirely sure whether the respondent will behave according to its statements [Richardson et al., 1995, p. 186] [Bruinsma and Rietveld,

1996, p. 6]. This is a rather fundamental problem that can not entirely be overcome. To reduce this problem, we presented a short time horizon of only two years in all questions relating to stated behavior.

Origin and destination of goods flows
We defined "origin of inbound goods flows of the warehouse" as "region where the main suppliers are located". We distinguished between the following regions of origin: Asia; USA; Europe; other regions. We asked the logistics managers to indicate the share of each region of origin expressed as a percentage of the total inbound goods flow of their warehouse. We measured the goods flows by volume (weight or units).

We defined "destination of outbound goods flows of the warehouse" as "region where the main customers are located". We distinguished between the following regions of destination: Asia; USA; Europe; other regions. We asked the logistics managers to indicate the share of each region of destination expressed as a percentage (by weight or units) of the total outbound goods flow of their warehouse.

Use of air cargo
The definition of air cargo (or air freight) is given by the existence of an "air waybill". Air cargo can be carried on air waybills –that is with a flight number- by: airplane; road (airport trucking); train.

We asked the logistics managers to indicate: (1) the share of inbound air cargo expressed as a percentage (by weight or units) of the total inbound goods flow of their warehouse, and (2) the share of outbound air cargo expressed as a percentage (by weight or units) of the total outbound goods flow of their warehouse. In the questionnaire we stressed that the volume of air cargo shipped is defined as the summation of air cargo volumes transported by airplane, truck, and train.

6.7 Schiphol-EDC-survey: sample design

For the Schiphol-EDC-population we accomplished the survey work through structured face-to-face interviews with logistics managers while for the national-EDC-population we used postal self-administered questionnaires. Here we used the personal interview mode because:

- The Schiphol-EDC-population is relatively small.
- Face-to-face interview surveys have been found generally to give higher response rates than self-completion surveys [Richardson et al., 1995, p. 58] [Stopher and Jones, 2003, p. 245]. Richardson et al. [1995, p. 58] indicate that response rates of the order of 75% to 85% are not uncommon.
- The possibilities offered to minimize survey errors, such as: clarifying the purpose of the research; ask follow-up questions; give additional explanation; respond to unrealistic answers; and building thrust [Richardson et al., 1995, p. 58-59] [Stopher and Jones, 2003, p. 245].

- The possibilities to ask complex questions which require a good deal of thought of the respondents [Richardson et al., 1995, p. 58-59] [Stopher and Jones, 2003, p. 245].

We composed a list of addresses in cooperation with SADC. We aimed at a full 100% sample. The Schiphol-EDC-population is a subset of the national-EDC-population. Thus here we worked with a stratified sample. Every warehouse of the Schiphol-EDC-population had an equal probability of being selected for the sample.

When we finished the draft version of the questionnaire instrument, we performed pilot testing through asking a small group of logistics professionals to comment on the questions. In May 2001, we started interviewing. We interviewed logistics managers due to their knowledge of, and insight in, all aspects on warehousing and distribution. If necessary, response validation was obtained by re-contacting logistics managers whose answers appeared to be inconsistent or unusual. In total, we interviewed 27 respondents. These warehouses are listed in appendix 6.4. They represent 61 EDCs. That is a response rate of 100%.

6.8 Schiphol-EDC-survey: questionnaire design

The questionnaire is given in appendix 6.5. It includes the following topics: general warehouse characteristics; location factors on the choice of the warehouse location; lock-in regarding warehouse location; origin and destination of goods flows; use of air cargo; and scenarios on increasing congestion. The topics are addressed in greater detail below. To be able to compare the national-EDC-population with the Schiphol-EDC-population, the two questionnaires we designed show great resemblance.

General warehouse characteristics
The same as in the national-EDC-survey.

Location factors on the choice of the warehouse location
The same as in the national-EDC-survey plus we used a standard list of location factors. After the logistics manager answered the open questions on location factors we handed the standard list over to him and requested to ring additional location factors on the list.

Lock-in regarding warehouse location
The same as in the national-EDC-survey plus we asked additional questions. In order to test the individual warehouses for location lock-in we used the following questions:

- First we asked the logistics managers: “Will your warehouse operations move to a new location within a period of 2 years?”. The answer categories are: no; unlikely; possibly; likely; yes.

- Then we asked: “Imagine that you can choose a new location for the establishment of your warehouse and that you can relocate the warehouse without costs; Would you

decide for the current location or would you decide differently?". The answer categories are: current location; different location. If the logistics managers ringed the answer category "different location" we asked to indicate this preferred warehouse location.

- If the following conditions were met we indicated that a warehouse was locked into its location: the answer to the first question is "no" or "unlikely" and the answer to the second question is "different location".

Moreover, we confronted the logistics managers with their responses and asked to express their underlying reasons. Through these open questions we obtained insight in the push-out-, pull-out, and keep forces that are experienced by the warehouses. If an EDC is locked into its location, keep forces outweigh push-out and pull-out forces.

Origin and destination of goods flows

The same as in the national-EDC-survey plus we asked additional questions. In addition we asked the logistics managers to break down the inbound and outbound goods flow of their warehouse as shown in figure 6.2 and 6.3. We asked the logistics managers to indicate the share of each sub-flow expressed as a percentage (by weight or units) of the total inbound and outbound goods flow of their warehouse.

(1) non European production plant → // → ship → seaport Rotterdam/ other European seaport → truck → warehouse SADC area
(2) non European production plant → // → airplane → airport Schiphol → truck → warehouse SADC area
(3) non European production plant → // → airplane → European airport other than Schiphol → truck → airport Schiphol → truck → warehouse SADC area
(4) non European production plant → // → airplane → European airport other than Schiphol → truck → warehouse SADC area
(5) European production plant → // → truck → warehouse SADC area
(6) other sub-flows

Figure 6.2: Total inbound goods flow broken down into sub-flows
Note: Goods flows between "//" are not described

(1) warehouse SADC area → truck → airport Schiphol → airplane → // → European customer
(2) warehouse SADC area → truck → airport Schiphol → truck → // → European customer
(3) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → airplane → // → European customer
(4) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → truck → // → European customer
(5) warehouse SADC area → truck → seaport Rotterdam/ other European seaport → ship → // → non European customer
(6) other sub-flows

Figure 6.3: Total outbound goods flow broken down into sub-flows
Note: Goods flows between "//" are not described

Use of air cargo
The same as in the national-EDC-survey plus we asked two additional questions. The first additional question is an open question where we asked the logistics managers to express why they make use of air cargo transport. Secondly we asked to indicate the share of traditional air freight expressed as a percentage (by weight or units) of the total inbound and outbound air cargo volume of the warehouse. Traditional air freight has a high value-weight ratio or is perishable.

Scenarios on increasing congestion
EDCs, once settled in the SADC area, can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make pressures to change -such as increasing congestion or policy interventions- ineffective when it comes to modal shift or relocation. Through the prior part of the questionnaire we obtained insight in location lock-in in the situational context and environment of the year 2000. To gain further insight in locked-in logistics and its threshold values we confronted the EDCs that are settled in the SADC area with hypothetical future situations of increasing congestion and asked the logistics managers to state their logistics adaptations to compensate for the congestion impacts on their business operations. In other words, we added an extra push-out factor to the situational context and environment of the year 2000.

Stated Adaptation:
We thus measured stated responses of the logistics managers. In the literature [Stopher and Jones, 2003, p. 334-335, p. 348], four groups of stated response data collection methods are distinguished:

- *Stated Preference*:
  Focus: trade-offs and utilities
  Method: choice experiments for conjoint analysis

Prototype question: "Given the levels of attributes in these alternatives, which would you prefer: (a)…., (b)….., etc. ?"

- *Stated Tolerance*:
  Focus: limits of acceptability and thresholds for change
  Method: transfer price, willingness to pay, and willingness to accept
  Prototype question: "Under what circumstances could you imagine yourself doing: (a)….., (b)…..., etc. ?"

- *Stated Adaptation*:
  Focus: reactive behavior and problem solving
  Method: gaming simulations and real-world experiments using scripts
  Prototype question: "What would you do differently if you were faced with the following specific constraints: (…..detailed scenario)"

- *Stated Prospect*:
  Focus: learning processes and information seeking
  Method: laboratory simulations and gaming simulations
  Prototype question: "Under what circumstances would you be likely to change your travel behavior and how would you go about it: (….broad context)"

We used the stated adaptation data collection method [Faivre d' Arcier et al., 1998] [Stopher and Jones, 2003, p. 365-375]. Stated adaptation is an interactive technique which allows us to obtain a picture of the attitudes and behaviors of respondents when they are confronted with hypothetical "what-if" games. It is a qualitative approach which is realized during an in-depth face-to-face interview. The main purpose of stated adaptation surveys is to explore the range of potential adaptation processes respondents undertake when they face certain conditions. There are two main groups of variables to consider. First the behavioral outcomes and second the constraints on behavior.

Stated adaptation differs from conventional stated preference exercises in that the respondent is fully free to state which response he can imagine when faced with several hypothetical situations. The hypothetical situations are used as a pretext to incite respondents to express their attitudes and let them imagine and assess the potential responses they could adopt.

Scenarios:
We used scenarios with incremental changes in congestion levels that were sufficiently great for the logistics managers to feel forced to consider making adaptations [see Faivre d' Arcier et al., 1998]. For the scenarios the reader is referred to the questionnaire (see appendix 6.5). The variable congestion is made up of two categories, namely:

- worsening road congestion in the Schiphol region;
- worsening airport congestion (congested runways, congested terminals, and congestion in the air).

We asked the logistics managers to state their logistics adaptations to compensate for the congestion impacts on their business operations. The respondents were fully free in mentioning logistics adaptations. We looked at all spatial-organizational changes, but focused on two logistics adjustment possibilities:

- making a modal shift for freight;
- relocation of the warehouse.

To and from the warehouses in the Schiphol area, freight can be transported by the following transport modes: airplane, truck, and train. In 2000, the year we collected our empirical data for this study, options for freight transport by rail as well as options for a modal shift to rail were still in their infancy. Therefore, we focused on two modal shift options:

- shift from air to road;
- shift from road to air.

We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking. In order to got the logistics managers respond realistically to the hypothetical situations of worsening congestion, we applied these changes in a framework the respondents already knew and experienced [see Faivre d' Arcier et al., 1998]. This framework is the logistics context and environment of the year 2000. All scenarios we presented to the logistics managers were applied to their in- and outbound logistics in that year. The scene-setting and order of presenting the scenarios is illustrated by the figures 6.4 to 6.6.

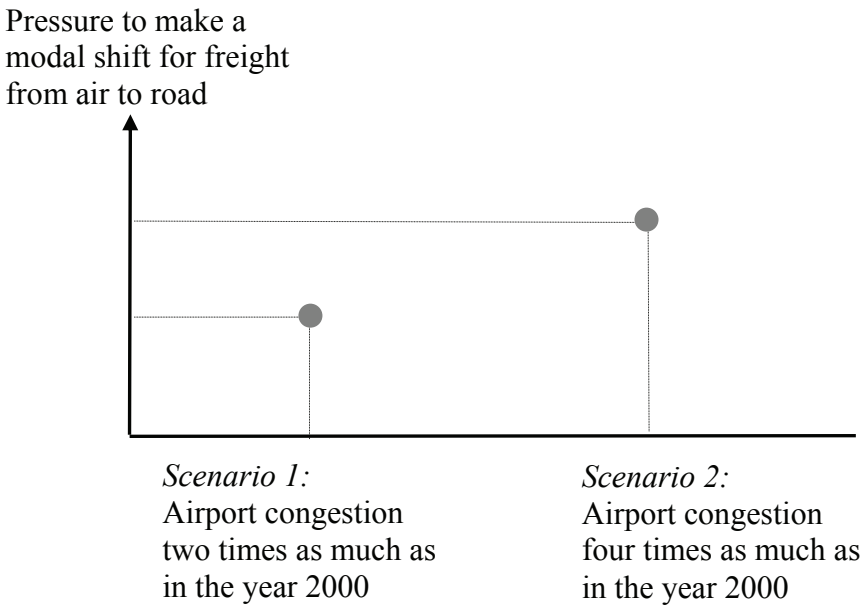

Figure 6.4: Scenario set 1- Increasing airport congestion while road congestion is stable at the 2000 level

Source: Adapted from Faivre d' Arcier et al., 1998

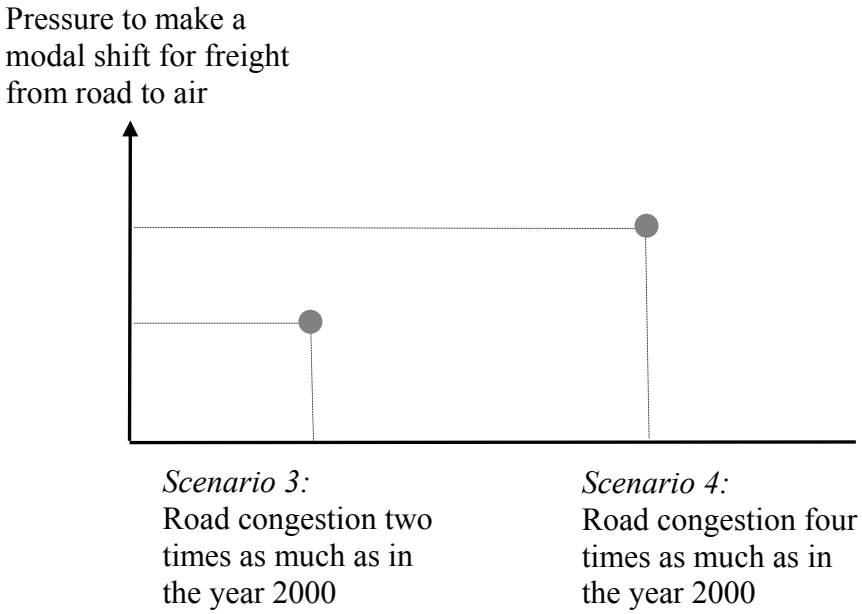

Figure 6.5: Scenario set 2- Increasing road congestion while airport congestion is stable at the 2000 level

Source: Adapted from Faivre d' Arcier et al., 1998

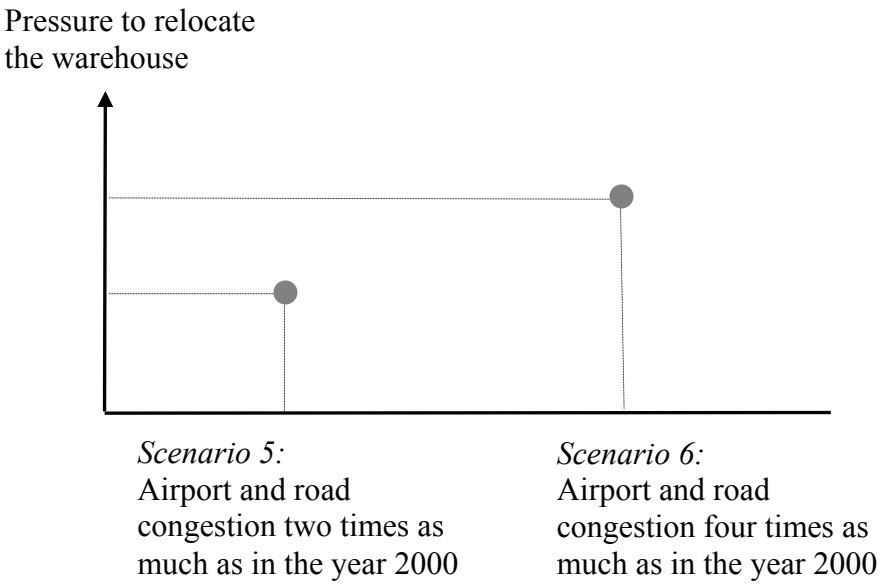

Figure 6.6: Scenario set 3- Increasing airport and road congestion
Source: Adapted from Faivre d' Arcier et al., 1998

We led the logistics managers to reveal gradually the logistics changes they considered [see Faivre d' Arcier et al., 1998]. The respondents could answer freely. We explored the range of potential adaptations the logistics managers may undertake when they face increasing congestion and the reasons underlying these adaptations. Examples of potential adaptations are: time shift to off-peak transportation; raise or lower the level of safety stock; make a modal shift for freight; investment at a new location; disinvestments at the existing warehouse, closure or disposal; relocation of the warehouse.

To make sure that the stated adaptations are realistic, we ascertained that the logistics managers have correctly understood the scenarios, tested the respondent's concentration and the effect of fatigue between the different scenarios, and checked whether the stated adaptations were plausible [Faivre d' Arcier et al., 1998] [Stopher and Jones, 2003, p. 372]. Wildly implausible responses may occur as a means the respondent uses to escape from the constraints as they become unbearable. In such cases, we pointed out that such an answer is not allowed in the game and rephrased the question.

6.9 Conclusions

In order to assess the empirical relevance and explanatory power of our model of the clustering of EDCs near airport Schiphol, we performed empirical research. From the model we deduced hypotheses that have been tested. We conducted a cross-sectional survey and collected data at the year 2000 over two populations:

- national-EDC-population;
- Schiphol-EDC-population.

The Schiphol-EDC-population is the warehouse cluster at the SADC business parks. Whereas the national-EDC-population consists of warehouses that are located elsewhere in The Netherlands. The populations have been compared and tested for similarities and differences. The chapter started with the presentation of the testable hypotheses. Then we addressed how and what data have been collected, and which constructs, definitions and measurement scales have been used.

About 75% of the EDCs that are located in The Netherlands are contracted out to a Logistics Service Provider or LSP (subcontractor). The warehouse of an LSP can contain one or more EDCs. Therefore, we used the following construct as being sampling unit and unit of analysis: "warehouses that contain one or more EDCs". Thus, warehouses instead of individual EDCs form the sampling unit as well as the unit of analysis.

For gathering data from the national-EDC-population we used postal self-completion questionnaires. In cooperation with Holland International Distribution Council (HIDC) we composed a list of addresses. This council organizes regular survey research among EDCs in The Netherlands. We aimed at a full 100% sample. We addressed the questionnaire to logistics managers because of their thorough knowledge of, and insight in, all logistics aspects on warehousing and distribution. We collected 63 well filled out questionnaires. That is a response rate of 20%. We examined the validity of our sample. In sum, we concluded that our database is sufficiently representative to draw meaningful conclusions.

For the Schiphol-EDC-population we accomplished the survey work through structured face-to-face interviews with logistics managers. We composed a list of addresses in cooperation with SADC. We aimed at a full 100% sample. In total, we interviewed 27 respondents. That is a response rate of 100%.

For the Schiphol-EDC-population we used the personal interview mode. This offered the possibility to ask complex questions which require a good deal of thought of the respondents. For example, we asked the logistics managers to break down the inbound and outbound goods flows of their warehouse. Through these data we can answer the question whether a distribution center is Schiphol- or non-Schiphol-dependent. Furthermore, we included a hypothetical "what-if" game to gain insight in locked-in logistics and its threshold values. In the game, we confronted the logistics managers with hypothetical future situations of increasing congestion and asked them to state their logistics adaptations to compensate for the congestion impacts on their business operations.

7. A key role for agglomeration economies and locked-in logistics

7.1 Introduction

In order to assess the empirical relevance and explanatory power of our model of the clustering of EDCs near airport Schiphol we performed empirical research. We conducted a cross-sectional survey and collected data at the year 2000 over two populations:

- national-EDC-population;
- Schiphol-EDC-population.

The Schiphol-EDC-population is the warehouse cluster at the business parks of the Schiphol Area Development Company (SADC). These business parks are situated in Schiphol's surrounding areas. The national-EDC-population consists of the warehouses located elsewhere in The Netherlands. The populations have been compared and tested for similarities and differences.

The chapter starts with presenting the results of the investigation of the Schiphol-EDC-population. More specifically, we address: transport modes used; location factors on the choice of the Schiphol location; reasons why air cargo transport is used; and lock-in regarding warehouse location. Then, the results on the comparison between the Schiphol- and the national-EDC-population are reported. Here we address similarities and differences on:

general warehouse characteristics; location factors on the choice of the warehouse location; lock-in regarding warehouse location; origin and destination of goods flows; and the use of air cargo.

Finally we show that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. Our model is based on New Economic Geography insights and has a number of properties that makes policy analysis very different to standard neoclassical location models. These properties arise because of the threshold effects in the model. We show that there are major threshold effects in the surrounding areas of Schiphol. This yields important implications for the EDC location policy. We explain that marginal policy interventions may have no impact on the growth rate of the EDC cluster as long as the policy instrument remains below a threshold value but that the same policy intervention can have a large effect when the threshold is crossed. The possibility of such non-linear responses makes it much more difficult to forecast the effect of a given policy change. Moreover, we show that the effects of the EDC location policy also exhibit phenomena of irreversibility due to locked-in logistics. In this connection, we discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. The new steering options utilize locked-in logistics.

7.2 Investigating the Schiphol-EDC-population

Here we present our results of the investigation of the Schiphol-EDC-population. We address: transport modes used; location factors on the choice of the Schiphol location; reasons why air cargo transport is used; and lock-in regarding warehouse location.

Transport modes used
Table 7.1 shows the modal split of the 27 surveyed warehouses in the SADC area. To and from these warehouses, freight can be transported by the transport modes airplane and truck. In 2000, the year we collected our empirical data for this study, options for freight transport by rail as well as options for a modal shift to rail were still in their infancy.

The definition of air cargo (or air freight) is given by the existence of an air waybill. To and from the warehouses in the Schiphol area, air cargo can be carried on air waybills –that is with a flight number- by airplane and truck (airport trucking). Examples of goods flows are given below. The goods flows between "//" are not described.

Examples of inbound goods flows:
Inbound goods flows received by airplane:
(*) non European production plant → // → airplane → airport Schiphol → truck → warehouse SADC area

Inbound goods flows received by truck (airport trucking plus conventional trucking):
(*) non European production plant → // → ship → seaport Rotterdam/ other European seaport → truck → warehouse SADC area

(*) non European production plant → // → airplane → European airport other than Schiphol → truck → airport Schiphol → truck → warehouse SADC area
(*) non European production plant → // → airplane → European airport other than Schiphol → truck → warehouse SADC area
(*) European production plant → // → truck → warehouse SADC area

Examples of outbound goods flows:
Outbound goods flows shipped by airplane:
(*) warehouse SADC area → truck → airport Schiphol → airplane → // → European customer

Outbound goods flows shipped by truck (airport trucking plus conventional trucking):
(*) warehouse SADC area → truck → airport Schiphol → truck → // → European customer
(*) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → airplane → // → European customer
(*) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → truck → // → European customer
(*) warehouse SADC area → truck → seaport Rotterdam/ other European seaport → ship → // → non European customer

Table 7.1: Reported shares of transport modes by the logistics managers

	Share of transport modes expressed as a percentage (by weight or units) of the total inbound goods flow			Share of transport modes expressed as a percentage (by weight or units) of the total outbound goods flow		
R	Air cargo received by plane (%)	Air cargo received by truck (%)	Non-air cargo received by truck (%)	Air cargo shipped by plane (%)	Air cargo shipped by truck (%)	Non-air cargo shipped by truck (%)
R1	10	0	90	17	0	83
R2	75	15	10	30	70	0
R3	14	26	60	25	25	50
R4	4	1	95	4	7	89
R5	90	0	10	54	10	36
R6	1	0	99	1	0	99
R7	98	0	2	66	24	10
R8	93	2	5	21	0	79
R9	35	20	45	10	30	60
R10	100	0	0	70	30	0
R11	10	0	90	5	0	95
R12	8	7	85	7	0	93
R13	3	2	95	8	25	67
R14	0	0	100	44	1	55
R15	100	0	0	50	40	10
R16	45	15	40	25	0	75
R17	4	0	96	5	1	94
R18	30	1	69	10	65	25
R19	60	0	40	18	9	73
R20	75	25	0	30	0	70
R21	100	0	0	20	10	70
R22	40	0	60	10	30	60
R23	5	0	95	0	0	100
R24	0	5	95	32	3	65
R25	15	0	85	2	0	98
R26	50	10	40	10	20	70
R27	3	0	97	2	16	82

Note 1: R= respondent

Note 2: The definition of air cargo is given by the existence of an air waybill

The column “Air cargo received by plane” gives the percentage of the goods flow (by weight or units) that is received by airplane via Schiphol. Together, the columns “Air cargo received by plane” and “Air cargo received by truck” give the percentage of the goods flow (by weight or units) that is received as air cargo via Schiphol. The same for the outbound goods flow. We used table 7.1 to construct the cumulative distributions as presented in tables 7.2 and 7.3.

Table 7.2: Cumulative distribution table of freight volumes transported by airplane via Schiphol

Maximum percentage of the in- and outbound goods flow that is transported by airplane via Schiphol	Warehouses that transport "less than" the indicated share (R= respondent)	Cumulative number of warehouses
5	R4, R6, R17, R23, R27	5
10	+ R11, R12, R13	8
20	+ R1, R25	10
30	+ R3, R18	12
40	+ R9, R22, R24	15
50	+ R14, R16, R26	18
60	+ R19	19
70	+	19
80	+ R2, R20	21
90	+ R5	22
100	+ R7, R8, R10, R15, R21	27

Source: ***Data are taken from table 7.1***
Note: ***Goods flows are measured by weight or units***

Table 7.3: Cumulative distribution table of freight volumes transported as air cargo via Schiphol

Maximum percentage of the in- and outbound goods flow that is transported as air cargo via Schiphol	Warehouses that transport "less than" the indicated share (R= respondent)	Cumulative number of warehouses
5	R6, R23	2
10	+ R11, R17	4
20	+ R1, R4, R12, R25, R27	9
30	+	9
40	+ R13, R22, R24	12
50	+ R3, R14	14
60	+ R9, R16, R19, R26	18
70	+	18
80	+ R18	19
90	+ R5	20
100	+ R2, R7, R8, R10, R15, R20, R21	27

Source: ***Data are taken from table 7.1***
Note: ***Goods flows are measured by weight or units***

Table 7.2 shows the warehouses that do not meet different shares of air cargo volumes transported by airplane while table 7.3 shows the warehouses that do not meet different shares of air cargo volumes transported by airplane and truck. However, the two groups of

warehouses that do not meet a share of 20% are almost identical. Recall our definition of a Schiphol-dependent EDC (see chapter 2).

> *A Schiphol-dependent EDC is an EDC that meets the following criteria: (1) a significant part of the inbound goods flows (by weight or units) is received via Schiphol by airplane or, (2) a significant part of the outbound goods flows (by weight or units) is shipped via Schiphol by airplane.*

The term "a significant part" points at a minimum volume. For different minimum volumes the corresponding Schiphol-dependent warehouses are given in table 7.2. In this thesis we apply a minimum level of 20%. Consequently, we define a Schiphol-dependent EDC as follows:

> *A Schiphol-dependent EDC is an EDC that meets the following criteria: (1) more than 20% of the inbound goods flows (by weight or units) is received via Schiphol by airplane or, (2) more than 20% of the outbound goods flows (by weight or units) is shipped via Schiphol by airplane.*

The Schiphol-dependent and non-Schiphol-dependent warehouses that relate to this definition are shown in table 7.4. Their general warehouse characteristics are given in appendix 7.1. We can see that almost 40% of the warehouses, that represent the EDC population in the SADC area, is non-Schiphol-dependent.

Table 7.4: Schiphol-dependent and non-Schiphol-dependent warehouses

Schiphol-dependent warehouses (N= 17)	Non-Schiphol-dependent warehouses (N= 10)
R2, R3, R5, R7, R8, R9, R10, R14, R15, R16, R18, R19, R20, R21, R22, R24, R26	R1, R4, R6, R11, R12, R13, R17, R23, R25, R27

Source: ***Data are taken from table 7.2***
Note 1: ***R= respondent***
Note2: ***Schiphol-dependent warehouses transport more than 20% of their in- or outbounds goods flows (by weight or units) by airplane via Schiphol***

Location factors on the choice of the Schiphol location
Recall hypothesis 1 (see chapter 6):

> ***Hypothesis 1:***
> *The EDCs that are located at the SADC business parks have been attracted into the area mainly because of economies of agglomeration operating in the Schiphol region.*

This hypothesis is tested by disentangling the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that region. There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. We defined the principal sources of economies of agglomeration in conformity with the Marshallian externalities (see chapter 5). Furthermore, we distinguish between two types of location endowments of the Schiphol region:

- Specific airport endowments, such as: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and landing fees; air fares; waiting time spent in terminals; and time and costs of getting to and from the airport.
- Non-airport endowments, such as: availability of fertile land; availability of natural resources; climate; access to the sea; labor costs; land prices; and transportation costs.

Table 7.5 shows the reported importance of location factors. First, each logistics manager was asked to express why the SADC area was chosen for the establishment of the warehouse. After he answered this open question, we handed a standard list of location factors over to him and requested to ring additional location factors on the list. We discriminate between location factors mentioned with and without help. Location factors mentioned spontaneously were given a score of 2 while location factors ringed on the list were given a score of 1. In conformity with our definitions of economies of agglomeration and location endowments we labeled the mentioned location factors as “A” (agglomeration economies), “E-a” (Endowment, specific airport), or “E-na” (Endowment, non-airport). The considerations underlying the labeling are discussed in greater detail in appendix 7.2.

Table 7.5: Importance of location factors on the choice of the SADC area

Location factors on the choice of the SADC area	Type	Warehouses mentioning location factor	Re-weighted frequencies
Proximity to former warehouse location	A	R1, R3, R4, R6, R8, R9, R11, R12, R13, R14, R16, R17, R19, R20, R21, R23, R24, R25, R26, R27	40
Proximity to airport Schiphol	E-a	R2, R3, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R17, R18, R19, R21, R24, R25	36
Availability of warehouse space/ land	A	R1, R4, R5, R13, R18, R20, R21, R23, R24, R25, R26	22
Accessibility by roads and rail	A	R1, R7, R8, R10, R13, R17, R18, R21, R25, R26	14
Proximity to logistics service providers (LSP)	A	R3, R7, R10, R13, R17, R24, R26	14
Quality of life for employees (*)	A	R10, R12, R18, R22, R26, R27	11
Status of immediate environment (**)	A	R1, R2, R10, R11, R20, R27	11
Number of flight destinations offered by airport Schiphol	E-a	R7, R10, R15, R18, R21, R24, R25	9
Proximity to our main customers	A	R4, R7, R11	6
Price/ rent of warehouse or land	E-na	R18, R23, R27	6
Flight frequencies offered by airport Schiphol	E-a	R10, R15, R18, R21, R25	5
Availability and education of staff	A	R10, R12, R18	5
Proximity to seaport Rotterdam	E-na	R12, R18	4
Support of regional and local governments	A	R12, R13	4
Presence of similar companies	A	R12, R13	4
Distance to suppliers and markets	E-na	R16, R26	3
Proximity to our Head Quarter/ Sales Office	A	R13	2
Expansion possibilities warehouse	A	R12	1

Note 1: ***R= respondent; Underlined responses were mentioned with help and given a score of 1; The rest of the responses were mentioned without help and given a score of 2***

Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

As can be seen from table 7.5, the location factor "Proximity to the former warehouse location" is most frequently mentioned. It appears that almost 75% of the warehouses representing the EDC population in the SADC area is attracted from the wider Schiphol region. Not from other regions in The Netherlands or other countries. This finding is consistent with the work of Pellenbarg [1985, p. 115-116] and Pen [2002, p. 136-137] who state that firms in general tend to relocate over short distances.

We pictured the importance of location endowments and economies of agglomeration by grouping the data of table 7.5 into a relative frequency distribution. This is shown in table 7.6.

Table 7.6: Relative frequency distribution of location endowments and economies of agglomeration for all 27 warehouses

Type of location factors on the choice of the SADC area	Frequencies	Percentage
A	134	68
E-a	50	25
E-na	13	7
Totals	197	100

Note 1: Frequencies re-weighted; Data are taken from table 7.5
Note 2: A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport

Table 7.6 indicates that economies of agglomeration is by far the most important force that attracts warehouses into the SADC area. An important question is whether there is a difference between Schiphol-dependent and non-Schiphol-dependent warehouses. The relative frequency distribution for both groups is given in table 7.7.

Table 7.7: Relative frequency distribution of location endowments and economies of agglomeration for Schiphol-dependent and non-Schiphol-dependent warehouses

Type of location factors on the choice of the SADC area	Schiphol-dependent warehouses (see table 7.4)		Non-Schiphol-dependent warehouses (see table 7.4)	
	Frequencies	Percentage	Frequencies	Percentage
A	68	61	66	78
E-a	37	33	13	15
E-na	7	6	6	7
Totals	112	100	85	100

Note 1: Frequencies re-weighted; Data are taken from table 7.5
Note 2: A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport

Table 7.7 provides the data necessary for the chi-square test to determine whether there is a difference between the two groups of warehouses in the importance of location endowments (= E-a plus E-na) and economies of agglomeration (= A). We tested at the 0.05 level of significance (α). Since there are two rows and two columns in the contingency table the chi-square test has 1 degree of freedom. Therefore we applied the Yates correction. The critical value of the chi-square distribution for α= 0.05 and 1 degree of freedom is 3.841. The null hypothesis of equality was rejected when the computed value of chi-square is greater than the critical value. Here, the computed value of the chi-square test statistic is 5.65 (p-value= 0.019). Since $\chi_1^2 = 5.65 > 3.841$ the null hypothesis is rejected. We conclude that Schiphol-dependent as well as non-Schiphol-dependent warehouses are attracted into the SADC area mainly because of economies of agglomeration. Economies of agglomeration are thus the main location factors. Not the specific airport endowments of Schiphol. However, the importance of economies of agglomeration as a location factor is higher for non-Schiphol-dependent warehouses than for Schiphol-dependent warehouses.

It is important to examine whether the results as given in table 7.7 are sensitive to modest departures from table 7.4 and 7.5. We examined the consequences of the following manipulations:

- In table 7.4 we used a class boundary of 20% -volume of freight transported via Schiphol by airplane- to distinguish between Schiphol-dependent and non-Schiphol-dependent warehouses. We examined whether the choice of a different class boundary results in an entirely different picture.
- The most important location factor in table 7.5 is “Proximity to former warehouse location”. We examined the effect of removing this location factor.
- In table 7.5, location factors mentioned spontaneously are given a score of 2. We examined the effect of giving these location factors a score of 3.

The three sensitivity analyses are shown in appendix 7.3. It appears that the manipulations do not cause significant shifts in the importance of location endowments and economies of agglomeration as presented in table 7.7. In sum, we conclude that table 7.7 is robust.

Our results support hypothesis 1. The traditional answer to the question why EDCs cluster around Schiphol is that EDCs are attracted to the airport due to the importance of having air transport services at their disposal. In other words, that they are attracted due to the specific airport endowments of Schiphol. However, we showed that this is only a partial answer and that almost 40% of the warehouses representing the EDC population in the SADC area is non-Schiphol-dependent. We uncovered that economies of agglomeration operating in the Schiphol region are the most important determinants in the process of attracting EDCs. This means that the self-reinforcing character of this process is empirically validated. Attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering this self-reinforcing growth process.

Reasons why air cargo transport is used

Having air transport services (or specific airport endowments) at their disposal is not the main location factor for EDCs. However it is still interesting to look deeper into the specific airport endowments and to find out why air cargo transport is used by the EDCs. The traditional perspective is that the product characteristics of the freight hauled strongly determine whether air cargo transport is used. Recall the definitions of traditional air freight and traditional sea freight (see chapter 2):

> *Traditional air freight meets the following requirements: (1) high value-weight ratio or, (2) perishable.*
>
> *Traditional sea freight meets the following requirements: (1) low value-weight ratio and, (2) non-perishable.*

The underlying idea is that air freight usually can not be cost-justified for low value items because the greater cost of air freight would represent too high a percentage of product costs. However, air transportation of lower-value goods, as well as their share in total air transportation, has reportedly increased since the beginning of the 1990s [Button and Stough, 2000, p. 268]. The main reasons for this shift are the Just-in-Time (JiT) principle and the continuing request to reduce inventories [Grübler, 1990, p. 167]. Both increase the importance of transport speed.

For each respondent, tables 7.8 to 7.11 show the shares of high value-weight and perishable goods expressed as a percentage of the air cargo goods flow. The air cargo goods flows are made up of air cargo transported by the modes airplane and airport trucking (see table 7.1). To characterize high value-weight and perishable goods and to indicate their shares we used the expert opinion of the logistics managers. Thus, we applied a subjective -instead of an objective- definition.

Table 7.8: Share of high value-weight products expressed as a percentage of the inbound air cargo goods flow

Share expressed as a percentage (by weight or units) of the inbound air cargo goods flow	Inbound air cargo goods flow	
	Warehouses mentioning share high value-weight products	Cumulative % of warehouses mentioning share high value-weight
0 but less than 5	R1, R6, R18, R20, R23, R27	23
5 but less than 10		23
10 but less than 20	R15	27
20 but less than 30	R13, R22	35
30 but less than 40	R21	39
40 but less than 50		39
50 but less than 60		39
60 but less than 70	R4	43
70 but less than 80		43
80 but less than 90	R2, R5, R9, R11, R16, R25, R26	70
90 but less than 100	R3, R7, R8, R10, R12, R17, R19, R24	100

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Note 2: R14 does not make use of inbound air cargo shipments; therefore N= 27-1= 26 warehouses

Table 7.9: Share of perishable products expressed as a percentage of the inbound air cargo goods flow

Share expressed as a percentage (by weight or units) of the inbound air cargo goods flow	Inbound air cargo goods flow	
	Warehouses mentioning share perishable products	Cumulative % of warehouses mentioning share perishable
0 but less than 5	R1, R3, R4, R6, R7, R8, R9, R10, R11, R13, R15, R17, R18, R19, R21, R22, R23, R24, R25, R27	77
5 but less than 10	R2	81
10 but less than 20	R5, R12, R16	92
20 but less than 30		92
30 but less than 40		92
40 but less than 50		92
50 but less than 60		92
60 but less than 70		92
70 but less than 80	R26	96
80 but less than 90		96
90 but less than 100	R20	100

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Note 2: R14 does not make use of inbound air cargo shipments; therefore N= 27-1= 26 warehouses

Table 7.10: Share of high value-weight products expressed as a percentage of the outbound air cargo goods flow

Share expressed as a percentage (by weight or units) of the outbound air cargo goods flow	outbound air cargo goods flow	
	Warehouses mentioning share high value-weight products	Cumulative % of warehouses mentioning share high value-weight
0 but less than 5	R1, R6, R18, R20, R27	19
5 but less than 10		19
10 but less than 20	R15	23
20 but less than 30	R13, R22	31
30 but less than 40	R21	35
40 but less than 50		35
50 but less than 60		35
60 but less than 70	R4, R24	43
70 but less than 80		43
80 but less than 90	R2, R5, R9, R14, R16, R26	66
90 but less than 100	R3, R7, R8, R10, R11, R12, R17, R19, R25	100

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Note 2: R23 does not make use of outbound air cargo shipments; therefore N= 27-1= 26 warehouses

Table 7.11: Share of perishable products expressed as a percentage of the outbound air cargo goods flow

Share expressed as a percentage (by weight or units) of the outbound air cargo goods flow	outbound air cargo goods flow	
	Warehouses mentioning share perishable products	Cumulative % of warehouses mentioning share perishable
0 but less than 5	R1, R3, R4, R6, R7, R8, R9, R10, R11, R13, R15, R17, R18, R19, R21, R22, R24, R25, R27	73
5 but less than 10	R2	77
10 but less than 20	R5, R12, R16	88
20 but less than 30	R14	92
30 but less than 40		92
40 but less than 50		92
50 but less than 60		92
60 but less than 70		92
70 but less than 80	R26	96
80 but less than 90		96
90 but less than 100	R20	100

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Note 2: R23 does not make use of outbound air cargo shipments; therefore N= 27-1= 26 warehouses

Respondents with low shares of high value-weight and perishable goods, transport large quantities of traditional sea freight by the fast air cargo transport modes. We apply a boundary of 20%:

- From the tables 7.8 and 7.9 we can see that the inbound air cargo goods flow of six respondents (R1, R6, R15, R18, R23, R27) has less than 20% high value-weight and perishable goods. We can say that they receive mainly traditional sea freight by the air cargo transport modes.
- From the tables 7.10 and 7.11 we can see that the outbound air cargo goods flow of five respondents (R1, R6, R15, R18, R27) has less than 20% high value-weight and perishable goods. We can say that they ship mainly traditional sea freight by the air cargo transport modes.
- Approximately 10% of the Schiphol-dependent warehouses and 40% of the non-Schiphol-dependent warehouses transport mainly traditional sea freight by the air cargo transport modes.

We conclude that the product characteristics of the freight hauled only provide us with a partial understanding of why air cargo is used. A more refined picture can be obtained through the reasons reported by the logistics managers. These are given in tables 7.12 and 7.13.

Table 7.12: Reasons underlying the use of inbound air cargo as reported by the logistics managers

Reasons that underlie the choice for air cargo transports	Inbound air cargo goods flow	
	Warehouses mentioning reason	% of warehouses mentioning reason
Transport speed	All 26 warehouses (*)	100
Low carrier rate	R7	4
Damage reduction	R10	4
Extensive distribution network	R16	4
Shipment tracking and tracing	R20	4
High value transport	R21	4

Note 1: R= respondent

Note 2: (*) R14 does not make use of inbound air cargo; therefore N= 27-1= 26 warehouses

Table 7.13: Reasons underlying the use of outbound air cargo as reported by the logistics managers

Reasons that underlie the choice for air cargo transports	Outbound air cargo goods flow	
	Warehouses mentioning reason	% of warehouses mentioning reason
Transport speed	All 26 warehouses (*)	100
Low carrier rate	R24, R26, R27	12
Extensive distribution network	R14, R16, R24	12
Damage reduction	R10	4
Documentation less complex	R13	4
High value transport	R21	4

Note 1: R= respondent
Note 2: (*) R23 does not make use of outbound air cargo; therefore N= 27-1= 26 warehouses

Tables 7.12 and 7.13 show the importance of transport speed. Evidently, this customer service consideration is the most important reason underlying the use of air cargo. In this connection, the question arises whether air transport is viewed as a premium emergency service or is used for regular service. This is shown in the tables 7.14 and 7.15.

Table 7.14: Regular versus emergency inbound air cargo transports

Type of air cargo transport	Inbound air cargo goods flow	
	Warehouses mentioning type	% of warehouses mentioning type
Mainly regular shipments	R6, R7, R8, R9, R15, R16, R19, R20, R21, R22, R24, R26	46
Mainly emergency shipments	R1, R12, R13, R17, R23, R25	23
Regular and emergency shipments	R2, R3, R4, R5, R10, R11, R18, R27	31
Total		100

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4
Note 2: R14 does not make use of inbound air cargo; therefore N= 27-1= 26 warehouses

Table 7.15: Regular versus emergency outbound air cargo transports

	Outbound air cargo goods flow	
Type of air cargo transport	Warehouses mentioning type	% of warehouses mentioning type
Mainly regular shipments	R6, R7, R8, R9, R14, R16, R19, R20, R22, R24, R25, R26, R27	50
Mainly emergency shipments	R11, R12, R13, R17, R21	19
Regular and emergency shipments	R1, R2, R3, R4, R5, R10, R15, R18	31
Total		100

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***R23 does not make use of outbound air cargo; therefore N= 27-1= 26 warehouses***

It appears that approximately 50% of the warehouses uses air freight for regular service. This group consists mainly of Schiphol-dependent warehouses. About 20% uses air freight as a premium emergency service. These are mainly non-Schiphol-dependent warehouses. However, we have seen that Schiphol-dependent as well as non-Schiphol-dependent warehouses are attracted into the SADC area mainly because of economies of agglomeration. Not because of the air transport services (or specific airport endowments) offered by airport Schiphol.

Lock-in regarding warehouse location

EDCs, once settled at the SADC business parks, can become locked into their Schiphol location. That is, high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to relocation. In order to test the individual warehouses for location lock-in we first asked the logistics managers “Will your warehouse operations move to a new location within a period of 2 years?”. Then we asked “Imagine that you can choose a new location for the establishment of your warehouse and that you can relocate the warehouse without costs; Would you decide for the current location or would you decide differently?”. We indicate that a warehouse is locked into its location if the respondent would decide for a different location but will not move. Table 7.16 gives the warehouses that reported that if they could choose a new warehouse location, they would not choose the SADC area again.

Table 7.16: Preferred warehouse locations as reported by the logistics managers

Warehouses that would not choose the SADC area again	Preferred warehouse location		
	Preferred warehouse location mentioned by the logistics managers	Within The Netherlands	Proximity to airport
R2	-	-	-
R3	Castricum	Yes	No
R4	Gouda	Yes	No
R5	Hoofddorp	Yes	Yes
R6	Schiphol Center	Yes	Yes
R7	France or Germany	No	-
R8	Schiphol Center	Yes	Yes
R9	Schiphol Center	Yes	Yes
R11	Zeewolde	Yes	No
R13	Proximity to Belgium border	Yes	-
R19	Schiphol Center	Yes	Yes
R20	Breda	Yes	No
R21	Maastricht	Yes	Yes
R22	Almere	Yes	No
R27	Belgium, France, or Germany	No	-

Note: R= respondent; Underlined respondents are non-Schiphol-dependent warehouses; The rest of the respondents are Schiphol-dependent warehouses; Data are taken from table 7.4

From table 7.16 we can see that 15 of the 27 warehouses, representing the EDC population in the SADC area, are not completely satisfied with their current warehouse location. Approximately 60% of the Schiphol-dependent and 50% of the non-Schiphol-dependent warehouses would not choose the SADC business parks again if they could choose a new warehouse location. Three Schiphol-dependent warehouses (R3, R20, and R22) mentioned preferred locations that do not offer proximity to an airport. This can be understood in the light of our conclusion that for Schiphol-dependent as well as non-Schiphol-dependent warehouses economies of agglomeration are the main location factors. Not specific airport endowments.

Eight of the 27 surveyed warehouses are locked into their SADC location (R2, R3, R9, R11, R13, R19, R20, R27). They have high thresholds producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to relocation. Approximately 30% of the Schiphol-dependent and 30% of the non-Schiphol-dependent warehouses is locked into its location. We can say that if a warehouse is locked into its location, keep forces win over push-out and pull-out forces. Tables 7.17 and 7.18 give the reported importance of push-out, pull-out, and keep forces.

Table 7.17: Importance of push-out and pull-out forces

Push-out and pull-out forces	Forces mentioned by the logistics managers	Frequencies
Price/ rent of warehouse or land	R2, R3, R4, R5, R11, R20, R22	7
Road congestion in the Schiphol region	R2, R6, R8, R9, R13, R27 (*)	6
Distance to airport Schiphol	R6, R8, R9	3
Quality of warehouse facilities	R5, R9, R22	3
Accessibility by public transport	R8, R19	2
Distance to suppliers and markets	R13, R22	2
Availability and education of staff	R13, R22	2
Options for freight transport by rail still in their infancy	R2	1
Expansion possibilities warehouse	R8	1
Distance to our main customers	R7	1
Distance to our main logistics service providers (LSP)	R21	1

Note 1: ***Reported by the 15 warehouses as given in table 7.16***

Note 2: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 3: ***(*) R6, R8, R9 reported on congested transport links from the SADC business parks to airport Schiphol; R2, R13, R27 reported on road congestion in the Schiphol region in general***

Table 7.18: Importance of keep forces

Keep forces	Forces mentioned by the logistics managers	Frequencies
Large fixed capital investments in the warehouse building/ logistics systems	R9, R20, R27	3
Warehouse operation started recently	R2, R13	2
Long-term lease on the warehouse	R9, R13	2
Unable to generate capital to relocate	R11	1
Anxious about loosing employees	R13	1
Anxious about loosing customers	R19	1
Proximity to our Head Quarter/ Sales Office	R13	1

Note 1: ***Reported by the 8 warehouses that are locked into the SADC area***

Note 2: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

From table 7.17 we can see that there are two main drawbacks of a warehouse location in the SADC area. First, it is an expensive location for EDCs. Second, the road congestion in the Schiphol region. Table 7.18 shows that large fixed capital investments in the warehouse building and logistics systems is a main inertia producing force.

Pellenbarg [1985, p. 96] links location inertia to risk avoiding behavior. It has long been recognized that firms are forced to make location decisions on the basis of incomplete and biased information [Pellenbarg, 1985] [Meester, 1999]. Six of the eight respondents that are locked into the SADC area reported that they had not researched alternative warehouse locations (R3, R9, R11, R13, R19, R27).

7.3 Comparing the Schiphol-EDC-population with the national-EDC-population

The traditional answer to the question why EDCs cluster around Schiphol is that EDCs are attracted to the airport due to the importance of having air transport services (or specific airport endowments) at their disposal. If this were true it would mean that around the airport a population would be formed of Schiphol-dependent EDCs that is different from the EDC population located elsewhere in The Netherlands. However, we have seen that economies of agglomeration are the most important determinants in the process of attracting EDCs into the SADC area. Not the specific airport endowments of Schiphol. The question that arises now is whether the EDC population in the SADC area differs from the EDC population located

elsewhere in The Netherlands. Here we present our results on the comparison of both populations. We address similarities and differences on: general warehouse characteristics; location factors on the choice of the warehouse location; lock-in regarding warehouse location; origin and destination of goods flows; and the use of air cargo.

General warehouse characteristics
Recall hypothesis 2 (see chapter 6):

> ***Hypothesis 2:***
> *With respect to general warehouse characteristics, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.*

This hypothesis is tested by testing for the difference between general warehouse characteristics from the two populations. The results are shown in the tables 7.19 and 7.20. Table 7.19 deals with qualitative variables while table 7.20 deals with quantitative variables.

Table 7.19: General warehouse characteristics: Testing for the difference between proportions from the two populations using the chi-square test

	Percentage of warehouses in population		Chi-square test α= 0.05
Variables	National-EDC-population (N= 63 warehouses)	Schiphol-EDC-population (N= 27 warehouses)	Difference between proportions
Logistics Service Providers (LSP)	46.0	51.9	Not significant $\chi_1^2 = 0.076$ p-value= 0.782
Public warehouses	36.5	48.1	Not significant $\chi_1^2 = 0.637$ p-value= 0.425
Warehouses performing Value Added Logistics (VAL)	55.6	81.5	Significant $\chi_1^2 = 4.411$ p-value= 0.036
Large warehouses (*)	57.1	22.2	Significant $\chi_1^2 = 7.910$ p-value= 0.005
Warehouses with large fixed capital investments in the building (**)	47.6	29.6	Not significant $\chi_1^2 = 1.824$ p-value= 0.177
Warehouses with large fixed capital investments in the logistics systems (***)	50.8	22.2	Significant $\chi_1^2 = 5.207$ p-value= 0.022

Note 1: ***(*) > 10,000 m^2; ≈ median national-EDC-population***

Note 2: ***(**) > 5 million Euro; ≈ median national-EDC-population; In case the respondent holds a long-term lease on the warehouse, the investment in the building is made by a real estate investment company***

Note 3: ***(***) >2 million Euro; ≈ median national-EDC-population***

As can be seen from table 7.19, for each variable we tested for the difference between proportions through a two-way contingency table. Therefore, we applied the Yates correction for computing the chi-square test statistic. For the variables "Large warehouses", "Warehouses with large fixed capital investments in the building", and "Warehouses with large fixed capital investments in the logistics systems", we set the boundaries of the class groupings at the median of the national-EDC-population.

Table 7.20: General warehouse characteristics: Testing for the difference between the means of the two populations using the t-test

	Means and variances of population		Two-tailed F-test α= 0.05	Two-tailed t-test α= 0.05
Variables	National-EDC-population (N= 63 whs)	Schiphol-EDC-population (N= 27 whs)	Difference between variances	Difference between means
Number of main EDCs in the warehouse	Mean= 2.0 Std dev= 2.7	Mean= 2.3 Std dev= 1.6	Not significant $F_L = 0.000$ p-value= 0.987	Not significant $t_{88} = -0.413$ p-value= 0.681
Number of employees (*)	Mean= 110.3 Std dev= 127.5	Mean= 31.3 Std dev= 49.2	Significant $F_L = 8.460$ p-value= 0.005	Significant $t_{87.4} = 4.238$ p-value= 0.000

Note 1: We used Levene's F-test (F_L) to test for the difference between variances
Note 2: (*) Full-timers plus part-timers

From tables 7.19 and 7.20, we conclude that there is evidence of a difference between the populations on the following general warehouse characteristics:

- the proportion warehouses performing Value Added Logistics (VAL) is higher for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands;
- the proportion large warehouses is less for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands;
- the proportion warehouses with large fixed capital investments in the logistics systems is less for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands;
- the average number of employees per warehouse is less for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands.

Location factors on the choice of the warehouse location

Recall hypothesis 3 (see chapter 6):

> ***Hypothesis 3:***
> *With respect to location factors on which the choice of location is based, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.*

This hypothesis is tested by comparing the reported importance of location factors. Table 7.21 shows the reported importance of location factors on the choice of The Netherlands. Table 7.22 gives this information on the choice of the site within The Netherlands. We discriminate between location factors mentioned with and without help. Location factors mentioned spontaneously were given a score of 2 while location factors mentioned with help were given a score of 1.

Table 7.21: Importance of location factors on the choice of The Netherlands

	Warehouses mentioning location factor			
	National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
Location factors	Re-weighted frequencies	Percentage	Re-weighted frequencies	Percentage
Existing ties with The Netherlands (*)	50	17	46	34
Transport infrastructure (**)	94	31	22	16
Intermediately positioned between our market areas in Europe	50	17	20	15
Access to logistics services/ logistics know how	18	6	14	10
Climate government create for business through customs policies	26	8	13	9
Languages spoken	24	8	10	7
Climate government create for business through tax structure/ tax policies	18	6	7	5
Quality, quantity and costs of available labor	22	7	5	4
Totals	302	100	137	100

Note 1: ***Frequencies re-weighted; Location factors mentioned with help were given a score of 1; Location factors mentioned without help were given a score of 2***

Note 2: ***(*) Examples are: our main customer/ Head Quarter/ Sales Office/ former warehouse is already located in The Netherlands***

Note 3: ***(**) Examples are: seaport Rotterdam, Amsterdam Airport Schiphol, transport links with other cities and internationally***

From table 7.21 we can see that, for both populations, the most important location factors are: "Existing ties with The Netherlands"; "Transport infrastructure"; and "Intermediately positioned between our market areas in Europe". To determine whether the two populations are different, we used the chi-square test of independence. The null hypothesis of equality is tested at the 0.05 level of significance (α). The critical value would be 14.067 since there are 7 degrees of freedom. The computed chi-square test statistic is 25.30 (p-value= 0.000). Since $\chi^2_7 = 25.30 > 14.067$ the null hypothesis is rejected. We conclude that the EDC population in the SADC area differs from the EDC population located elsewhere in The Netherlands in the importance of location factors on the choice of The Netherlands.

We examined whether this result is sensitive to re-weighting the frequencies in table 7.21. We examined the consequences of the following manipulation: location factors mentioned spontaneously are given a score of 3 (instead of 2). The sensitivity analysis is shown in appendix 7.4. It appears that this manipulation does not cause significant shifts. In sum, we conclude that table 7.21 is robust.

Table 7.22: Importance of location factors on the choice of the site within The Netherlands

		Warehouses mentioning location factor			
		National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
Location factors	Type	Re-weighted frequencies	Percentage	Re-weighted frequencies	Percentage
Proximity to former warehouse location	A	24	7	40	20
Proximity to airport	E	40	12	36	18
Availability of warehouse space/ land	A	40	12	22	11
Accessibility by roads and rail	A	56	15	14	7
Proximity to logistics service providers (LSP)	A	10	3	14	7
Quality of life for employees (*)	A	10	3	11	5
Status of immediate environment (**)	A	0	0	11	5
Number of transport destinations offered by nearby air-/seaport	E	0	0	9	5
Proximity to our main customers	A	4	1	6	3
Price/ rent of warehouse or land	E	32	9	6	3
Transport frequencies offered by nearby air-/seaport	E	0	0	5	3
Availability and education of staff	A	26	7	5	3
Proximity to seaport	E	34	10	4	2
Support of regional and local governments	A	10	3	4	2
Presence of similar companies	A	2	1	4	2
Distance to suppliers and markets	E	34	10	3	2
Proximity to our Head Quarter/ Sales Office/ production plant	A	16	5	2	1
Expansion possibilities warehouse	A	2	1	1	1
Costs of available labor	E	4	1	0	0
Totals		344	100	197	100

Note 1: ***Frequencies re-weighted; Location factors mentioned with help were given a score of 1; Location factors mentioned without help were given a score of 2***

Note 2: ***A= Agglomeration economies; E= Endowment of geographical location***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

If we apply the chi-square test of independence to table 7.22, the validity of the test would seriously be affected because 11 of the 38 cells in the contingency table would have theoretical frequencies below 5. Therefore, we combined categories as is shown in table 7.23.

Table 7.23: Relative frequency distribution of location endowments and economies of agglomeration for the national- and Schiphol-EDC-population

Type of location factors	National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
	Frequencies	Percentage	Frequencies	Percentage
A	200	58	134	68
E	144	42	63	32
Totals	344	100	197	100

Note 1: Frequencies re-weighted; Data are taken from table 7.22
Note 2: A= Agglomeration economies; E= Endowment of geographical location

If we apply the chi-square test to table 7.23, the contingency table has two columns and two rows, so that there is 1 degree of freedom. The null hypothesis of equality is tested at the 0.05 level of significance (α). The critical value of the chi-square distribution is 3.841. We applied the Yates correction. The computed chi-square test statistic is 4.79 (p-value= 0.030). Since $\chi_1^2 = 4.79 > 3.841$ the null hypothesis is rejected. We conclude that economies of agglomeration are the main location factors for both populations. Not location endowments. It seems that the importance of economies of agglomeration as a location factor is higher for the Schiphol-EDC-population than for the national-EDC-population. We examined whether these results are sensitive to the following modest manipulations:

- An important location factor in table 7.22 is "Proximity to former warehouse location". We examined the effect of removing this location factor.
- In table 7.22, location factors mentioned spontaneously are given a score of 2. We examined the effect of giving them a score of 3.

The two sensitivity analyses are shown in appendix 7.5. These results lead us to the following conclusions. First, the conclusion that economies of agglomeration are the main location factors for both populations is robust. Second, we can not confidently accept or reject the evidence that the importance of economies of agglomeration as a location factor is higher for the Schiphol-EDC-population than for the national-EDC-population.

Lock-in regarding warehouse location
Recall hypothesis 4 (see chapter 6):

> ***Hypothesis 4:***
> *With respect to the proportion of warehouses that are locked into their location, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.*

This hypothesis is tested by testing for the difference between the proportions of warehouses that are locked into their location. The results are given in table 7.24. We see a striking difference between the populations. The proportion of warehouses that is locked into their location is three times as high for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands.

The question that arises now is how to explain this difference in location lock-in. The expected answer is that it is because of differences in general warehouse characteristics between the national-EDC-population and the Schiphol-EDC-population. For instance, subcontracted warehouses that contain several EDCs of several firms might have a higher threshold value than own-account warehouses that contain only one EDC. The threshold value relates to inertia and keep forces. If a warehouse is locked into its location, keep forces outweigh push-out and pull-out forces. However, the evidence we have examined does not point in this direction. From the table 7.19 we can see that there is no evidence of a difference between the national-EDC-population and the Schiphol-EDC-population regarding the proportions of Logistics Service Providers (subcontracted warehouses) and public warehouses. Moreover, the percentages of Logistics Service Providers and public warehouses in the group of warehouses locked into the SADC area are almost similar to the percentages of Logistics Service Providers and public warehouses in the total Schiphol-EDC-population.

An other explanation for the striking difference in location lock-in can be a difference in push-out and pull-out forces. We stress that, in order to test the individual warehouses for location lock-in, we asked the logistics managers the following two questions. First we asked “Will your warehouse operations move to a new location within a period of 2 years?”. Then we asked “Imagine that you can choose a new location for the establishment of your warehouse and that you can relocate the warehouse without costs; Would you decide for the current location or would you decide differently?”. We indicated that a warehouse is locked into its location if the respondent would decide for a different location but will not move. The evidence we have examined suggests that the warehouses in the SADC area are confronted with stronger push-out and pull-out forces than the warehouses located elsewhere in The Netherlands.

Table 7.24: Lock-in regarding warehouse location: Testing for the difference between proportions from the two populations using the chi-square test

	Percentage of warehouses in population		Chi-square test α= 0.05
Variable	National-EDC-population (N= 63 warehouses)	Schiphol-EDC-population (N= 27 warehouses)	Difference between proportions
Locked into warehouse location	9.5	29.6	Significant Fisher's Exact Test p-value= 0.025

Note: We utilized Fisher's Exact Test because one cell of the 2x2 contingency table has theoretical frequencies below 5

Origin and destination of goods flows

Recall hypothesis 5 (see chapter 6):

Hypothesis 5:
With respect to origin and destination of goods flows, the EDC population in the SADC area is similar to the EDC population located elsewhere in The Netherlands.

This hypothesis is tested by testing for the difference in the average share per region of origin and per region of destination. The share is expressed as a percentage (by weight or units) of the goods flow. The results are summarized in the tables 7.25 and 7.26. We conclude that the two populations are almost identical with respect to origin an destination of goods flows.

Table 7.25: Origin of goods flows: Testing for the difference between the means of the two populations using the t-test

	Share inbound goods flow per region of origin (*)		Two-tailed F-test α= 0.05	Two-tailed t-test α= 0.05
Region of origin	National-EDC-population (N= 63 whs)	Schiphol-EDC-population (N= 27 whs)	Difference between variances	Difference between means
Europe	Mean= 33.8 Std dev= 35.9	Mean= 25.2 Std dev= 29.7	Not significant F_L = 2.197 p-value= 0.142	Not significant t_{88} = 1.095 p-value= 0.277
USA	Mean= 17.8 Std dev= 29.1	Mean= 22.9 Std dev= 34.6	Not significant F_L = 1.444 p-value= 0.233	Not significant t_{88} = -0.715 p-value= 0.477
Asia	Mean= 44.5 Std dev= 40.9	Mean= 48.9 Std dev= 38.1	Not significant F_L = 1.664 p-value= 0.200	Not significant t_{88} = -0.473 p-value= 0.637

Note 1: We used Levene's F-test (F_L) to test for the difference between variances
Note 2: (*) For each warehouse the share per region of origin is expressed as a percentage (by weight or units) of its total inbound goods flow

Table 7.26: Destination of goods flows: Testing for the difference between the means of the two populations using the t-test

	Share outbound goods flow per region of destination (*)		Two-tailed F-test α= 0.05	Two-tailed t-test α= 0.05
Region of destination	National-EDC-population (N= 63 whs)	Schiphol-EDC-population (N= 27 whs)	Difference between variances	Difference between means
Europe	Mean= 94.4 Std dev= 13.5	Mean= 83.0 Std dev= 18.2	Not significant F_L = 2.646 p-value= 0.107	Significant t_{88} = 3.314 p-value= 0.001
USA	Mean= 1.7 Std dev= 5.6	Mean= 2.3 Std dev= 5.0	Not significant F_L = 0.079 p-value= 0.779	Not significant t_{88} = -0.522 p-value= 0.603
Asia	Mean= 2.2 Std dev= 5.6	Mean= 3.5 Std. dev.= 4.6	Not significant F_L = 0.046 p-value= 0.830	Not significant t_{88} = -1.108 p-value= 0.271

Note 1: We used Levene's F-test (F_L) to test for the difference between variances
Note 2: (*) For each warehouse the share per region of destination is expressed as a percentage (by weight or units) of its total outbound goods flow

Use of air cargo
Recall hypothesis 6 (see chapter 6):

> ***Hypothesis 6:***
> *With respect to the use of air cargo, the EDC population in the SADC area differs from the EDC population located elsewhere in The Netherlands.*

This hypothesis is tested by testing for the difference in the average share of air cargo transport. The share is expressed as a percentage (by weight or units) of the goods flow. The results are shown in table 7.27. We can see that the average share of the in- and outbound air cargo is higher for the warehouses in the SADC area than for the warehouses located elsewhere in The Netherlands.

Table 7.27: Use of air cargo: Testing for the difference between the means of the two populations using the t-test

	Means and variances of population		Two-tailed F-test α= 0.05	Two-tailed t-test α= 0.05
Variables	National-EDC-population (N= 63 whs)	Schiphol-EDC-population (N= 27 whs)	Difference between variances	Difference between means
Share inbound air cargo (*)	Mean= 22.2 Std dev= 31.7	Mean= 44.3 Std dev= 39.5	Significant F_L = 5.867 p-value= 0.017	Significant $t_{41.0}$ = -2.578 p-value= 0.014
Share outbound air cargo (**)	Mean= 10.9 Std dev= 22.6	Mean= 36.7 Std dev= 30.9	Significant F_L = 5.811 p-value= 0.018	Significant $t_{38.4}$ = -3.916 p-value= 0.000

Note 1: ***We used Levene's F-test (F_L) to test for the difference between variances***

Note 2: ***(*) For each warehouse the share of inbound air cargo is expressed as a percentage (by weight or units) of its total inbound goods flow; (**) For each warehouse the share of outbound air cargo is expressed as a percentage (by weight or units) of its total outbound goods flow***

7.4 Policy implications

In chapter 5 we have seen that our model of the clustering of EDCs near airport Schiphol exhibits four properties that makes policy analysis very different compared to standard neoclassical location models, namely: non-linear effects in the process of attracting EDCs; quasi-permanent EDC location effects; quasi-permanent EDC transport mode effects; non-linear effects in the process of pushing-out EDCs. They yield important implications for the EDC location policy aimed at the Schiphol area. In this chapter we empirically validated the first and second property. Regarding these two properties, we now show how the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region. Moreover, we discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. The new steering options utilize the phenomenon of locked-in logistics.

Non-linear effects in the process of attracting EDCs

We uncovered that economies of agglomeration are the most important determinants in the process of attracting EDCs into the SADC area. This means that the self-reinforcing character of this process is empirically validated. That is, attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster.

Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering the self-reinforcing growth process. Below the thresholds, a small variation in location policy can result in a small effect on the growth rate of the EDC cluster. From that policy makers may conclude that the clustering of EDCs is not much affected by policy changes. However, a marginal policy

variation can have non-linear effects when the threshold is crossed. The possibility of non-linear responses makes it much more difficult to forecast the effect of a given policy change. It implies that the same intervention can have different impacts the first and second time it is applied. Unless policy makers are aware of the non-linearity, estimates based on historical data may provide a very misleading indication of what future policy changes will do.

Quasi-permanent EDC location effects
We have seen that the EDCs that are settled in the SADC area can become locked into their location. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to relocation. We uncovered that the proportion of warehouses that is locked into their location is three times as high for warehouses located in the SADC area than for warehouses located elsewhere in The Netherlands. A bad EDC location policy for the Schiphol area may thus have significant long-lasting bad effects. Moreover, reversing these effects may be difficult and may require a policy reform that is much larger than the policy change that led to the initial effect. In other words, the impact of the policy need not be reversed when the policy is reversed.

Additional options for governmental steering
The main policy implication of locked-in logistics, its threshold values and its threshold effects is one of caution. However, locked-in logistics also yields important new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. Here we discuss governmental steering options that utilize location lock-in.

Suppose that we increase the administrative measures for the SADC business parks near Schiphol –for the SADC warehouse selection criteria, the reader is referred to chapter 3- so that from now on less EDCs are permitted to locate there. At the same time we lift the administrative measures for an EDC business park elsewhere in the wider Schiphol region. Then, the growth rate of the EDC cluster near Schiphol will be reduced and, at the same time, a new EDC cluster will be formed. Although this new EDC location does not offer proximity to Schiphol, it attracts Schiphol-dependent warehouses due to the economies of agglomeration operating in the Schiphol region. Over time, the spatial structure of the Schiphol region will be transformed from a mono location system for Schiphol-dependent EDCs into a duo location system with two large clusters of Schiphol-dependent EDCs. Due to location lock-in the two clusters will continue to exist. Even when we lift the administrative measures for the EDC business parks near Schiphol. Thus, the impact of the policy is not reversed when the policy is reversed. By lifting and increasing the administrative measures that permit EDCs to locate at one of the two business parks we can change the growth rate of the EDC clusters. This duo location system can be extended into a three or more location system.

7.5 Conclusions

The traditional answer to the question why EDCs cluster around Schiphol, is that EDCs are attracted to the airport due to the importance of having air transport services at their disposal. In other words, that they are attracted due to the specific airport endowments of Schiphol.

However, we revealed that this is only a partial answer. We have seen that almost 40% of the warehouses, that represent the EDC population in the SADC area, is non-Schiphol-dependent. Moreover, the evidence we have examined suggests that the increasing importance of transport speed and air cargo is not a key determinant in the process of attracting EDCs into the SADC area.

We disentangled the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that region. We are led to the conclusion that Schiphol-dependent as well as non-Schiphol-dependent warehouses are attracted into the SADC area mainly because of economies of agglomeration. Those are the main location factors. Not the specific airport endowments of Schiphol. This explains why Schiphol is such an attractive location for both, Schiphol-dependent and non-Schiphol-dependent warehouses. For many EDCs, Schiphol fulfills a broader function than being a major hub for air transport. However, the importance of economies of agglomeration as a location factor is higher for non-Schiphol-dependent warehouses than for Schiphol-dependent warehouses.

The finding that economies of agglomeration are the most important determinants in the process of attracting EDCs into the SADC area means that the self-reinforcing character of this process is empirically validated. That is, attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, can support further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering the self-reinforcing growth process.

We have found that growth of the Schiphol agglomeration not only can result in economies but also in diseconomies in terms of location endowments and economies of agglomeration. EDCs that are settled near Schiphol are confronted with declining location conditions. That are push-out and pull-out forces. In this connection, the logistics managers reported two main drawbacks of the SADC area. First, it is an expensive location for EDCs. Second, the road congestion in the Schiphol region.

We have investigated push-out and pull-out forces on the one hand and keep forces on the other hand. Keep forces produce inertia that can make push-out and pull-out forces ineffective when it comes to relocation. The most important keep factor in the SADC area, as reported by the logistics managers, is formed by large fixed capital investments in warehouse buildings and logistics systems. We have seen that approximately 30% of the warehouses in the SADC area is locked into its location. Location lock-in is a situation where high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to relocation. We uncovered that the proportion of warehouses that is locked into their location is three times as high for warehouses in the SADC area than for warehouses located elsewhere in The Netherlands. This is a striking difference. Due to location lock-in the clustering of EDCs near Schiphol exhibits phenomena of irreversibility.

Furthermore, we have illustrated that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region.

8. How Schiphol-dependent EDCs can turn into non-Schiphol-dependent EDCs

8.1 Introduction

In this chapter we present further results of our investigation of the Schiphol-EDC-population. The purpose of this chapter is to demonstrate how the EDCs may react when they are confronted with pressures to change such as worsening location conditions or policy interventions. We study the effects of a specific pressure to change, namely increasing congestion.

In chapter 7 we have seen that worsening congestion is a main drawback of a warehouse location in the SADC area. At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in airport congestion: congestion of airspace and air traffic control delays; inadequate runway capacity; and congested terminals for passengers and freight. Furthermore, accessing Schiphol airport is becoming increasingly difficult as surface traffic congestion grows. In the wider Schiphol region, the road network suffers from heavy congestion. Transport speeds have fallen as the volume of traffic has continued to grow on all roads. EDCs that are settled at the SADC business parks are confronted with increasing congestion on the transport links with the airport as well as other national and international cities.

EDCs, once settled in the SADC area, can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make pressures to

change –such as worsening location conditions or policy interventions- ineffective when it comes to modal shift or relocation. From chapter 7, we obtained insight in location lock-in in the situational context and environment of the year 2000. To gain further insight in locked-in logistics and its threshold values we confronted the EDCs that are settled in the SADC area with hypothetical future situations of increasing congestion. In other words, we added an extra push-out factor to the situational context and environment of the year 2000. We asked the logistics managers to state their logistics adaptations to compensate for the congestion impacts on their business operations.

We used scenarios with incremental changes in congestion levels that were sufficiently great for the logistics managers to feel forced to consider making adaptations. For the scenarios, the reader is referred to appendix 6.5. The variable congestion is made up of two categories, namely:

- worsening road congestion in the Schiphol region;
- worsening airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air).

We asked the logistics managers to state their logistics adaptations to compensate for the congestion impacts. The respondents were fully free in mentioning logistics adaptations. We present all spatial-organizational changes that were mentioned, but concentrate on two logistics adjustment possibilities:

- making a modal shift for freight;
- relocation of the warehouse.

To and from the warehouses in the Schiphol area, freight can be transported by the following transport modes: airplane, truck, and train. In 2000, when we collected our empirical data for this study, options for freight transport by rail as well as options for a modal shift to rail were still in their infancy. Therefore, we focused on two modal shift options:

- shift from air to road;
- shift from road to air.

We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking. We used the stated adaptation data collection method (see chapter 6). The flowchart of our stated adaptation survey procedure is presented in figure 8.1. We used three sets of scenarios:

Set 1: increasing airport congestion while road congestion is stable at the 2000 level;
Set 2: increasing road congestion while airport congestion is stable at the 2000 level;
Set 3: increasing airport and road congestion.

To study location lock-in and its threshold values we used scenario set 3. Here we also could have used set 1 and 2. To study lock-in regarding transportation mode, we used scenario set 1 and 2 while we also could have used set 3. The reason we chose this limited procedure was that should duration time of the interview be too long, or should the design be too complicated, the respondents might lose concentration and focus simply on making a choice.

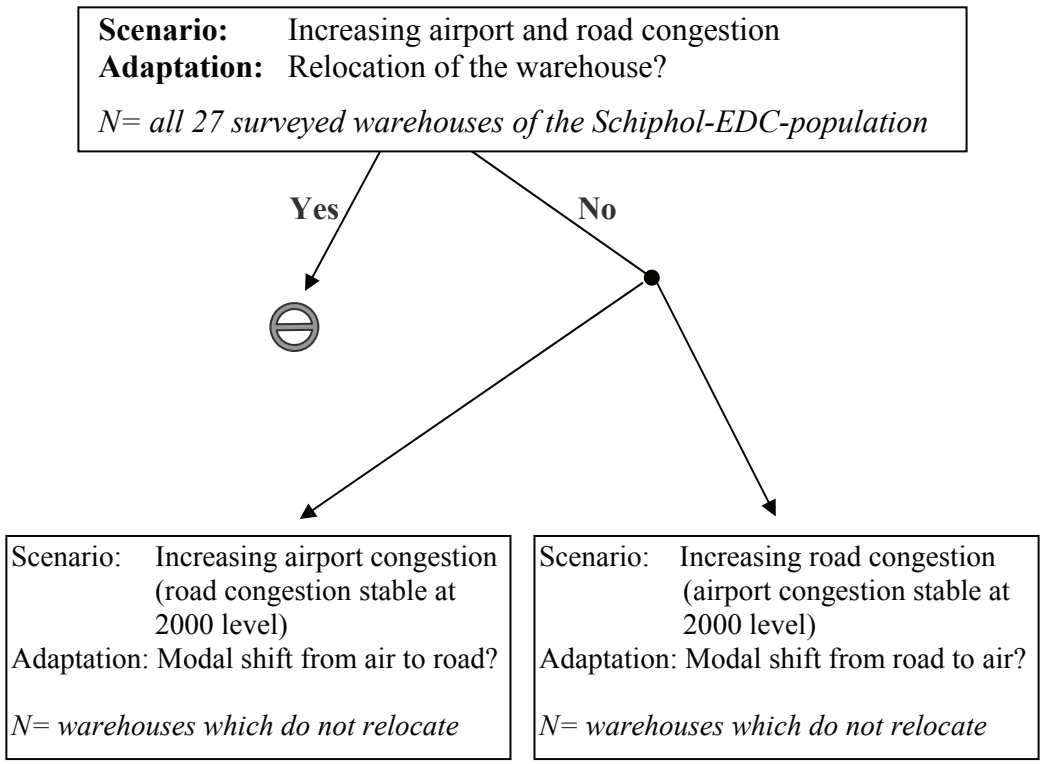

Figure 8.1: Flowchart of the stated adaptation survey procedure
Note: The hypothetical future situations of increasing congestion are applied to the logistics context and environment of the year 2000

The chapter starts with presenting the stated adaptations of the logistics managers –in terms of relocation of their warehouse- when they are confronted with increasing airport and road congestion. Then, for those warehouses which do not relocate, we report the stated adaptations –in terms of modal shift- when they are faced with increasing airport congestion or increasing road congestion. Finally, we show that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region. In this connection, we discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. The new steering options utilize the phenomenon of locked-in logistics.

8.2 Effects of increasing airport and road congestion in terms of relocation

Here we present the stated adaptations of the logistics managers –in terms of relocation of their warehouse- when they are confronted with hypothetical future situations of increasing airport and road congestion. Recall hypothesis 7 (see chapter 6):

> ***Hypothesis 7:***
> *The EDCs in the SADC area will not react to increasing congestion by relocating the EDC facility.*

This hypothesis is tested by assessing the sensitivity of the warehouses to increasing airport and road congestion. We start with the reported relocation decisions in the situational context and environment of the year 2000. Then we show how the introduction of the additional spreading force, in the form of worsening congestion, changes the relocation rate. The respondents were confronted with two hypothetical future levels of airport and road congestion, namely: two times and four times the 2000 level.

Relocation rate in the logistics context of the year 2000
Table 8.1 presents the reported relocation decisions of the logistics managers when they are faced with the logistics context and environment of the year 2000. We can see that the relocation rate is about 15% (category “Yes” plus “Likely”).

Warehouses start to locate away from the SADC area if push-out and pull-out forces outweigh keep forces. From the viewpoint of the company location policy for the Schiphol area as developed by the Dutch government it is highly undesirable if the threshold values producing location inertia are higher for non-Schiphol-dependent warehouses than for Schiphol-dependent warehouses. Table 8.2 shows that this seems to be true in the context of the year 2000. We can see that the relocation rate (category “Yes” plus “Likely”) is two times as high for Schiphol-dependent than for non-Schiphol-dependent warehouses. However, because of the small frequencies in the cells of the table, this conclusion must be hedged with caveats.

Table 8.1: Stated adaptations on relocation in the context of the year 2000

Logistics context and environment of the year 2000		
Adaptation: Relocation of the warehouse within 2 years?	Warehouses stating adaptation (N= 27)	Frequencies
No	R2, R13, R15, R16, R17, R18, R19, R24, R25, R27	10 (37%)
Unlikely	R3, R9, R11, R12, R20, R23, R26	7 (26%)
Possibly	R1, R4, R8, R10, R14	5 (19%)
Likely	R5, R6, R7, R21	4 (15%)
Yes	R22	1 (3%)
Total		27 (100%)

Note: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Table 8.2: Relative frequency distribution of stated adaptations on relocation for Schiphol-dependent and non-Schiphol-dependent warehouses in the context of the year 2000

	Logistics context and environment of the year 2000			
Adaptation: Relocation of the warehouse within 2 years?	Schiphol-dependent warehouses		Non-Schiphol-dependent warehouses	
	Frequency	Percentage	Frequency	Percentage
No + unlikely	10	59	7	70
Possibly	3	18	2	20
Yes + likely	4	23	1	10
Totals	17	100	10	100

Source: Data are taken from table 8.1

Relocation rate under extra airport and road congestion

We have seen that in the situational context and environment of the year 2000, approximately 15% of the warehouses is driven away from the SADC business parks (table 8.1, category "Yes" plus "Likely"). The tables 8.3 and 8.4 present the reported relocation decisions of the logistics managers when they are faced with an additional push-out factor in the form of increasing congestion. If airport and road congestion becomes two times the level of 2000, it causes 30% of the warehouses to leave (table 8.3, category "Yes" plus "Likely"). And if the warehouses are confronted with airport and road congestion that is four times the 2000 level, even 60% of the warehouses start to locate away from the Schiphol agglomeration (table 8.4, category "Yes" plus "Likely"). These data suggest that the impact of push-out pressures is subjected to linear responses. However, this result is sensitive to modest changes in the tables

8.1, 8.3 and 8.4 due to the small frequencies. Therefore, the result can not be viewed as conclusive. In sum, we can best say that the data we have examined point to the possibility of linear effects in the process of pushing-out EDCs.

Table 8.3: Stated adaptations on relocation if airport and road congestion increases two times

Scenario: Airport and road congestion 2 times as much as in the year 2000		
Adaptation: Relocation of the warehouse within 2 years?	Warehouses stating adaptation (N= 27)	Frequencies
No	R13, R15, R17, R19	4 (15%)
Unlikely	R2, R9, R12, R16, R18, R20, R23, R24, R25	9 (33%)
Possibly	R1, R4, R10, R14, R27	5 (19%)
Likely	R3, R5, R6, R7, R11, R26	6 (22%)
Yes	R8, R21, R22	3 (11%)
Total		27 (100%)

Note: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Table 8.4: Stated adaptations on relocation if airport and road congestion increases four times

Scenario: Airport and road congestion 4 times as much as in the year 2000		
Adaptation: Relocation of the warehouse within 2 years?	Warehouses stating adaptation (N= 27)	Frequencies
No	R13, R15, R19	3 (11%)
Unlikely	R20, R23	2 (8%)
Possibly	R2, R4, R14, R16, R24, R25	6 (22%)
Likely	R1, R5, R6, R7, R9, R10, R12, R17, R18, R27	10 (37%)
Yes	R3, R8, R11, R21, R22, R26	6 (22%)
Total		27 (100%)

Note: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Table 8.5 provides results on differences in the relocation rate (category "Yes" plus "Likely") between Schiphol-dependent and non-Schiphol-dependent warehouses. We can see that if airport and road congestion worsens, the proportion warehouses leaving the SADC area is higher for the Schiphol-dependent warehouses than for the non-Schiphol-dependent warehouses. However, because of the small frequencies in the cells of the table, this conclusion must be hedged with caveats.

Table 8.5: Relative frequency distribution of stated adaptations on relocation for Schiphol-dependent and non-Schiphol-dependent warehouses under increasing airport and road congestion

	Scenario: Airport and road congestion 2 times as much as in the year 2000				Scenario: Airport and road congestion 4 times as much as in the year 2000			
Adaptation: Relocation of the warehouse within 2 years?	Schiphol-dependent whs		Non-Schiphol-dependent whs		Schiphol-dependent whs		Non-Schiphol-dependent whs	
	#	%	#	%	#	%	#	%
No + unlikely	8	47	5	50	3	18	2	20
Possibly	2	12	3	30	4	23	2	20
Yes + likely	7	41	2	20	10	59	6	60
Totals	17	100	10	100	17	100	10	100

Source: Data are taken from tables 8.3 and 8.4

8.3 For those warehouses which do not relocate: effects of increasing airport congestion in terms of modal shift

Now we concentrate on those warehouses which reported to stay under increasing congestion. That are the categories "No" and "Unlikely" in the tables 8.3 and 8.4. Recall hypothesis 8 (see chapter 6):

> ***Hypothesis 8:***
> *For those EDCs in the SADC area which do not relocate; They will not react to increasing congestion by changing the composition and relative importance of the transportation modes used.*

In this section, the hypothesis is tested by assessing the sensitivity of the warehouses to increasing airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air). The respondents were confronted with two hypothetical future levels of airport congestion, namely: two times and four times the 2000 level. In the scenarios, road congestion is stable at the 2000 level. We start with the reported adaptations in terms of making a modal shift for freight. Then we present all other changes that were mentioned.

Making a modal shift from air to road

The tables 8.6 and 8.7 show the reported modal shift decisions of the logistics managers when they are faced with worsening airport congestion. We stress that we confined ourselves to whether the warehouses may shift a part of their goods flows from air to road. This study does not provide data on modal shift volumes.

If airport congestion increases up to two times the 2000 level, approximately 50% of the warehouses mentioned to shift a part of their goods flows from air to road (table 8.6, category "Yes" plus "Likely")[8]. Even more than half of the warehouses makes such a modal shift if airport congestion becomes four times the 2000 level (table 8.7, category "Yes" plus "Likely")[9]. We conclude that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that will be used as adjustment possibility in response to increasing airport congestion.

From the tables 8.6 and 8.7 it can be seen that this is true for non-Schiphol-dependent as well as Schiphol-dependent warehouses. However, a modal shift for freight from air to road can turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. To illustrate this point, we recall our definition of a Schiphol-dependent EDC (see chapter 7).

> *A Schiphol-dependent EDC is an EDC that meets the following criteria: (1) more than 20% of the inbound goods flows (by weight or units) is received via Schiphol by airplane or, (2) more than 20% of the outbound goods flows (by weight or units) is shipped via Schiphol by airplane.*

[8] The respondents R9 and R15 mentioned that other members of their logistics network –that are distribution centers located elsewhere in Europe- will take over a part of their goods flows that are received and shipped via Schiphol by airplane.

[9] R15 mentioned that other members of his logistics network will take over a part of his goods flows that are flown via Schiphol.

Table 8.6: Stated adaptations on model shift if airport congestion increases two times

Scenario: Airport congestion 2 times as much as in the year 2000		
Adaptation: Modal shift from air to road?	Warehouses stating adaptation (N= 13) (*)	Frequencies
No	R17, R19, R23	3 (23%)
Unlikely	R25	1 (8%)
Possibly	R9, R15, R18	3 (23%)
Likely	R2, R12, R16, R20, R24	5 (38%)
Yes	R13	1 (8%)
Total		13 (100%)

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***(*) Reported by the respondents who do not relocate if airport and road congestion increases two times; see table 8.3, category "No" plus "Unlikely"***

Table 8.7: Stated adaptations on model shift if airport congestion increases four times

Scenario: Airport congestion 4 times as much as in the year 2000		
Adaptation: Modal shift from air to road?	Warehouses stating adaptation (N= 5) (*)	Frequencies
No	R23	1 (20%)
Unlikely	R19	1 (20%)
Possibly	-	0 (0%)
Likely	R15, R20	2 (40%)
Yes	R13	1 (20%)
Total		5 (100%)

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***(*) Reported by the respondents who do not relocate if airport and road congestion increases four times; see table 8.4, category "No" plus "Unlikely"***

Other spatial-organizational adaptations

Table 8.8 gives all other reported adaptations of the logistics managers under increasing airport congestion.

Table 8.8: Stated adaptations different from modal shift under increasing airport congestion

Adaptation: Different from modal shift	Scenario: Airport congestion 2 times as much as in the year 2000 — Warehouses stating adaptation (N= 4) (*)	Scenario: Airport congestion 4 times as much as in the year 2000 — Warehouses stating adaptation (N= 2) (**)
Time shift to off-peak transportation	R17	-
Raise level of safety stock	-	-
Phase-out existing warehouse, closure, disposal	-	-
No adaptations: This level of congestion has no impact on our warehouse operations	R19	R19
No adaptations: However, this level of congestion has impact on our warehouse operations	R23, R25	R23

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***Adaptations reported by the respondents who do not respond to increasing airport congestion by a modal shift; For (*) see table 8.6, category "No" plus "Unlikely"; For (**) see table 8.7, category "No" plus "Unlikely"***

8.4 For those warehouses which do not relocate: effects of increasing road congestion in terms of modal shift

Here we present further results of our investigation of those warehouses which reported to stay under increasing congestion (the categories "No" and "Unlikely" in the tables 8.3 and 8.4). Recall hypothesis 8 (see chapter 6):

> ***Hypothesis 8:***
> *For those EDCs in the SADC area which do not relocate; They will not react to increasing congestion by changing the composition and relative importance of the transportation modes used.*

In this section, the hypothesis is tested by assessing the sensitivity of the warehouses to increasing road congestion in the Schiphol region. The respondents were confronted with two hypothetical future levels of road congestion, namely: two times and four times the 2000 level. In the scenarios, airport congestion is stable at the 2000 level. We start with the reported adaptations in terms of making a modal shift for freight. Then we present all other changes that were mentioned.

Making a modal shift from road to air

The tables 8.9 and 8.10 show the reported modal shift decisions of the logistics managers when they are faced with worsening road congestion in the Schiphol region. We stress that we confined ourselves to whether the warehouses may shift a part of their goods flows from road to air. This study does not provide data on modal shift volumes.

It can be seen that even if road congestion becomes four times the level of 2000, a modal shift for freight from road to air is hardly considered (table 8.10, category "Yes" plus "Likely"). The EDCs in the SADC area can thus become locked into the transport mode road. That is, high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to a modal shift from road to air.

Table 8.9: Stated adaptations on model shift if road congestion increases two times

Scenario: Road congestion 2 times as much as in the year 2000		
Adaptation: Modal shift from road to air?	Warehouses stating adaptation (N= 13) (*)	Frequencies
No	R13, R17, R19, R20, R23, R24	6 (46%)
Unlikely	R2, R9, R16	3 (23%)
Possibly	R15, R18, R25	3 (23%)
Likely	-	0 (0%)
Yes	R12	1 (8%)
Total		13 (100%)

Note 1: R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4

Note 2: (*) Reported by the respondents who do not relocate if airport and road congestion increases two times; see table 8.3, category "No" plus "Unlikely"

Table 8.10: Stated adaptations on model shift if road congestion increases four times

Scenario: Road congestion 4 times as much as in the year 2000		
Adaptation: Modal shift from road to air?	Warehouses stating adaptation (N= 4) (*)	Frequencies
No	R19, R20, R23	3 (75%)
Unlikely	-	0 (0%)
Possibly	-	0 (0%)
Likely	R15	1 (25%)
Yes	-	0 (0%)
Total		4 (100%)

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***(*) Reported by the respondents who do not relocate if airport and road congestion increases four times; see table 8.4, category "No" plus "Unlikely"; R13 is missing, therefore N= 5-1= 4 warehouses***

Other spatial-organizational adaptations

Table 8.11 gives all other reported adaptations of the logistics managers under increasing road congestion in the Schiphol region. It can be seen that a significant number of warehouses opt for a time shift to avoid traffic jams.

Table 8.11: Stated adaptations different from modal shift under increasing road congestion

Adaptation: Different from modal shift	Scenario: Road congestion 2 times as much as in the year 2000 — Warehouses stating adaptation (N= 9) (*)	Scenario: Road congestion 4 times as much as in the year 2000 — Warehouses stating adaptation (N= 4) (**)
Time shift to off-peak transportation	R2, R13, R17, R19, R24	R19
Raise level of safety stock	R17	-
Phase-out existing warehouse, closure, disposal	-	R13
No adaptations: This level of congestion has no impact on our warehouse operations	R20	R20
No adaptations: However, this level of congestion has impact on our warehouse operations	R9, R16, R23	R23

Note 1: ***R= respondent; Underlined responses were mentioned by non-Schiphol-dependent warehouses; The rest of the responses were mentioned by Schiphol-dependent warehouses; Data are taken from table 7.4***

Note 2: ***Adaptations reported by the respondents who do not respond to increasing road congestion by a modal shift; For (*) see table 8.9, category "No" plus "Unlikely"; For (**) see table 8.10, category "No" plus "Unlikely", including R13***

8.5 Policy implications

In chapter 5 we have seen that our model of the clustering of EDCs near airport Schiphol exhibits four properties that makes policy analysis very different compared to standard neoclassical location models, namely: non-linear effects in the process of attracting EDCs; quasi-permanent EDC location effects; quasi-permanent EDC transport mode effects; non-linear effects in the process of pushing-out EDCs. They yield important implications for the EDC location policy aimed at the Schiphol area. In chapter 7 we empirically validated the first and second property. In this chapter we addressed the third and fourth property. Below, we show how the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy regarding the third and fourth property. That is, policy makers should be aware of the powerful role threshold effects play in the airport region. Moreover, we discuss new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. The new steering options utilize the phenomenon of locked-in logistics.

Quasi-permanent EDC transport mode effects
We have seen that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that can be used as adjustment possibility in response to increasing airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air). In contrast, under increasing road congestion in the Schiphol region a modal shift for freight from road to air is hardly considered. The EDCs in the SADC area can thus become locked into the transport mode road. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to a modal shift from road to air.

A modal shift for freight from air to road can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. Due to lock-in regarding the transport mode road, this effect may be quasi-permanent. A small policy intervention that is ineffective in terms of relocation of EDCs can, however, result in a modal shift for freight. If it results in a modal shift from air to road, there may thus be significant long-lasting effects. Moreover, reversing these effects may be difficult and may require a policy reform that is much larger than the policy change that led to the initial effect.

Non-linear effects in the process of pushing-out EDCs
We have seen that in the situational context and environment of the year 2000, approximately 15% of the warehouses is driven away from the SADC business parks. If airport and road congestion becomes two times the level of 2000, it causes 30% of the warehouses to leave. And if the warehouses are confronted with road and airport congestion that is four times the 2000 level, even 60% of the warehouses start to locate away from the Schiphol agglomeration. The data we have examined suggest that the impact of push-out pressures is subjected to linear responses.

However, we would like to point to the possibility of non-linear effects in the process of pushing-out EDCs due to location lock-in and its threshold values. Below the thresholds, a small variation in location policy may result in a small relocation effect. A marginal policy variation can have non-linear effects when the threshold is crossed and push-out and pull-out forces outweigh keep forces.

Additional options for governmental steering
The main policy implication of locked-in logistics, its threshold values and its threshold effects is one of caution. However, locked-in logistics also yields important new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. Here we discuss governmental steering options that utilize lock-in regarding transportation mode.

At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in airport congestion (congested runways, congested terminals, and congestion in the air). Furthermore, accessing Schiphol airport is becoming increasingly difficult as surface traffic congestion grows. In the wider Schiphol region, the road network suffers from heavy congestion. Transport speeds have fallen as the volume of traffic has

continued to grow on all roads. For the EDC cluster near Schiphol, increasing congestion is a strong pressure to change.

EDCs, once settled in the SADC area, can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to modal shift or relocation. The interesting point is the fact that if the spreading force of congestion operates just below or just above the threshold, a small policy intervention can be very effective. A small policy change can strengthen the spreading force of congestion so that it crosses the threshold. Or, in contrast, weaken the spreading force of congestion so that it operates below the threshold. In a wide variety of ways, different levels of the Dutch government can affect the congestion at airport Schiphol and the road congestion in the wider Schiphol region. We stress that one of the main tasks of SADC is to provide connecting roads from the SADC business parks to the highways and to Schiphol (see chapter 3). In the presence of congestion, not providing additional infrastructure from the SADC business parks to the highways and to Schiphol will strengthen its spreading force whereas improving the infrastructure will weaken its spreading force.

If the policy strengthens the spreading force of congestion so that it crosses the threshold it can alter the nature of the EDC cluster at the SADC business parks in three ways. First, increasing airport and road congestion can change the growth rate of the EDC cluster because it causes warehouses to leave. Second, increasing airport congestion can affect the mix of Schiphol-dependent and non-Schiphol-dependent warehouses. Warehouses that are not driven away from the SADC area –that are warehouses with high threshold values in terms of relocation- may decide to make a modal shift for freight from air to road to escape from the worsening airport congestion. Such a modal shift can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. Due to lock-in regarding the transport mode road, this effect may be quasi-permanent. Third, increasing road congestion can result in a time shift. Warehouses that are not driven away from the SADC area may opt for off-peak transportation, for instance night distribution, to avoid traffic jams.

8.6 Conclusions

In this chapter we presented further results of our investigation of the Schiphol-EDC-population. We demonstrated how the EDCs may react when they are confronted with pressures to change such as worsening location conditions or policy interventions. We studied the effects of a key pressure to change for the EDCs, namely:

- increasing road congestion in the Schiphol region;
- increasing airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air).

From chapter 7 we obtained insight in location lock-in in the situational context and environment of the year 2000. To gain further insight in locked-in logistics and its threshold

values we confronted the EDCs in the SADC area with hypothetical future situations of increasing congestion. We asked the logistics managers to state their logistics adaptations to compensate for the congestion impacts. In other words, we added an extra push-out factor to the logistics context of the year 2000.

We have seen that in the logistics context and environment of the year 2000, approximately 15% of the warehouses is driven away from the SADC business parks. If airport and road congestion becomes two times the level of 2000, it causes 30% of the warehouses to leave. And if the warehouses are confronted with road and airport congestion that is four times the 2000 level, even 60% of the warehouses say that they will start to locate away from the Schiphol agglomeration. The data we have examined suggest that the impact of push-out pressures is subjected to linear responses. However, this conclusion must be hedged with caveats. We pointed to the possibility of non-linear effects in the process of pushing-out EDCs due to location lock-in and its threshold values.

We have seen that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that may be used as adjustment possibility in response to increasing airport congestion at Schiphol. In contrast, under increasing road congestion in the Schiphol region EDCs may opt for off-peak transportation – for instance night distribution- to avoid traffic jams. However, a modal shift for freight from road to air to escape from the worsening road congestion is hardly considered. The EDCs in the SADC area can thus become locked into the transport mode road. That is, high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to a modal shift from road to air.

We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking. A modal shift for freight from air to road can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. This effect may be quasi-permanent due to lock-in regarding the transport mode road.

Furthermore, we have illustrated that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region.

9. Conclusions

9.1 Introduction

In this thesis we have presented a new model of the clustering of European Distribution Centers (EDCs) near Amsterdam Airport Schiphol. We assessed the empirical relevance and explanatory power of our model. We studied the EDC cluster at the business parks of the Schiphol Area Development Company (SADC). The SADC business parks are situated just outside the airport.

In this chapter, we evaluate our work and put it into perspective. First, we specify major research findings. Then, we explain the scientific and social relevance of our research. Finally, we point out the limitations in our material and give suggestions on what new work is now appropriate.

9.2 Research findings

Research question 1
Recall research question 1 (see chapter 1):

> *What are the determinants and mechanisms that explain the clustering of EDCs in the SADC area?*

The traditional answer to the question why EDCs cluster around Schiphol, is that EDCs are attracted to the airport due to the importance of having air transport services at their disposal. However, we revealed that this is only a partial answer. The evidence we have examined suggests that the increasing importance of transport speed, and therefore the increasing importance of air cargo, is not a key determinant in the process of attracting EDCs into the SADC area. Moreover, we have seen that almost 40% of the warehouses, that represent the EDC population in the SADC area, is non-Schiphol-dependent. We define a Schiphol dependent EDC as an EDC that meets the following criteria: (1) more than 20% of the inbound goods flows (by weight or units) is received via Schiphol by airplane or, (2) more than 20% of the outbound goods flows (by weight or units) is shipped via Schiphol by airplane.

In this thesis we apply the theoretical framework of New Economic Geography. We developed a new model of spatial economic development of the Schiphol area in which the following location forces interplay in the making of the EDC cluster:

- location endowments;
- agglomeration economies;
- locked-in logistics.

Location endowments stress the location benefits of the Schiphol area due to differences in physical geography. For the Schiphol area –or an airport region in general- we introduced two types of location endowments. First, specific airport endowments. That are air transport services. Examples are: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and landing fees; air fares; waiting time spent in terminals; and time and costs of getting to and from the airport. Second, non-airport endowments. Examples are: availability of fertile land; availability of natural resources; climate; access to the sea; labor costs; land prices; and transportation costs.

Agglomeration economies stress the location benefits of the Schiphol area due to its concentrations of economic activity. There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location. From the New Economic Geography literature we obtained four principal sources of economies of agglomeration, namely: (1) linkages (or input-output relationships) between firms associated with large local markets, the build-up of specialized input services, and internal economies of scale; (2) thick markets allowing the formation of a highly specialized labor force; (3) knowledge spillovers; (4) existence of modern infrastructure. These are the so called “Marshallian externalities”. We defined the sources of economies of agglomeration in conformity with the Marshallian externalities. Location endowments and agglomeration economies attract EDCs into the Schiphol area, whereas locked-in logistics refers to inertia of EDCs once they are settled in the Schiphol area.

We disentangled the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that region. We are led to the conclusion that Schiphol-dependent as well as non-Schiphol-dependent warehouses are attracted into the SADC area mainly because of economies of agglomeration. Those are the main location factors. Not the specific airport endowments of Schiphol. This explains why Schiphol is such an attractive location for both, Schiphol-dependent and non-Schiphol-dependent warehouses. For many EDCs, Schiphol fulfills a broader function than being a major hub for air transport. However, the importance of economies of agglomeration as a location factor is higher for non-Schiphol-dependent warehouses than for Schiphol-dependent warehouses.

The finding that economies of agglomeration are the most important determinants in the process of attracting EDCs into the SADC area means that the self-reinforcing character of this process is empirically validated. That is, attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, can support further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering the self-reinforcing growth process.

We have found that growth of the Schiphol agglomeration not only can result in economies but also in diseconomies in terms of location endowments and economies of agglomeration. EDCs that are settled near Schiphol are confronted with declining location conditions. That are push-out and pull-out forces. In this connection, the logistics managers of the warehouses reported two main drawbacks of the SADC area. First, it is an expensive location for EDCs. Second, the road congestion in the Schiphol region.

We have investigated push-out and pull-out forces on the one hand and keep forces on the other hand. Keep forces produce inertia that can make push-out and pull-out forces ineffective when it comes to relocation. The most important keep factor in the SADC area, as reported by the logistics managers of the warehouses, is formed by large fixed capital investments in warehouse buildings and logistics systems. We have seen that approximately 30% of the warehouses in the SADC area is locked into its location. Location lock-in is a situation where high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to relocation. We uncovered that the proportion of warehouses that is locked into their location is three times as high for warehouses in the SADC area than for warehouses located elsewhere in The Netherlands. This is a striking difference. Due to location lock-in the clustering of EDCs near Schiphol exhibits phenomena of irreversibility.

Research question 2
Recall research question 2 (see chapter 1):

> *What is the effect of increasing congestion on the EDC cluster in the SADC area in terms of firm relocation?*
>
> *For those EDCs in the SADC area which do not relocate; What is the effect of increasing congestion on the composition and relative importance of the transport modes used?*

We demonstrated how the EDCs may react when they are confronted with pressures to change such as worsening location conditions or policy interventions. We studied the effect of a specific pressure to change, namely increasing congestion. We have seen that in the logistics context and environment of the year 2000, approximately 15% of the warehouses is driven away from the SADC business parks. If airport and road congestion becomes two times the level of 2000, it causes 30% of the warehouses to leave. And if the warehouses are confronted with road and airport congestion that is four times the 2000 level, even 60% of the warehouses say that they will start to locate away from the Schiphol agglomeration. We defined airport congestion as congested runways, congested terminals and congestion in the air. The data we have examined suggest that the impact of push-out pressures is subjected to linear responses. However, this conclusion must be hedged with caveats. We pointed to the possibility of non-linear effects in the process of pushing-out EDCs due to location lock-in and its threshold values.

We have seen that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that may be used as adjustment possibility in response to increasing airport congestion at Schiphol. In contrast, under increasing road congestion in the Schiphol region EDCs may opt for off-peak transportation – for instance night distribution- to avoid traffic jams. However, a modal shift for freight from road to air to escape from the worsening road congestion is hardly considered. The EDCs in the SADC area can thus become locked into the transport mode road. That is, high thresholds are formed producing inertia that can make pressures to change –such as worsening location conditions or policy interventions- ineffective when it comes to a modal shift from road to air.

We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called “airport trucking”. A modal shift for freight from air to road can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. This effect may be quasi-permanent due to lock-in regarding the transport mode road.

Research question 3
Recall research question 3 (see chapter 1):

> *Can we find additional options for governmental steering that can help to control the location allocation of EDCs in the Schiphol area?*

Our model of the clustering of EDCs near airport Schiphol is based on New Economic Geography insights and has a number of properties that makes policy analysis very different to standard neoclassical location models. These properties arise because of the threshold effects in the model. Threshold effects are often neglected in standard neoclassical location models. We uncovered that there are major threshold effects in the surrounding areas of Schiphol. This yields important implications for the EDC location policy. The main policy implication of locked-in logistics, its threshold values and its threshold effects is one of caution. However, locked-in logistics also yields important new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. We described and illustrated two lines of new governmental steering options. The first line utilizes the phenomenon of location lock-in and can be used for steering between EDC clusters. The second line utilizes lock-in regarding transportation mode to steer within an EDC cluster.

Additional options for governmental steering between EDC clusters:
Suppose that we increase the administrative measures for the SADC business parks near Schiphol so that from now on less EDCs are permitted to locate there. At the same time we lift the administrative measures for an EDC business park elsewhere in the wider Schiphol region. Then, the growth rate of the EDC cluster near Schiphol will be reduced and, at the same time, a new EDC cluster will be formed. Although this new EDC location does not offer proximity to Schiphol, it attracts Schiphol-dependent warehouses due to the economies of agglomeration operating in the Schiphol region. Over time, the spatial structure of the Schiphol region will be transformed from a mono location system for Schiphol-dependent EDCs into a duo location system with two large clusters of Schiphol-dependent EDCs. Due to location lock-in the two clusters will continue to exist. Even when we lift the administrative measures for the EDC business parks near Schiphol. Thus, the impact of the policy is not reversed when the policy is reversed. By lifting and increasing the administrative measures that permit EDCs to locate at one of the two business parks we can change the growth rate of the EDC clusters. This duo location system can be extended into a three or more location system.

Additional options for governmental steering within an EDC cluster:
At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in airport congestion (congested runways, congested terminals, and congestion in the air). Furthermore, accessing Schiphol airport is becoming increasingly difficult as surface traffic congestion grows. In the wider Schiphol region, the road network suffers from heavy congestion. Transport speeds have fallen as the volume of traffic has continued to grow on all roads. For the EDC cluster near Schiphol, increasing congestion is a strong pressure to change.

EDCs, once settled in the SADC area, can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to modal shift or relocation. The interesting point is the fact that if the spreading force of congestion operates just below or just above the threshold, a small policy intervention can be very effective. A small policy change can strengthen the spreading force of congestion so that it crosses the threshold. Or, in contrast, weaken the spreading force of congestion so that it operates below

the threshold. In a wide variety of ways, different levels of the Dutch government can affect the congestion at airport Schiphol and the road congestion in the wider Schiphol region. We stress that one of the main tasks of SADC is to provide connecting roads from the SADC business parks to the highways and to Schiphol. In the presence of congestion, not providing additional infrastructure from the SADC business parks to the highways and to Schiphol will strengthen its spreading force whereas improving the infrastructure will weaken its spreading force.

If the policy strengthens the spreading force of congestion so that it crosses the threshold it can alter the nature of the EDC cluster at the SADC business parks in three ways. First, increasing airport and road congestion can change the growth rate of the EDC cluster because it causes warehouses to leave. Second, increasing airport congestion can affect the mix of Schiphol-dependent and non-Schiphol-dependent warehouses. Warehouses that are not driven away from the SADC area –that are warehouses with high threshold values in terms of relocation- may decide to make a modal shift for freight from air to road to escape from the worsening airport congestion. Such a modal shift can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. Due to lock-in regarding the transport mode road, this effect may be quasi-permanent. Third, increasing road congestion can result in a time shift. Warehouses that are not driven away from the SADC area may opt for off-peak transportation, for instance night distribution, to avoid traffic jams.

9.3 Scientific and societal relevance

This thesis deals with the explanation of why EDCs cluster around Amsterdam Airport Schiphol. The Netherlands is an attractive location for EDCs. Approximately one-half of all EDCs in Europe is located in The Netherlands. In 2002, the EDC sector contributed about 95,000 jobs (full time equivalents) and 1% of the gross national product (GNP) to the Dutch economy. Schiphol is a major European airport and represents an important concentration of EDCs.

The amount and nature of distribution centers located in the surrounding areas of Schiphol is a prime concern for Dutch policymakers because of two reasons. First, attracting EDCs means attracting all kinds of international goods flows, investments and employment. Second, EDC activities are space demanding while the amount of open space available outside the airport is limited and earmarked for airport-dependent firms. The explanation of why economic activities cluster around airports is important for location theory and location policy regarding airport regions.

Our model of the clustering of EDCs near airport Schiphol is based on New Economic Geography insights and has a number of properties that makes policy analysis very different to standard neoclassical location models. These properties arise because of the threshold effects in the model. Threshold effects are often neglected in standard neoclassical location models. We uncovered that there are major threshold effects in the surrounding areas of Schiphol. This yields important implications for the EDC location policy. The main message

of this thesis is that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region. We empirically validated three important threshold effects. They are described and illustrated below.

Non-linear effects in the process of attracting EDCs:
We uncovered that economies of agglomeration are the most important determinants in the process of attracting EDCs into the SADC area. This means that the self-reinforcing character of this process is empirically validated. That is, attracting firms and activities in sufficient numbers can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster.

Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering the self-reinforcing growth process. Below the thresholds, a small variation in location policy can result in a small effect on the growth rate of the EDC cluster. From that policy makers may conclude that the clustering of EDCs is not much affected by policy changes. However, a marginal policy variation can have non-linear effects when the threshold is crossed. The possibility of non-linear responses makes it much more difficult to forecast the effect of a given policy change. It implies that the same intervention can have different impacts the first and second time it is applied. Unless policy makers are aware of the non-linearity, estimates based on historical data may provide a very misleading indication of what future policy changes will do.

Quasi-permanent EDC location effects:
We have seen that the EDCs that are settled in the SADC area can become locked into their location. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to relocation. We uncovered that the proportion of warehouses that is locked into their location is three times as high for warehouses located in the SADC area than for warehouses located elsewhere in The Netherlands. A bad EDC location policy for the Schiphol area may thus have significant long-lasting bad effects. Moreover, reversing these effects may be difficult and may require a policy reform that is much larger than the policy change that led to the initial effect. In other words, the impact of the policy need not be reversed when the policy is reversed.

Quasi-permanent EDC transport mode effects:
We have seen that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that can be used as adjustment possibility in response to increasing airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air). In contrast, under increasing road congestion in the Schiphol region a modal shift for freight from road to air is hardly considered. The EDCs in the SADC area can thus become locked into the transport mode road. That is, high thresholds are formed producing inertia that can make small policy interventions –or other pressures to change- ineffective when it comes to a modal shift from road to air.

Within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. A modal shift for freight from air to road can easily turn Schiphol-dependent

warehouses into non-Schiphol-dependent warehouses. Due to lock-in regarding the transport mode road, this effect may be quasi-permanent. A small policy intervention that is ineffective in terms of relocation of EDCs can, however, result in a modal shift for freight. If it results in a modal shift from air to road, there may thus be significant long-lasting effects. Moreover, reversing these effects may be difficult and may require a policy reform that is much larger than the policy change that led to the initial effect.

9.4 Concluding remarks

In this section we give suggestions on what new research is now appropriate. The recommendations for further research and applications result from the aforementioned research findings and the limitations of this study.

Time frame
The data collection method we applied is survey research. One basic decision which must be made for all surveys is the choice of time frame for the data collection effort. It is possible to collect data from a cross-sectional survey or a time-series survey. A cross-sectional survey involves the collection of data at one point in time over a large number of identifiable groups which constitute a fraction of the total population. Whereas a time-series survey involves the collection of data using the same survey method at a number of successive points in time. We conducted a cross-sectional survey and collected data at the year 2000 over two populations: the national-EDC-population and the Schiphol-EDC-population. The Schiphol-EDC-population is the warehouse cluster at the SADC business parks. These business parks are situated in Schiphol's surrounding areas. The national-EDC-population consists of the warehouses that are located elsewhere in The Netherlands. Future research could repeat our survey among the same populations but at a next point in time. The results from both studies can be compared with the specific aim of testing the stability of the results over time.

Case study
This thesis deals with the explanation of why EDCs cluster around airport Schiphol. In other words, we focused on a specific case namely the Schiphol agglomeration. We have presented a new model of the clustering of EDCs near Schiphol. Moreover, we have tested the empirical relevance and explanatory power of the model. Our model proved to be a strong research framework. We uncovered that there are major threshold effects in the surrounding areas of Schiphol. This yields important implications for the EDC location policy. The main message of this thesis is that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region.

The findings of our study are limited to the Schiphol agglomeration. Whereas our model provides a viable research framework to study the spatial economic development of port regions in general, such as the surrounding areas of: major airports, regional airports, or seaports. Our model is especially useful for studying the clustering of distribution centers near major airports and major seaports where the amount of open space available outside the port

is limited and earmarked for port-related activities. This points at a compelling need to carry out our analysis at other port regions to see whether similar thresholds, threshold values and threshold effects can be found.

Type of firm
The consideration of only one specific type of firm –that is the EDC- limits the explanatory power of our model. Airports and seaports not only attract distribution centers but also offices. If we want to explain why offices cluster in the surrounding areas of ports, we need to extend our model. These extensions should focus on characteristics to describe the stylized facts of offices.

Pressures to change
We gained insight in locked-in logistics and its threshold values through scenarios of increasing congestion. However, other pressures to change can be equally important. Additional research is needed to specify more precisely the threshold values and the conditions under which non-linear effects and phenomena of irreversibility occur.

Welfare effects
There are legal constraints on the uses to which the SADC business parks may be put. Only Schiphol-dependent firms are permitted. SADC uses selection criteria to distinguish Schiphol-dependent firms from non-Schiphol-dependent firms. However, we have seen that almost 40% of the warehouses, that represent the EDC population in the SADC area, is non-Schiphol-dependent. Moreover, Schiphol-dependent warehouses can easily turn into non-Schiphol-dependent warehouses by a modal shift from air to road. Due to lock-in regarding the transport mode road, this effect may be quasi-permanent. Within Europe, freight transport by air is increasingly substituted by road transport. In summary, the evidence we have examined suggests that the warehouse selection policy does not result in the formation of a cluster of Schiphol-dependent EDCs at the SADC business parks. Future research could focus on replacing the current warehouse selection policy by a pricing policy. The welfare implications of different policies could be compared through a Cost Benefit Analysis (CBA). In the CBA all effects of a policy are systematic evaluated and, when possible, given a monetary value. The result is a profitability analysis, a welfare balance from the community's point of view. It shows how the economic and social benefits such as transport-cost reduction and economies of agglomeration weigh against the economic and social costs of the policy such as investments in the development of business parks, investments in infrastructure, increasing congestion, and environmental intrusion for those living in the region. CBA information is useful in almost every stage of policy preparation to facilitate decision-making.

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Appendices

Appendix 1.1: Empirical illustration of locked-in logistics and its consequences

Case study EDC Yamaha Motor Europe[10]

Where is the best place to locate the new EDC

In the second half of the 1980s, Yamaha Motor Europe embarked on a strategy that would eliminate the many local warehouses scattered across the continent and consolidate operations into a single facility. The new facility was designed to handle the European distribution of spare parts and accessories of Yamaha Motor Europe. The product range of Yamaha Motor Europe consists of: motor cycles, power boats, outboard engines, scooters, snow mobiles, swimming pools, and car engines. Preparations and construction of the EDC started in 1989. At the beginning of 1993, the new facility opened at the SADC business park named "Park Oude Meer", very close to airport Schiphol. In total, the facility covers more than 20,000 square meters and 150,000 stock keeping units (SKUs). Yamaha decided to build its EDC very close to the airport because of the following reasons:

- close to Uithoorn where, at that time, another Yamaha office was located;
- close to Amstelveen where many Japanese families live and a Japanese school is located;
- to be situated near a major European airport creates a positive image;
- relatively low land price.

[10] The information for the case study is derived from the interview with Mr. A. Jager, Division Manager of Yamaha Motor Distribution, held on the 7th of December 1999.

Organization of the goods flows: inbound goods flow of the EDC
The production plants are located in Japan and Europe. The most important production location is Japan. The goods flow from Japan to the EDC is organized as follows. First, the spare parts and accessories are transported as sea cargo by ship from Japan to seaport Rotterdam in The Netherlands. From there, the goods are transported by truck to the EDC. Only in case of emergency, air transport is used. On average, 95% (by weight) of the inbound goods flow from Japan to the EDC is transported by maritime and road transport.

The European production plants are situated in France, Spain, and Italy. They produce spare parts for scooters. From these plants the parts are transported by truck to the EDC. At the start of the 1990s, there was little demand for scooters in Europe and scooter parts formed only a minor goods flow. Suddenly, in the second half of the 1990s, demand for scooters rose quickly in France, Spain and Italy. The scooter market in these countries was booming. As a consequence, in the year 2000, almost 50% (by volume) of the total inbound goods flow of the EDC consisted of scooter parts produced in France, Spain, and Italy, flowing back to these countries again.

Organization of the goods flows: outbound goods flow of the EDC
The EDC is the starting point for the deliveries of spare parts and accessories -via 25 Yamaha distributors- to the 7000 Yamaha dealers in Europe. Each distributor functions as a representative office and is responsible for its part of the dealer network. Ordering procedures are completely automated. The order flow goes from the dealers via the distributors to the EDC. All deliveries from the EDC into Europe, are “direct” and “next day” deliveries. For the outbound goods flow, Yamaha uses express transport services. The main express companies used are:

- DHL for deliveries in: United Kingdom, Italy, Belgium, Denmark, and Sweden. First, DHL transports the Yamaha products by truck to its distribution center in Brussels (Belgium). From there, Yamaha products are shipped by truck and airplane.
- CAT for deliveries in Germany. The main distribution center of CAT is located in Cologne (Germany). In all cases, road transport is used.
- Chronopost for deliveries in: France, Portugal, and Spain. The main distribution center of Chronopost is located in Paris (France). In principle, for shipments from the EDC to Paris road transport is used. For the distribution from Paris into Europe, Chronopost uses trucks and airplanes.

It can be seen that for the outbound distribution, from the EDC to the distribution centers of DHL, CAT and Chronopost, road transport is used. And that from there, in most cases, Yamaha products are distributed into Europe by truck. If the express companies decide to transport Yamaha products by air, they fly from the airports of Brussels or Paris, not Amsterdam.

Locked-in logistics: lock-in regarding warehouse location
In 2000, the Yamaha EDC in the Schiphol area is confronted with two important negative changes in its logistics environment. First, due to the booming scooter market in the south of Europe the organization of the inbound goods flows changed drastically. As a consequence, the EDC location that minimizes transportation costs for products moving between the manufacturing plants and the market shifted southwards into Europe. Secondly, the increased road congestion in the wider Schiphol region. Road congestion is especially a problem for the outbound goods flows. For shipments from the EDC to the distribution centers of the express companies, road transport is used. Here, time schedules are very tight.

The question that arises now is whether Yamaha will react to the declining location conditions by relocating the EDC. Yamaha invested heavily in the construction of the EDC, especially in the order picking installation. Therefore, in spite of the worsening road congestion and although it would be more efficient to situate the EDC southwards, Yamaha will not relocate the EDC for several years. The large fixed capital investment in the warehouse building and logistics systems is the most important hurdle that keeps Yamaha from relocating.

Locked-in logistics: lock-in regarding transportation mode
We have seen that the EDC is not driven away from the SADC business parks by the declining location conditions. The next question is whether the EDC will compensate the impacts of the worsening location conditions by making substantial on-site adjustments, such as a modal shift for freight. A strategy the EDC may apply to cope with the fallen transport speeds on the roads in the wider Schiphol region, is to shift a part of the outbound goods flows from “road to air”. However, the outbound goods flow (spare parts) can be characterized as low value-weight and non-perishable. Therefore, we can say that such a modal shift will result in transporting traditional sea freight by airplane via Schiphol.

Note: In 2006, Yamaha Motor Europe started a feasibility study about securing future service levels offered to the marketplace. An important question is whether next day deliveries of parts and accessories to customers can be guaranteed. In The Netherlands, next to the ever-growing road congestion, the number of roads with speed limitations is increasing. As a consequence, the Yamaha EDC near Schiphol is confronted with a time window for order picking that narrows year by year.

Appendix 3.1: Interviewed policy makers

The Province of North Holland:

- Mr. R.J.P. Toole; the Province of North Holland, Secretary Governing Body Schiphol (Bestuursforum Schiphol)
- Mr. M. Van den Berg; the Province of North Holland, Project manager Schiphol

City of Amsterdam:

- Mr. W.H.A. Vehmeyer; city of Amsterdam, Director of Economic Development

City of Haarlemmermeer:

- Mr. N.W. Kamphorst; city of Haarlemmermeer, Director of Economic Development

Amsterdam Airport Schiphol:

- Mr. M. Schaafsma; Schiphol Real Estate, Senior Town Planner
- Mr. K. Smilde; Schiphol Real Estate, Director

Governing Body Schiphol (Bestuursforum Schiphol):

- Mr. N.W. Kamphorst; city of Haarlemmermeer, Director of Economic Development
- Mr. K. Smilde; Schiphol Real Estate, Director
- Mr. R.J.P. Toole; the Province of North Holland, Secretary Governing Body Schiphol (Bestuursforum Schiphol)
- Mr. W.M. Trommels; Schiphol Area Development Company (SADC), Managing Director
- Mr. M. Van den Berg; the Province of North Holland, Project manager Schiphol

- Mr. W.H.A. Vehmeyer; city of Amsterdam, Director of Economic Development

Schiphol Area Development Company (SADC):

- Mr. W.M. Trommels; Schiphol Area Development Company (SADC), Managing Director
- Mrs. Hilde I. Van der Meer; Schiphol Area Development Company (SADC), Director Marketing & Sales

Appendix 3.2: SADC criteria to select Schiphol-dependent warehouses (period 1987-2000)

Source: Schiphol Area Development Company (SADC), 2001

Criteria used from 1987 until 1995:
A Schiphol-dependent warehouse is a warehouse that meets one of the following criteria:

- At least 25% of the goods flows (by weight, units, or value) consists of airfreight and the airfreight is shipped via Amsterdam Airport Schiphol on a daily basis.
- A letter of recommendation on the strategic importance of the warehouse is written by Schiphol.
- The warehouse is part of the aviation industry.
- The warehouse is located at Schiphol and needs to be relocated.
- The warehouse is the first subsidiary of a foreign company willing to establish itself in The Netherlands.

Criteria used from 1995 until 1999:
A Schiphol-dependent warehouse is a warehouse that meets one of the following criteria[11]:

- *At least 25% of the inbound- or outbound goods flows (by weight, units, or value) consists of airfreight.*

[11] differences from the former criteria are printed in Italic

- *Due to its function as European Distribution Center (EDC) airfreight is received or shipped as a priority daily.*
- *The warehouse is part of a logistics chain which is linked to Amsterdam Airport Schiphol.*
- The warehouse is part of the aviation industry.
- The warehouse is located at Schiphol and needs to be relocated.
- The warehouse is the first subsidiary of a foreign company willing to establish itself in The Netherlands.

Criteria used in 1999 and 2000:
A Schiphol-dependent warehouse is a warehouse that meets one of the following criteria[12]:

- At least 25% of the inbound- or outbound goods flows (by weight, units, or value) consists of airfreight.
- *Due to its function as European Distribution Center (EDC) airfreight is received or shipped as a priority two times a week at least.*
- The warehouse is part of a logistics chain which is linked to Amsterdam Airport Schiphol.
- The warehouse is part of the aviation industry.
- The warehouse is located at Schiphol and needs to be relocated.
- The warehouse is the first subsidiary of a foreign company willing to establish itself in The Netherlands.

[12] differences from the former criteria are printed in Italic

Appendix 6.1: National-EDC-survey, introductory letter

[Logo of Holland International Distribution Council]

[Date]

[Company name]
[Name of the logistics manager]
[PO box number]
[ZIP code and city]

Dear [Name of the logistics manager],

Currently, a study on progress in European Distribution is carried out by "The Netherlands Research School for Transport, Infrastructure and Logistics" (TRAIL) and "Holland International Distribution Council" (HIDC). The emphasis of this study is on European Distribution Centers (EDCs) in The Netherlands and, within that area, on: (1) warehouse characteristics, (2) the location pattern, and (3) the use of modes of transportation. The purpose of this study is: (1) to get a picture of the latest developments in European Distribution, (2) to disseminate and contribute to scientific knowledge on European

Distribution, and (3) to develop insight and instruments that can offer help to improve the logistics processes of EDCs in The Netherlands.

First, more about TRAIL. TRAIL is The Netherlands' national institute of knowledge in the fields of TRAnsport, Infrastructure and Logistics. In TRAIL the following three universities collaborate on fundamental and applied scientific research: (1) Delft University of Technology, (2) Erasmus University Rotterdam, and (3) University of Groningen.

For this research project, practical experiences are very important. Therefore we decided to send this letter and questionnaire. This letter is sent to *owners* and *operators* of EDCs. For this research, an EDC is defined as a European facility primarily responsible for the distribution of one or more product groups to (most) customers in at least five different European countries. We would appreciate it very much if you would cooperate by filling out the added questionnaire, preferably by the (assistant) logistics manager of the EDC. We have strived to keep the questionnaire short. You should count on about 20 minutes to fill it out completely.

What is in it for you? After the completion of the study, you will be sent a report that summarizes the most important findings. We would like to stress that the results of the study will be worked out in such a way that anonymity is guaranteed and that all data will be used confidentially.

Please, return the questionnaire before [Date] in the enclosed envelop. If you need any further information, please do not hesitate to contact us. In advance, we would like to thank you very much for your cooperation.

On behalf of the research team,

René de Koning; HIDC
Tim van Rees; HIDC
Prof. Dr René de Koster; Erasmus University Rotterdam
Dr Remko van Hoek; Erasmus University Rotterdam/ Cranfield University
Drs Ing. Pim Warffemius; Erasmus University Rotterdam

If you need any further information, please contact:
Drs Ing. Pim Warffemius
Phone: 010-408 2645
Email: Warffemius@fsw.eur.nl

Or else,
Prof. Dr René de Koster
Phone: 010-408 2006
Email: rkoster@fbk.eur.nl

Please, return the questionnaire in the enclosed envelop.

Enclosure: questionnaire

Appendix 6.2: National-EDC-survey, respondents

Table A6.1: Respondents national-EDC-survey

Warehouse	Logistics Manager	Warehouse location
Acer	Mr. J. van Winden	Tilburg
Akiyama	Mr. J.C. Bruin	Hoofddorp
American Saw Company	Mr. de Jonge	Helmond
Ameron International	Mr. H. Brok	Geldermalsen
Ampco Edc Services	Mr. F.J.M. Bijlhouwer	Woerden
Canon	Mr. E.P.C. Meergartt	Amstelveen
Cleton & Co	Mr. R. van Dalen	Ridderkerk
Currie European Transport	Mr. H. Dellepoort	Nijmegen
Daewoo Motor Euro Parts Center	Mr. E.J. Wisse	Breda
Danzas Fashion	Mr. J. Hendriks	Blerick
Danzas Solutions	Mr. T.H. van Bilsen	Amsterdam
Doall	Mr. G. Verschuren	Dordrecht
EDCR	Mr. J.G. Bax	Roosendaal
EGL (Eagle Global Logistics)	Mr. P. Palmboom	Schiphol-Oost
EMI Compact Disc	Mrs. J. van der Sterren	Uden
European Transport Systems	Mr. A. Scholtens	Groot Ammers
EXEL	Mr. T. de Vries	Amersfoort
Foot Locker Europe	Mr. R. van Goethem	Heijen
Franklin Mint Fulfillment Center	Mr. M.J.M. Uden	Rotterdam
Hankook Tires	Mrs. S. Karreman	Rotterdam

Hays Logistics Benelux	Mr. E. van de Kerkhof	Helmond
Hays Logistics Benelux	Mr. T. van Laar	Ede
Hays Logistics Benelux	Mr. J. van Oostrom	Oud Beijerland
Hays Logistics Benelux	Mr. J.T. Verschoor	Veghel
Hendriks Expeditie- & Veembedrijf	Mr. F.H.P. London	Amsterdam
Herfurth Logistics	Mr. C. Korteweg	Rotterdam
Hoya lens Europe	Mr. T. van de Biggelaar	Uithoorn
Ilogistix	Mr. P. Mooren	Tilburg
Jan de Rijk Logistics	Mr. R. Poort	Roosendaal
Kloosterboer Vlissingen	Mr. J.E. Kloosterboer	Vlissingen
Koyo Seiko	Mr. C.G. van Barneveld	Almere
Kyocera Mita Europe	Mr. R. Ekstein	Hoofddorp
Limij International	Mr. J.M.J. Sporck	Nuth
Marconi Data Systems Europe	Mr. J.M. de Boer	De Meern
MSD (Merck Sharp & Dohme)	Mr. N. Odijk	Haarlem
Modus Media International	Mr. J. Zweers	Apeldoorn
MOL Logistics	Mr. B. Crawford	Tilburg
Nichiyu Europe	Mr. K. Amano	Amstelveen
Nikon Europe	Mr. J. van der Zon	Badhoevedorp
Nissan motor parts centre	Mr. Visser	Amsterdam
Nordson European Distribution	Mr. H. Keeris	Maastricht
Omron Europe	Mr. A.F.A. Mom	Den Bosch
Partylite distribution	Mr. J.J. van den Bosch	Tilburg
PC Chips Europe	Mr. C. de Klein	Nijmegen
Reebok Distribution	Mr. E. Hartel	Rotterdam
Road Air	Mr. M. van Lexmond	Best
Samsung Electronics	Mr. R. Glerum	Moerdijk
Santrade	Mr. A. Nieuwpoort	Schiedam
Schenker-BTL	Mr. P.W.P. Fontein	Beringe
Seacon Logistics	Mr. H.J.G. Berden	Venlo
Sony Logistics Europe	Mrs. R. Edge	Tilburg
Texas Instruments Logistics Center	Mr. J. Schoenmaker	Utrecht
Timberland Europe	Mr. M. Kamphuis	Enschede
Traffic	Mr. A.J.A. Oudejans	Moerdijk
Tsubakimoto Europe	Mr. L. Laurman	Roosendaal
Unisys	Mr. P.E.J.L. de Potter	Sassenheim
UPS Logistics Group	Mr. P.H.C. van den Hurk	Roermond
Van Dorst Transport	Mr. A.J.M van Dorst	Bergen op Zoom
Versteijnen Logistics	Mr. W. Hamerlinck	Tilburg
VTE (Venlo Transport en Expeditie)	Mr. C.S.A.M Kuijken	Venlo
Yamaha Motor Distribution	Mr. E. Theunissen	Schiphol-Rijk
Yamanouchi Europe	Mr. J. Beuling	Meppel
Yanmar Europe	Mr. J. van Gelder	Almere

Note: Warehouse location refers to the city where the distribution center is located

Appendix 6.3: National-EDC-survey, questionnaire

Guidelines for filling out the questionnaire
Please, read the following guidelines below carefully before you start filling out the questionnaire:

- This mailing list is sent to *owners* and *operators* of European Distribution Centers (EDCs).
- An *EDC* is defined as: a European facility primarily responsible for the distribution of one or more product groups to (most) customers in at least five different *European* countries.
- In case you operate *multiple* EDC operations, please fill out the questionnaire for only one operation (the operation at which address you received the questionnaire).
- In case you *operate* the EDC, but are not the *owner* of the stock in the EDC, please answer the questions to which we added *"(main client)"* as far as possible, from the viewpoint of your *main client* at the EDC.

  Example: Logistics service provider A runs two EDC operations, one EDC in Rotterdam and one EDC in Amsterdam. The EDC in Rotterdam provides logistics services for companies B and C. The EDC in Amsterdam provides logistics services for company D. This questionnaire is sent to the EDC in Rotterdam. In that case the (assistant) logistics manager of the EDC in Rotterdam fills out the questionnaire for the operation in Rotterdam and answers the questions to which we added "(main client)" for his/her main customer in Rotterdam which is company B.

- If you can not answer a question, please leave that particular question open.

Questionnaire

A. GENERAL – REGARDING YOUR EDC FACILITY

A1. Please, characterize your EDC facility (multiple answers possible):

O production facility
O finished-goods warehouse
O transshipment operation
O wholesaler; supplying manufacturers
O wholesaler; supplying retailers
O retailer; supplying consumers (directly or via own stores)
O public warehouse
O dedicated warehouse
O logistics service provider; If the answer is yes, please indicate your main clients and their country of origin:

Your main clients:	*Country of origin:*
-	-
-	-
-	-
-	-

A2. In which sector(s) does your facility operate (for example: automotive, pharmaceutical, consumer electronics, apparel, construction etc.)?

A3. Please, describe your (main client's) assortment (for example: videos, shoes, audio, valves)

A4. How many people are employed in your facility (including part-timers)?

A5. How many **direct** and **indirect** full time equivalents (FTEs) are, on average, working at your facility (for your main client)?

Number of **direct** FTEs (working on the shop floor):
Number of **indirect** FTEs (not working on the shop floor):

A6. Please, indicate the different nationalities of the top- and middle management people working within your facility, and next indicate the number of top- and middle management people of each nationality.

Nationalities of top- and middle management:	Number of top- and middle management people:
-	-
-	-
-	-
	_____+
	Total:

A7. What is the size of your warehouse facility (in m^2)?

O less than 1000 m²
O 1000-3000 m²
O 3000-5000 m²
O 5000-10,000 m²
O 10,000-20,000 m²
O more than 20,000 m²

A8. How many different stock keeping units (SKUs) are **stored** or **handled** in your warehouse on average?

a. stored:
O less than 500
O 500-1000
O 1000-5000
O 5000-10,000
O 10,000-20,000
O 20,000-50,000
O 50,000-100,000
O more than 100,000

b. handled:
O less than 500
O 500-1000
O 1000-5000
O 5000-10,000
O 10,000-20,000
O 20,000-50,000
O 50,000-100,000
O more than 100,000

A9. Please, check the following special properties that hold for a significant part (more than about 10%) of your (main client's) product range (multiple answers are possible):

O perishable products (short storage life)
O flammable
O conditioning required (for example: cooling, freezing, humidity)
O special storage conditions required (for example: anti-theft protection, dust-free, clean-room)
O other, please describe below:

A10. How many EDCs does your company (your main client) have?

Number of EDCs:

A11. When (year + month) was your warehouse ready for operation at this location?

*A12. Please, describe why this **country** was chosen as location for establishment of the warehouse instead of other European countries (4 factors at maximum).*

(1)
(2)
(3)
(4)

*A13. Please, describe why this **location** was chosen as location for establishment of the warehouse instead of other locations in this country (4 factors at maximum).*

(1)
(2)
(3)
(4)

A14. Imagine that you can choose a new location for the establishment of your warehouse. Would you decide for the current location or would you decide differently? Why? Please, describe below:

O *current location*
O *different location*

Why? Please, describe below:

A15. Will your warehouse operations move to a new location within a period of 2 years? Please, mark a box and describe why:

O *no*
O *very unlikely*
O *unlikely*
O *likely*
O *very likely*
O *yes*

Why? Please, describe below:

*A16. How much capital (in million **Euro** and in substitution value for the year 2000) has been invested approximately in the warehouse and the logistics systems? (Office buildings should only be included as far as direct service for the warehouse operation is concerned).*

Invested capital in warehouse building and technical installations (for example: climate control, sprinkler, water etc.):
O less than 2 million Euro
O 2-5 million Euro
O 5-10 million Euro
O 10-15 million Euro
O 15-25 million Euro
O 25-40 million Euro
O 40-60 million Euro
O more than 60 million Euro

Invested capital in logistics systems (for example: order picking installation, storage system, information system, internal transport):
O less than 2 million Euro
O 2-5 million Euro
O 5-10 million Euro
O 10-15 million Euro
O 15-25 million Euro
O 25-40 million Euro
O 40-60 million Euro
O more than 60 million Euro

Total investment:
O less than 2 million Euro
O 2-5 million Euro
O 5-10 million Euro
O 10-15 million Euro
O 15-25 million Euro
O 25-40 million Euro
O 40-60 million Euro
O more than 60 million Euro

B1. EUROPEAN DISTRIBUTION STRUCTURE – INBOUND LOGISTICS

B1. In which countries are your (main client's) main suppliers located? What is the share of each of these countries, measured in percentage (by weight/units: strike out what is not applicable) of the total (main client's) ***inbound*** *goods flow?*

Countries where your (main client's) main suppliers are located:	*% (by weight/units) of the total (main client's)* ***inbound*** *goods flow:*
-	-
-	-
-	-
-	-
	+
	100%

B2. What is the percentage (by weight/units: strike out what is not applicable) of the total ***inbound*** *goods flow that consists of air-cargo. Air cargo can be transported by the transport modes: airplane, truck (airport trucking) or train (air-cargo shuttle).*

B3. What is the percentage (by weight/units: strike out what is not applicable) of the **total inbound air-cargo goods flow** (mentioned at B2) that consists of high-value and perishable products? (For categorizing your inbound goods flow, compare your warehouse with other EDCs)

B4. Is the percentage mentioned at B2 increasing, decreasing or stable in time? Please, mark a box.

O increasing
O decreasing
O stable

B2. EUROPEAN DISTRIBUTION STRUCTURE – OUTBOUND LOGISTICS

*B5. To which countries (European and non-European) do you ship from your warehouse? What is the share of each of these countries, measured in percentage (by weight/units: strike out what is not applicable) of the total **outbound** goods flow?*

Countries to which you ship:	*% (by weight/units) of the total **outbound** goods flow:*
-	-
-	-
-	-
-	-
	_____+
	100%

*B6. What is the percentage (by weight/units: strike out what is not applicable) of the total **outbound** goods flow that consists of air-cargo. Air cargo can be transported by the transport modes: airplane, truck (airport trucking) or train (air-cargo shuttle).*

B7. What is the percentage (by weight/units: strike out what is not applicable) of the **total outbound air-cargo goods flow** (mentioned at B6) that consists of high-value and perishable products? (For categorizing your outbound goods flow, compare your warehouse with other EDCs).

B8. Is the percentage mentioned at B6 increasing, decreasing or stable in time? Please, mark a box.

O increasing
O decreasing
O stable

C. WAREHOUSE ORGANISATION

C1. Please, (1) indicate which of the processes below play an important role in your facility (multiple answers are possible) and, (2) if applicable, break down the goods flow in volume percentages (bulk, pallets, boxes, units):

Please, break down the goods flow in the following volume percentages:

% Bulk; % Pallets; %Boxes; % Units

O Receiving goods……
O Inspection of received goods ……
O Receiving and handling returns ……
O Cross-docking / transshipment ……..
O Storage of goods ……
O Re-packing of products ……..
O Internal movements for optimization purposes……..
O Order picking ……
O Packing ……...
O Preparation for shipment ……

O *Value added logistics (VAL); please, describe below:*

O Cycle counting
O Transport planning
O Transportation; please, describe below which part:

O Route planning
O Other, please describe: ….....

C2. Indicate for your facility the number of outgoing orders on a daily basis.

Average number of daily orders:

C3. Indicate for your facility the number of daily order lines.

Average number of daily order lines:

C4. Indicate for your facility the number of daily units shipped.

Average number of daily units shipped:

C5. Indicate for your facility the number of daily order lines needing value added logistics (VAL) operations.

Average number of daily order lines needing VAL:

C6. Please, indicate below the automation systems used in your facility: (Examples of automation are, use of: cranes, sorters, palletisers, warehouse management system, automated guided vehicles (AGVs), radio frequency system, etc.)

C7. Which quality performance indicators are used in your facility? (Multiple answers are possible).

O Pick errors
O Delivery accuracy
O Returns
O Packaging errors
O Order completeness
O Other, please describe: .....

C8. What is, measured from 1-1-1999 until 31-12-1999, the percentage of orders shipped from your facility with errors (examples of errors are: quantity errors, time errors, packaging errors, product errors, shipment mode errors, etc.)

Type of errors measured at your EDC:	% of orders shipped with this error:
-	-
-	-
-	-
-	-

C9. Compared to warehouses of competitors how would you, for your facility, qualify: A, B, C, D, E, and F. Please, mark one or more boxes on a scale of 1 (= worse than competitors) to 3 (= better than competitors).

	1= worse than competitors	2= equal to competitors	3= better than competitors
A) Quality of your operation			
B) Ease of handling variable numbers of orders			
C) Ease of handling late quantity or SKU changes in orders			
D) Ease of handling late changes in customization demands (VAL)			
E) Ease of faster delivery of orders			
F) Ease of handling illness and absence of personnel			

C10. What are the organizational methods that your warehouse adapted from the "mother" company (or the “mother” company of your main client)? Please, mark one or more boxes below:

O ISO
O Formalized working methods
O Reward systems
O Statistical Process Control (SPC)
O Performance measurement systems
O Kaizen
O Quality circles
O Consensus decision making
O Empowerment
O Other, please describe: .....

D. FUTURE OF EUROPEAN DISTRIBUTION

D1. Please, indicate how important you consider the following early developments for future competitiveness in European distribution. Please, mark one or more boxes on a scale of 1 (= not important at all) to 5 (= crucial).

	(1) Not important at all (counter productive)	(2) Not important	(3) Somewhat important	(4) Important	(5) Crucial
Decentralization of stock and warehouses					
Direct distribution from factory to client avoiding the warehouse					
Replacing inventory with information					
Performing customization/ late configuration in the warehouse					
In transit merging of partial orders to consolidated shipments on their way to the customers					
Consolidation of different product lines in one central warehouse					
Linking customer service (call center etc.) to warehouses					
Outsourcing the warehouse to a third party					
Facilitating returns of un-used products to the warehouse					
Re-use/ re-manufacturing/ repairing of used products					
Outsourcing handling and storage of return goods flows					

E. RESULTS

We thank you very much for participating in this study. We would be glad to send you the report of our main findings if you enclose your business card and provide us with your details below.

Please, mark the box if you want to receive the report of our main findings: O *YES*

Company name:
Country of origin of your company:
Facility's name (warehouse):
Facility's address:
Contact Person (your name):
Job title:
Direct telephone number:

Thank you very much for your cooperation!

Appendix 6.4: Schiphol-EDC-survey, respondents

Table A6.2: Respondents Schiphol-EDC-survey

Warehouse	Logistics Manager	Warehouse location
Airborne Express	Mr. M. Trapman	Park Oude Meer
All-in logistics	Mr. J. Wouters	Park Oude Meer
Boeing European Service Center	Mr. C. Correa	Park Oude Meer
Canon	Mr. E.P.C. Meergartt	Park Oude Meer
Corning	Mr. W. Plessius	Park Oude Meer
Danzas Industry Solutions	Mr. R. Toorians	Park Oude Meer
Danzas/ AEI Intercontinental	Mr. B.J.J. Johansen	Park Oude Meer
Dufri International	Mr. R. Hoogland	Park Oude Meer
EGL (Eagle Global Logistics)	Mr. P. Palmboom	Sky-Park
Emery Worldwide	Mr. J. Hester	Park Oude Meer
Globalware solutions	Mr. M. Bekkers	Park Oude Meer
Idexx Europe	Mr. G. Mansir	Park Oude Meer
Intel International	Mr. R. Rosiek	Park Oude Meer
Jamco Europe	Mr. S. Simon	Sky-Park
'K' Line	Mr. E. Wong	Park Oude Meer
Kühne & Nagel	Mr. E. van der Velde	Park Oude Meer
LG Electronics	Mr. H. Corver	Park Oude Meer

MP International[13]	Mr. A. Philips	Sky-Park
Nippon Express	Mr. R. Drijsen	Park Oude Meer
Noortman	Mr. R. Mensch	Park Oude Meer
Richardson Electronics	Mr. K. Commandeur	Sky-Park
Ricoh Europe	Mr. H. Snoeks	Park Oude Meer
Scanlan Group	Mr. R. Eekhout	Park Oude Meer
Ushio Europe	Mr. P.G. Fennis	Sky-Park
Wilson Logistics	Mr. W. Woltjer	Park Oude Meer
Yamaha Motor Distribution	Mr. A. Jager	Park Oude Meer
Yamato Transport Europe	Mr. R. Florentinus	Park Oude Meer

Note: Warehouse location refers to the names of the SADC business parks (see figure 3.3)

[13] MP International is located just outside the business parks of SADC (Schiphol Area Development Company).

Appendix 6.5: Schiphol-EDC-survey, questionnaire

Questionnaire

GENERAL – REGARDING YOUR EDC FACILITY

1. Please, characterize your EDC facility (multiple answers possible):

O own account warehouse (self operated warehouse)

O subcontracted warehouse (you are a logistics service provider); If the answer is yes, please indicate your main clients:

The warehouse fulfills a EDC function for the following clients: - - - -

O dedicated warehouse

O public warehouse

O warehousing only

O warehousing and VAL (Value Added Logistics)

2. In which sector(s) does your facility operate? For example: IT and computers, photo and film industry, pharmaceutical products, aviation industry, automotive, or fashion and clothing.

3. Please, describe the products that are stored in your warehouse. For example: videos, shoes, audio, valves.

4. How many people are employed in your facility (including part-timers)?

5. What is the size of your warehouse facility (in m^2)?
O less than 1000 m²
O 1000-3000 m²
O 3000-5000 m²
O 5000-10,000 m²
O 10,000-20,000 m²
O more than 20,000 m²

6. Which "measure" do you use to quantify the in- and outbound goods flows of your warehouse? (multiple answers possible)
O weight, expressed in: kilos, tons, other, ..…….
O units, expressed in: boxes, pallets, other, …..……
O value, expressed in: Dollars, Euros, other, ……
O other, please describe: ……

7. When (year + month) was your warehouse ready for operation at this location?

8. Please, describe why **The Netherlands** was chosen as location for establishment of your warehouse instead of other European countries?

Location factors mentioned spontaneously:
-
-
-
-

Note for the interviewer:
First, ask the respondent to express location factors spontaneously. Then, request the respondent to ring additional location factors on the standard list as given in appendix 1.

9. Please, describe why within The Netherlands the **SADC area near airport Schiphol** was chosen as location for establishment of the warehouse instead of other locations in the country?

Location factors mentioned spontaneously:
-
-
-
-

Note for the interviewer:
First, ask the respondent to express location factors spontaneously. Then, request the respondent to ring additional location factors on the standard list as given in appendix 2.

10. How much capital (in million **Euros**) has been invested approximately in the warehouse and the logistics systems?

Invested capital in warehouse building and technical installations (for example: climate control, sprinkler, water etc.):
O less than 2 million Euro
O 2-5 million Euro
O 5-10 million Euro
O 10-15 million Euro
O 15-25 million Euro
O 25-40 million Euro
O 40-60 million Euro
O more than 60 million Euro

Invested capital in logistics systems (for example: order picking installation, storage system, information system, internal transport):
O less than 2 million Euro
O 2-5 million Euro
O 5-10 million Euro
O 10-15 million Euro
O 15-25 million Euro
O 25-40 million Euro
O 40-60 million Euro
O more than 60 million Euro

EUROPEAN DISTRIBUTION STRUCTURE – INBOUND LOGISTICS

11. In which countries are the main suppliers located of the products stored in your warehouse? What is the share of each of these countries expressed as a percentage of the total **inbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

Countries where your main suppliers are located:	% of the total **inbound** goods flow:
-	-
-	-
-	-
-	-
	_____+
	100%

12. The inbound logistics will take the form of multi-modal or inter-modal transport using a combination of air, maritime, rail, and road. The total **inbound** goods flow of your warehouse can be broken down into sub-flows. They start at a production plant and finish at your warehouse. Below, standard sub-flows are presented. Please, ring the standard sub-flows that describe your **inbound** logistics. When you ring the answer category "other sub-flows", please describe the additional sub-flows that are required.

(1) non European production plant → // → ship → seaport Rotterdam/ other European seaport → truck → warehouse SADC area
(2) non European production plant → // → airplane → airport Schiphol → truck → warehouse SADC area
(3) non European production plant → // → airplane → European airport other than Schiphol → truck → airport Schiphol → truck → warehouse SADC area
(4) non European production plant → // → airplane → European airport other than Schiphol → truck → warehouse SADC area
(5) European production plant → // → truck → warehouse SADC area
(6) other sub-flows

Remark: ***The goods flow between "//" is not described***

13. Above, you indicated the sub-flows that describe your **inbound** logistics. What is the share of each of these sub-flows expressed as a percentage of the total **inbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

Sub-flow number:	% of the total **inbound** goods flow:
-	-
-	-
-	-
-	-
	_____+
	100%

14. Air cargo can be transported by the transport modes: airplane, truck (airport trucking) or train (air-cargo shuttle). Moreover, air cargo is hauled under a flight number. What is the share of **inbound** air cargo expressed as a percentage of the total **inbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

15. Please, express the reasons underlying your decision to make use of air cargo for the **inbound** logistics.

16. What is the percentage of the **total inbound air cargo goods flow** of your warehouse that consists of high-value and perishable products? Examples of perishable products are fresh fruit, newspapers, or high tech products with a very short life cycle. For categorizing your goods flow, compare your warehouse with other EDCs. (Goods flows are measured by weight/ units; strike out what is not applicable).

Product characteristics:	% of the **total inbound air cargo goods flow**:
- high value weight ratio	-
- perishable	-

EUROPEAN DISTRIBUTION STRUCTURE – OUTBOUND LOGISTICS

17. To which countries (European and non-European) do you ship from your warehouse? What is the share of each of these countries expressed as a percentage of the total **outbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

Countries to which you ship:	% of the total **outbound** goods flow:
-	-
-	-
-	-
-	-
	_____+
	100%

18. The outbound logistics will take the form of multi-modal or inter-modal transport using a combination of air, maritime, rail, and road. The total **outbound** goods flow of your warehouse can be broken down into sub-flows. They start at your warehouse and finish at the final customers (European and non-European). Below, standard sub-flows are presented. Please, ring the standard sub-flows that describe your **outbound** logistics. When you ring the answer category "other sub-flows", please describe the additional sub-flows that are required.

(1) warehouse SADC area → truck → airport Schiphol → airplane → // → European customer
(2) warehouse SADC area → truck → airport Schiphol → truck → // → European customer
(3) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → airplane → // → European customer
(4) warehouse SADC area → truck → airport Schiphol → truck → European airport other than Schiphol → truck → // → European customer
(5) warehouse SADC area → truck → seaport Rotterdam/ other European seaport → ship → // → non European customer
(6) other sub-flows

Remark: The goods flow between "//" is not described

19. Above, you indicated the sub-flows that describe your **outbound** logistics. What is the share of each of these sub-flows expressed as a percentage of the total **outbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

Sub-flow number:	% of the total **outbound** goods flow:
-	-
-	-
-	-
-	-
	_____+
	100%

20. Air cargo can be transported by the transport modes: airplane, truck (airport trucking) or train (air-cargo shuttle). Moreover, air cargo is hauled under a flight number. What is the share of **outbound** air cargo expressed as a percentage of the total **outbound** goods flow of your warehouse? (Goods flows are measured by weight/ units; strike out what is not applicable).

21. Please, express the reasons underlying your decision to make use of air cargo for the **outbound** logistics.

22. What is the percentage of the **total outbound air cargo goods flow** of your warehouse that consists of high-value and perishable products? Examples of perishable products are fresh fruit, newspapers, or high tech products with a very short life cycle. For categorizing your goods flow, compare your warehouse with other EDCs. (Goods flows are measured by weight/ units; strike out what is not applicable).

Product characteristics:	% of the **total outbound air cargo goods flow**:
- high value weight ratio	-
- perishable	-

RESEARCH ON ALTERNATIVE LOCATIONS AND MODES

23. Has your company researched alternative warehouse locations over the past two years? Please, mark a box.

O yes
O no

24. Has your company researched alternative transport modes for the in- and outbound logistics of your warehouse? Please, mark a box.

O yes
O no

SCENARIOS ON INCREASING CONGESTION – TRANSPORT MODES

25. What would you do differently if you were faced with the following logistics constraints:

Below we will present two hypothetical future situations of increasing congestion. Both scenarios are applied to your in- and outbound logistics in the year 2000. Furthermore, both scenarios introduce a change on only one variable, namely **congestion at airport Schiphol**. Congestion at airport Schiphol is made up of the following categories: (1) congested runways, (2) congested terminals, and (3) congestion in the air. Increasing congestion at Schiphol may have the following effects on your in- and outbound logistics: delayed shipments, an increase in the time needed to respond to customer demands, increasing operational uncertainties, and more incompatibilities of adjacent links in the supply chain.

Scenario 1: airport congestion **two times** as much as in the year 2000

Adaptation: less shipments via Schiphol by airplane?; please mark a box:
O no; O unlikely; O possibly; O likely; O yes

When you marked **no or unlikely**:
Please, express the underlying reasons of your decision

When you marked **possibly, likely, or yes**:
Please, explain the modal shift you will undertake and why

Scenario 2: airport congestion **four times** as much as in the year 2000

Adaptation: less shipments via Schiphol by aiplane?; please mark a box:
O no; O unlikely; O possibly; O likely; O yes

When you marked **no or unlikely**:
Please, express the underlying reasons of your decision

When you marked **possibly, likely, or yes**:
Please, explain the modal shift you will undertake and why

26. What would you do differently if you were faced with the following logistics constraints:

Below we will present two hypothetical future situations of increasing congestion. Both scenarios are applied to your in- and outbound logistics in the year 2000. Furthermore, both scenarios introduce a change on only one variable, namely **road congestion in the Schiphol region**. Increasing road congestion in the Schiphol region may have the following effects on your in- and outbound logistics: delayed shipments, an increase in the time needed to respond to customer demands, increasing operational uncertainties, and more incompatibilities of adjacent links in the supply chain.

Scenario 3: road congestion **two times** as much as in the year 2000

Adaptation: less shipments by truck?; please mark a box:
O no; O unlikely; O possibly; O likely; O yes

When you marked **no or unlikely**:
Please, express the underlying reasons of your decision

When you marked **possibly, likely, or yes**:
Please, explain the modal shift you will undertake and why

Scenario 4: road congestion **four times** as much as in the year 2000

Adaptation: less shipments by truck?; please mark a box:
O no; O unlikely; O possibly; O likely; O yes

When you marked **no or unlikely**:
Please, express the underlying reasons of your decision

When you marked **possibly, likely, or yes**:
Please, explain the modal shift you will undertake and why

SCENARIOS ON INCREASING CONGESTION – WAREHOUSE LOCATION

27. Will your warehouse operations move to a new location within a period of 2 years? Please, mark a box and describe why:

O no
O unlikely
O possibly
O likely
O yes

Why? Please, describe below:

28. Imagine that you can choose a new location for the establishment of your warehouse and that you can relocate the warehouse without costs. Would you decide for the current location or would you decide differently? Why? Please, describe below:

O current location
O different location, namely:……

Why? Please, describe below:

29. What would you do differently if you were faced with the following logistics constraints:

Below we will present two hypothetical future situations of increasing congestion. Both scenarios are applied to your in- and outbound logistics in the year 2000. Furthermore, both scenarios introduce a change on only one variable, namely **the total Schiphol congestion**. The total Schiphol congestion is made up of the following two categories: (1) road congestion in the Schiphol region, and (2) congestion at airport Schiphol (congested runways, congested terminals, congestion in the air). An increase of this congestion may have the following effects on your in- and outbound logistics: delayed shipments, an increase in the time needed to respond to customer demands, increasing operational uncertainties, and more incompatibilities of adjacent links in the supply chain.

Scenario 5:	airport and road congestion **two times** as much as in the year 2000
Adaptation:	relocation of the warehouse within 2 years? please mark a box: O no; O unlikely; O possibly; O likely; O yes
Please, express the underlying reasons of your decision	

Scenario 6:	airport and road congestion **four times** as much as in the year 2000
Adaptation:	relocation of the warehouse within 2 years? please mark a box: O no; O unlikely; O possibly; O likely; O yes
Please, express the underlying reasons of your decision	

COMPLETION - CONTACT ADDRESS

30. To round off, do you wish to add remarks or issues we did not discuss during this interview? Please describe below:

31. We thank you very much for participating in this study. We would be very glad to send you the report of our main findings. Please, enclose your business card and provide us with your details below.

Company name:
Country of origin of your company:
Facility's name (warehouse):
Facility's address:
Contact Person (your name):
Job title:
Direct telephone number:

APPENDIX 1- LIST OF LOCATION FACTORS ON COUNTRY LEVEL

Please, ring additional location factors on the list below.

Possible location factors on the choice of The Netherlands:

- O Intermediately positioned between our market areas in Europe
- O Access to logistics services/ logistics know how
- O Climate government create for business through tax structure/ tax policies
- O Climate government create for business through customs policies
- O Transport infrastructure
- O Flexibility of staff
- O Languages spoken
- O Support of national government
- O Land prices
- O Labor costs

APPENDIX 2- LIST OF LOCATION FACTORS ON SITE LEVEL

Please, ring additional location factors on the list below.

Possible location factors on the choice of the SADC area near airport Schiphol:

- O Distance to suppliers and markets
- O Proximity to airport Schiphol
- O Number of flight destinations offered by airport Schiphol
- O Flight frequencies offered by airport Schiphol
- O Rate of flights that departure and arrive as scheduled
- O Accessibility by roads and rail
- O Quality of life for employees
- O Availability and education of staff
- O Expansion possibilities warehouse
- O Support of regional and local governments
- O Land prices

Appendix 7.1: General warehouse characteristics

Table A7.1: General warehouse characteristics of Schiphol-dependent and non-Schiphol-dependent warehouses in the SADC area

General warehouse characteristics	Number of warehouses			
	Schiphol-dependent warehouses (N= 17)		Non-Schiphol-dependent warehouses (N= 10)	
Logistics Service Providers	10	(59%)	4	(40%)
Public warehouses	9	(53%)	4	(40%)
Warehouses performing Value Added Logistics	14	(82%)	8	(80%)
Size of the warehouse				
Less than 1000 M^2	4	(24%)	2	(20%)
1000- 3000 M^2	3	(17%)	0	(0%)
3000- 5000 M^2	4	(24%)	2	(20%)
5000- 10,000 M^2	3	(17%)	3	(30%)
10,000- 20,000 M^2	2	(12%)	1	(10%)
More than 20,000 M^2	1	(6%)	2	(20%)
Fixed capital investments in the building (**)				
Less than 2 million Euro	6	(35%)	2	(22%) *
2- 5 million Euro	8	(47%)	3	(34%) *
5- 10 million Euro	1	(6%)	1	(11%) *
10- 15 million Euro	2	(12%)	0	(0%) *
15- 25 million Euro	0	(0%)	1	(11%) *
25- 40 million Euro	0	(0%)	2	(22%) *
More than 40 million Euro	0	(0%)	0	(0%) *
Fixed capital investments in the logistics systems				
Less than 2 million Euro	15	(88%)	6	(67%) *
2- 5 million Euro	0	(0%)	1	(11%) *
5- 10 million Euro	2	(12%)	1	(11%) *

10- 15 million Euro	0	(0%)	1	(11%) *
More than 15 million Euro	0	(0%)	0	(0%) *
Number of main EDCs in the warehouse				
1 EDC	8	(46%)	6	(60%)
2 EDCs	1	(6%)	1	(10%)
3 EDCs	3	(18%)	2	(20%)
4 EDCs	3	(18%)	1	(10%)
More than 4 EDCs	2	(12%)	0	(0%)
Number of employees in the warehouse (***)				
Less than 5 employees	5	(29%)	1	(10%)
5- 20 employees	9	(53%)	3	(30%)
20- 50 employees	1	(6%)	2	(20%)
50- 100 employees	1	(6%)	3	(30%)
100- 200 employees	1	(6%)	0	(0%)
More than 200 employees	0	(0%)	1	(10%)

Note 1: ***For categorizing Schiphol-dependent and non-Schiphol-dependent warehouses, see table 7.4***

Note 2: ***(*) One respondent is missing; therefore N= 10-1= 9 warehouses***

Note 3: ***(**) In case the respondent holds a long-term lease on the warehouse, the investment in the building is made by a real estate investment company***

Note 4: ***(***) Full-timers plus part-timers***

Appendix 7.2: Labeling the mentioned location factors

Each logistics manager was asked to express why the SADC area was chosen for the establishment of the warehouse. In conformity with our definitions of economies of agglomeration and location endowments we labeled the mentioned location factors as "A" (agglomeration economies), "E-a" (Endowment, specific airport), or "E-na" (Endowment, non-airport). The mentioned location factors and their labels are shown in table 7.5. The considerations underlying the labeling are discussed below.

Proximity to former warehouse location (A):
Respondents that mentioned the location factor "Proximity to former warehouse location" did relocate but did not leave the wider Schiphol region. This location factor represents the investments of the respondent in long-standing relations with the regional economic environment and in mutual adaptations to reduce transaction costs. Examples are: a local work force with specialized knowledge and skills has been assembled; the total labor force outside the organization is understood; long-standing relationships have been built up with the local business community (such as: local customers; local logistics service providers; airport Schiphol; local banks and credit agencies; local specialized technical expertise; and local government); and risk avoiding behavior of the organization's executives. This location factor is about benefits due to being close to the current agglomeration. Therefore, we labeled it as "A".

Proximity to airport Schiphol (E-a):
This location factor mainly relates to specific airport endowments. It stresses the comparative advantages of the Schiphol region due to the availability of the airport. This location factor is about benefits due to differences in physical geography. It is not about the benefits of being close to other firms or concentrations of industry.

Availability of warehouse space/ land (A):
Within an agglomeration, floor space regularly becomes available from companies that decide to relocate and invest at a new location or disinvest at the existing location.

Accessibility by roads and rail (A):
An important economy of agglomeration is formed by the savings to the individual firms from the use of common infrastructure facilities –that are paid for and maintained not by any individual firm but by the community at large. As an agglomeration grows, it provides more income to the community and a higher level of demand necessary for the provision of economically viable infrastructure.

Proximity to logistics service providers (A):
With the emphasis on supply chain management, the use of third party logistics service providers is growing rapidly. Transportation, warehousing and other logistics activities have been outsourced to third parties for many years. Nearly every global organization uses the logistics services of an international freight forwarder. This location factor is about the connections or linkages between the respondents and their freight forwarders as a source of economies of agglomeration. Apart from the transportation costs benefits, an other advantage of the placement of an EDC near its freight forwarder is the minimization of the time needed for transporting products to and from the warehouse of the freight forwarder. This increases the time window for order picking in the EDC.

Quality of life for employees (A):
This location factor relates to societal infrastructure, including: (international) schools; universities; libraries; hospitals; theaters; shopping centers; sports events and facilities; and the international orientation of the city of Amsterdam. As an agglomeration grows it provides more societal infrastructure and community services.

Status of immediate environment (A):
This location factor is about the status of the Schiphol agglomeration. Here respondents mentioned the image-effect of being located near a major European airport, other international firms, and an international city (Amsterdam).

Number of flight destinations offered by airport Schiphol (E-a):
Specific airport endowment.

Proximity to our main customers (A):
An important basis of agglomeration economies is the connections or linkages between economic activities. This location factor focuses on the forward linkages with the main customers. Centralizing the stockholding operation in an EDC can create internal economies

of scale and reduce inventory costs. This is achieved however at the expense of increasing transport costs and longer delivery lead times from the warehouse to the customer. These disadvantages can partly be overcome by locating the EDC near its main customers.

Price/ rent of warehouse or land (E-na):
We stress that in attracting companies, the Schiphol region competes with other European airport regions. There are enormous variations in the prices of warehouse space and land between these regions. These spatial variations persist and can therefore be counted among the location endowments. This location factor is about benefits due to differences in physical geography. It is not about the benefits of being close to other firms or concentrations of industry.

Flight frequencies offered by airport Schiphol (E-a):
Specific airport endowment.

Availability and education of staff (A):
Large agglomerations of economic activities offer a wide range of skilled and unskilled labor. Such a common pool of labor, offers workers and firms the possibility of rapid and efficient search an (re)hire in an environment of high turnover.

Proximity to seaport Rotterdam (E-na):
This location factor is about the comparative advantages of the Schiphol region due to its proximity to seaport Rotterdam. That is access to the sea. This location factor is about benefits due to differences in physical geography. It is not about the benefits of being close to other firms or concentrations of industry.

Support of regional and local governments (A):
As an agglomeration grows it provides more societal infrastructure and community services, including all kinds of governmental services.

Presence of similar companies (A):
This location factor refers to benefits due to knowledge spillovers in a cluster of related businesses.

Distance to suppliers and markets (E-na):
This location factor is about locating the distribution center at the point that minimizes transportation costs for products moving between the manufacturing plants (production centers) and markets (consumption centers). That is the so called “center of gravity”. Here respondents stressed the benefits of being intermediately positioned between the market areas in Europe. This location factor is not about the benefits of being close to other firms or concentrations of industry. It is about minimizing the transportation costs by locating in the center of gravity. That is the Schiphol region.

Proximity to our Head Quarter/ Sales Office (A):
This location factor refers to the importance of face-to-face contacts as a vehicle for the production and communication of ideas, knowledge and information.

Expansion possibilities warehouse (A):
Shifts in the demand of floor space and machine capacity can more easily be met at the level of an industrial agglomeration than at the level of a single firm. Sudden increases in demand at one firm may take up slack capacity at another firm that is part of the same agglomeration making the overall usage more efficient. As a consequence, far less capital needs to be immobilized in back-up inventories and capacity. Here, agglomeration is encouraged by responses to uncertainty in the business environment.

Appendix 7.3: Sensitivity analysis (1)

It is important to examine whether the results as given in table 7.7 are sensitive to modest departures from table 7.4 and 7.5. We examined the consequences of the following manipulations:

- In table 7.4 we used a class boundary of 20% -volume of freight transported via Schiphol by airplane- to distinguish between Schiphol-dependent and non-Schiphol-dependent warehouses. We examined whether the choice of a different class boundary results in an entirely different picture.
- The most important location factor in table 7.5 is "Proximity to former warehouse location". We examined the effect of removing this location factor.
- In table 7.5, location factors mentioned spontaneously are given a score of 2. We examined the effect of giving these location factors a score of 3.

Different class boundary

The importance of economies of agglomeration for Schiphol-dependent and non-Schiphol-dependent warehouses and for different class boundaries is shown in table A7.2. A class boundary of 20% is identical to table 7.7. It appears that the choice of a different class boundary does not cause significant shifts in the importance of location endowments and economies of agglomeration as presented in table 7.7.

Table A7.2: Relative frequency distribution of location endowments and economies of agglomeration for Schiphol-dependent and non-Schiphol-dependent warehouses for different class boundaries

Maximum percentage of the in- and outbound goods flow that is transported by airplane via Schiphol (*)	Type of location factors on the choice of the SADC area	Warehouses that transport "more than" the indicated share		Warehouses that transport "less than" the indicated share	
		#	%	#	%
5	A	110	66	24	77
	E-a	47	28	3	10
	E-na	9	6	4	13
10	A	80	63	54	78
	E-a	41	32	9	13
	E-na	7	5	6	9
20	A	68	61	66	78
	E-a	37	33	13	15
	E-na	7	6	6	7
30	A	57	63	77	73
	E-a	31	34	19	18
	E-na	3	3	10	9
40	A	47	63	87	71
	E-a	25	33	25	21
	E-na	3	4	10	8
50	A	34	60	100	72
	E-a	23	40	27	19
	E-na	0	0	13	9
60	A	32	60	102	71
	E-a	21	40	29	20
	E-na	0	0	13	9
70	A	32	60	102	71
	E-a	21	40	29	20
	E-na	0	0	13	9
80	A	24	56	110	72
	E-a	19	44	31	20
	E-na	0	0	13	8
90	A	22	56	112	71
	E-a	17	44	33	21
	E-na	0	0	13	8
100	A	0	0	134	68
	E-a	0	0	50	25
	E-na	0	0	13	7

Note 1: ***# = Frequencies; Frequencies re-weighted; Data are taken from tables 7.2 and 7.5***

Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Note 3: ***(*) Goods flows are measured by weight or units***

Removal of location factor "Proximity to former warehouse location"

First we removed the location factor "Proximity to former warehouse location" from table 7.5. This is shown in table A7.3. Then we recalculated table 7.7. These data are presented in table A7.4.

Table A7.3: Importance of location factors on the choice of the SADC area; Location factor "Proximity to former warehouse location" is discarded

Location factors on the choice of the SADC area	Type	Warehouses mentioning location factor	Re-weighted frequencies
Proximity to airport Schiphol	E-a	R2, R3, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R17, R18, R19, R21, R24, R25	36
Availability of warehouse space/ land	A	R1, R4, R5, R13, R18, R20, R21, R23, R24, R25, R26	22
Accessibility by roads and rail	A	R1, R7, R8, R10, R13, R17, R18, R21, R25, R26	14
Proximity to logistics service providers (LSP)	A	R3, R7, R10, R13, R17, R24, R26	14
Quality of life for employees (*)	A	R10, R12, R18, R22, R26, R27	11
Status of immediate environment (**)	A	R1, R2, R10, R11, R20, R27	11
Number of flight destinations offered by airport Schiphol	E-a	R7, R10, R15, R18, R21, R24, R25	9
Proximity to our main customers	A	R4, R7, R11	6
Price/ rent of warehouse or land	E-na	R18, R23, R27	6
Flight frequencies offered by airport Schiphol	E-a	R10, R15, R18, R21, R25	5
Availability and education of staff	A	R10, R12, R18	5
Proximity to seaport Rotterdam	E-na	R12, R18	4
Support of regional and local governments	A	R12, R13	4
Presence of similar companies	A	R12, R13	4
Distance to suppliers and markets	E-na	R16, R26	3
Proximity to our Head Quarter/ Sales Office	A	R13	2
Expansion possibilities warehouse	A	R12	1

Source: ***Data are taken from table 7.5***

Note 1: ***R= respondent; Underlined responses were mentioned with help and given a score of 1; The rest of the responses were mentioned without help and given a score of 2***

Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

Table A7.4: Relative frequency distribution of location endowments and economies of agglomeration for Schiphol-dependent and non-Schiphol-dependent warehouses

Type of location factors on the choice of the SADC area	Schiphol-dependent warehouses (see table 7.4)		Non-Schiphol-dependent warehouses (see table 7.4)	
	Frequencies	Percentage	Frequencies	Percentage
A	48	52	46	71
E-a	37	40	13	20
E-na	7	8	6	9
Totals	92	100	65	100

Note 1: ***Frequencies re-weighted; Data are taken from table A7.3***
Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Table A7.4 provides the data necessary for the chi-square test to determine whether there is a difference between the two groups of warehouses in the importance of location endowments (= E-a plus E-na) and economies of agglomeration (= A). We tested at the 0.05 level of significance (α). Since there are two rows and two columns in the contingency table the chi-square test has 1 degree of freedom. Therefore we applied the Yates correction. The critical value of the chi-square distribution for α= 0.05 and 1 degree of freedom is 3.841. The null hypothesis of equality was rejected when the computed value of chi-square is greater than the critical value. Here, the computed value of the chi-square test statistic is 4.74 (p-value= 0.031). Since $\chi_1^2 = 4.74 > 3.841$ the null hypothesis is rejected. It appears that removing the location factor "Proximity to former warehouse location" does not cause significant shifts in the importance of location endowments and economies of agglomeration as presented in table 7.7.

Location factors mentioned spontaneously are given a score of 3 (instead of 2)
First we re-weighted the frequencies from table 7.5. This is shown in table A7.5. Then we recalculated table 7.7. These data are presented in table A7.6.

Table A7.5: Importance of location factors on the choice of the SADC area; Frequencies are re-weighted

Location factors on the choice of the SADC area	Type	Warehouses mentioning location factor	Re-weighted frequencies
Proximity to former warehouse location	A	R1, R3, R4, R6, R8, R9, R11, R12, R13, R14, R16, R17, R19, R20, R21, R23, R24, R25, R26, R27	60
Proximity to airport Schiphol	E-a	R2, R3, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R17, R18, R19, R21, R24, R25	53
Availability of warehouse space/ land	A	R1, R4, R5, R13, R18, R20, R21, R23, R24, R25, R26	33
Accessibility by roads and rail	A	R1, R7, R8, R10, R13, R17, R18, R21, R25, R26	18
Proximity to logistics service providers (LSP)	A	R3, R7, R10, R13, R17, R24, R26	21
Quality of life for employees (*)	A	R10, R12, R18, R22, R26, R27	16
Status of immediate environment (**)	A	R1, R2, R10, R11, R20, R27	16
Number of flight destinations offered by airport Schiphol	E-a	R7, R10, R15, R18, R21, R24, R25	11
Proximity to our main customers	A	R4, R7, R11	9
Price/ rent of warehouse or land	E-na	R18, R23, R27	9
Flight frequencies offered by airport Schiphol	E-a	R10, R15, R18, R21, R25	5
Availability and education of staff	A	R10, R12, R18	7
Proximity to seaport Rotterdam	E-na	R12, R18	6
Support of regional and local governments	A	R12, R13	6
Presence of similar companies	A	R12, R13	6
Distance to suppliers and markets	E-na	R16, R26	4
Proximity to our Head Quarter/ Sales Office	A	R13	3
Expansion possibilities warehouse	A	R12	1

Source: ***Data are taken from table 7.5***

Note 1: ***R= respondent; Underlined responses were mentioned with help and given a score of 1; The rest of the responses were mentioned without help and given a score of 3;***

Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

Table A7.6: Relative frequency distribution of location endowments and economies of agglomeration for Schiphol-dependent and non-Schiphol-dependent warehouses

Type of location factors on the choice of the SADC area	Schiphol-dependent warehouses (see table 7.4)		Non-Schiphol-dependent warehouses (see table 7.4)	
	Frequencies	Percentage	Frequencies	Percentage
A	99	62	97	78
E-a	51	32	18	15
E-na	10	6	9	7
Totals	160	100	124	100

Note 1: ***Frequencies re-weighted; Data are taken from table A7.5***
Note 2: ***A= Agglomeration economies; E-a= Endowment, specific airport; E-na= Endowment, non-airport***

Table A7.6 provides the data necessary for the chi-square test to determine whether there is a difference between the two groups of warehouses in the importance of location endowments (= E-a plus E-na) and economies of agglomeration (= A). We tested at the 0.05 level of significance (α). Since there are two rows and two columns in the contingency table the chi-square test has 1 degree of freedom. Therefore we applied the Yates correction. The critical value of the chi-square distribution for α= 0.05 and 1 degree of freedom is 3.841. The null hypothesis of equality was rejected when the computed value of chi-square is greater than the critical value. Here, the computed value of the chi-square test statistic is 7.96 (p-value= 0.005). Since $\chi_1^2 = 7.96 > 3.841$ the null hypothesis is rejected. It appears that re-weighting the frequencies does not cause significant shifts in the importance of location endowments and economies of agglomeration as presented in table 7.7.

Appendix 7.4: Sensitivity analysis (2)

In this appendix we examine whether table 7.21 is sensitive to re-weighting the frequencies. We examine the consequences of the following manipulation:

location factors mentioned spontaneously are given a score of 3 (instead of 2).

First we re-weighted the frequencies from table 7.21. This is shown in table A7.7. Then we applied the chi-square test of independence.

Table A7.7: Importance of location factors on the choice of The Netherlands; Frequencies are re-weighted

	Warehouses mentioning location factor			
	National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
Location factors	Re-weighted frequencies	Percentage	Re-weighted frequencies	Percentage
Existing ties with The Netherlands (*)	75	17	69	36
Transport infrastructure (**)	141	31	29	15
Intermediately positioned between our market areas in Europe	75	17	27	14
Access to logistics services/ logistics know how	27	6	18	10
Climate government create for business through customs policies	39	8	17	9
Languages spoken	36	8	13	7
Climate government create for business through tax structure/ tax policies	27	6	9	5
Quality, quantity and costs of available labor	33	7	7	4
Totals	453	100	189	100

Source: ***Data are taken from table 7.21***

Note 1: ***Location factors mentioned with help were given a score of 1; Location factors mentioned without help were given a score of 3***

Note 2: ***(*) Examples are: our main customer/ Head Quarter/ Sales Office/ former warehouse is already located in The Netherlands***

Note 3: ***(**) Examples are: seaport Rotterdam, Amsterdam Airport Schiphol, transport links with other cities and internationally***

We apply the chi-square test of independence. The null hypothesis of equality is tested at the 0.05 level of significance (α). The critical value would be 14.067 since there are 7 degrees of freedom. The computed chi-square test statistic is 42.39 (p-value= 0.000). Since $\chi^2_7 = 42.39 >$ 14.067 the null hypothesis is rejected. It appears that re-weighting the frequencies does not cause significant shifts. In sum, we conclude that table 7.21 is robust.

Appendix 7.5: Sensitivity analysis (3)

It is important to examine whether the results as given in table 7.23 are sensitive to modest departures from table 7.22. We examined the consequences of the following manipulations:

- An important location factor in table 7.22 is "Proximity to former warehouse location". We examined the effect of removing this location factor.
- In table 7.22, location factors mentioned spontaneously are given a score of 2. We examined the effect of giving them a score of 3.

Removal of location factor "Proximity to former warehouse location"
First we removed the location factor "Proximity to former warehouse location" from table 7.22. This is shown in table A7.8. Then we recalculated table 7.23. These data are presented in table A7.9.

Table A7.8: Importance of location factors on the choice of the site within The Netherlands; Location factor "Proximity to former warehouse location" is discarded

		Warehouses mentioning location factor			
		National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
Location factors	Type	Re-weighted frequencies	Percentage	Re-weighted frequencies	Percentage
Proximity to airport	E	40	13	36	22
Availability of warehouse space/ land	A	40	13	22	13
Accessibility by roads and rail	A	56	18	14	9
Proximity to logistics service providers (LSP)	A	10	3	14	9
Quality of life for employees (*)	A	10	3	11	7
Status of immediate environment (**)	A	0	0	11	7
Number of transport destinations offered by nearby air-/seaport	E	0	0	9	6
Proximity to our main customers	A	4	1	6	4
Price/ rent of warehouse or land	E	32	10	6	4
Transport frequencies offered by nearby air-/seaport	E	0	0	5	3
Availability and education of staff	A	26	8	5	3
Proximity to seaport	E	34	10	4	3
Support of regional and local governments	A	10	3	4	3
Presence of similar companies	A	2	1	4	3
Distance to suppliers and markets	E	34	10	3	2
Proximity to our Head Quarter/ Sales Office/ production plant	A	16	5	2	1
Expansion possibilities warehouse	A	2	1	1	1
Costs of available labor	E	4	1	0	0
Totals		320	100	157	100

Source: ***Data are taken from table 7.22***

Note 1: ***Frequencies re-weighted; Location factors mentioned with help were given a score of 1; Location factors mentioned without help were given a score of 2***

Note 2: ***A= Agglomeration economies; E= Endowment of geographical location***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

Table A7.9: Relative frequency distribution of location endowments and economies of agglomeration for the national- and Schiphol-EDC-population

Type of location factors	National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
	Frequencies	Percentage	Frequencies	Percentage
A	176	55	94	60
E	144	45	63	40
Totals	320	100	157	100

Note 1: ***Frequencies re-weighted; Data are taken from table A7.8***
Note 2: ***A= Agglomeration economies; E= Endowment of geographical location***

We apply the chi-square test to table A7.9. The contingency table has two columns and two rows, so that there is 1 degree of freedom. The null hypothesis of equality is tested at the 0.05 level of significance (α). The critical value of the chi-square distribution is 3.841. We applied the Yates correction. The computed chi-square test statistic is 0.82 (p-value= 0.456). Therefore, since $\chi_1^2 = 0.82 < 3.841$ the null hypothesis is not rejected. It appears that removing the location factor "Proximity to former warehouse location" has a serous effect on the data as presented in table 7.23.

Location factors mentioned spontaneously are given a score of 3 (instead of 2)
First we re-weighted the frequencies from table 7.22. This is shown in table A7.10. Then we recalculated table 7.23. These data are presented in table A7.11.

Table A7.10: Importance of location factors on the choice of the site within The Netherlands; Frequencies are re-weighted

		Warehouses mentioning location factor			
		National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
Location factors	Type	Re-weighted frequencies	Percentage	Re-weighted frequencies	Percentage
Proximity to former warehouse location	A	36	7	60	21
Proximity to airport	E	60	12	53	19
Availability of warehouse space/ land	A	60	12	33	12
Accessibility by roads and rail	A	84	15	18	6
Proximity to logistics service providers (LSP)	A	15	3	21	7
Quality of life for employees (*)	A	15	3	16	6
Status of immediate environment (**)	A	0	0	16	6
Number of transport destinations offered by nearby air-/seaport	E	0	0	11	4
Proximity to our main customers	A	6	1	9	3
Price/ rent of warehouse or land	E	48	9	9	3
Transport frequencies offered by nearby air-/seaport	E	0	0	5	2
Availability and education of staff	A	39	7	7	2
Proximity to seaport	E	51	10	6	2
Support of regional and local governments	A	15	3	6	2
Presence of similar companies	A	3	1	6	2
Distance to suppliers and markets	E	51	10	4	1
Proximity to our Head Quarter/ Sales Office/ production plant	A	24	5	3	1
Expansion possibilities warehouse	A	3	1	1	1
Costs of available labor	E	6	1	0	0
Totals		516	100	284	100

Source: ***Data are taken from table 7.22***

Note 1: ***Location factors mentioned with help were given a score of 1; Location factors mentioned without help were given a score of 3***

Note 2: ***A= Agglomeration economies; E= Endowment of geographical location***

Note 3: ***(*) Examples are proximity to an international city or proximity to an international school; (**) Examples are the image-effect of being located near a major European airport and an international city***

Table A7.11: Relative frequency distribution of location endowments and economies of agglomeration for the national- and Schiphol-EDC-population

Type of location factors	National-EDC-population (N= 63 warehouses)		Schiphol-EDC-population (N= 27 warehouses)	
	Frequencies	Percentage	Frequencies	Percentage
A	300	58	196	69
E	216	42	88	31
Totals	516	100	284	100

Note 1: ***Frequencies re-weighted; Data are taken from table A7.10***
Note 2: ***A= Agglomeration economies; E= Endowment of geographical location***

We apply the chi-square test to table A7.11. The contingency table has two columns and two rows, so that there is 1 degree of freedom. The null hypothesis of equality is tested at the 0.05 level of significance (α). The critical value of the chi-square distribution is 3.841. We applied the Yates correction. The computed chi-square test statistic is 8.73 (p-value= 0.000). Since $\chi_1^2 = 8.73 > 3.841$ the null hypothesis is rejected. It appears that re-weighting the frequencies does not cause significant shifts in the data as presented in table 7.23.

Summary

This thesis deals with the explanation of why European Distribution Centers (EDCs) cluster around Amsterdam Airport Schiphol. The Netherlands is an attractive location for EDCs. Approximately one-half of all EDCs in Europe are located in The Netherlands. In 2002, the EDC sector contributed about 95,000 jobs (full time equivalents) and 1% of the gross national product (GNP) to the Dutch economy. Schiphol represents an important concentration of EDCs.

The amount and nature of distribution centers located in the surrounding areas of Schiphol is a prime concern for Dutch policymakers because of two reasons. First, attracting EDCs means attracting all kinds of international goods flows, investments and employment. Second, EDCs are space demanding while the amount of open space available outside the airport is limited and earmarked for airport-dependent (or airport-related) firms. However, it is unknown whether the right locations are allocated to the right distribution centers and whether a bad location policy has long-lasting bad effects.

The explanation of why economic activities cluster around airports is important for location theory and location policy regarding airport regions. The traditional answer to the question why distribution centers cluster around Schiphol is that they are attracted to the airport due to the importance of having air transport services at their disposal. However, we show that this is only a partial answer. In this thesis we present a new model of the clustering of EDCs around airport Schiphol. In the model, the following location forces interplay:

- location endowments;

- agglomeration economies;
- locked-in logistics.

We assessed the empirical relevance and explanatory power of the model. Our model shows that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. We uncovered that there are major implications of threshold effects in the surrounding areas of the airport. Threshold effects are often neglected in standard neoclassical location models. Our model explains that marginal policy interventions may have no impact on the growth rate of the EDC cluster as long as the level of the policy instrument remains below a threshold value but that the same policy intervention can have a large effect when the threshold is crossed. The possibility of such non-linear responses makes it much more difficult to forecast the effect of a given policy change. Moreover, the model shows that the effects of the EDC location policy also exhibit phenomena of irreversibility.

Problem definition and objectives

Chapter 1 outlines the problem definition and objectives of the study. Schiphol is a major European airport, handling an ever-growing number of passengers and freight. Demand for industry locations near Schiphol has grown accordingly. However, the amount of enclosed or open space available outside the terminal that can be used for the building of maintenance facilities, hotels, offices or warehouses is limited. To control economic development of Schiphol's surrounding areas, the Dutch government applies planning and zoning regulations on what can be built and on the uses to which the land may be put. The government directives say that only airport-dependent activities are permitted. Uncontrolled economic development of Schiphol's surrounding areas can result in the allocation of scarce land just outside the airport to non-airport-dependent firms. As a consequence, airport-dependent firms arriving later might then be confronted with completely occupied business parks forcing them to decide for a location near another but smaller Dutch airport, a non-airport location in The Netherlands, or a location near a major European airport in another country. Moreover, uncontrolled economic development can easily result in: overcrowded business parks; rising land costs; congested routes from the business parks to connecting roads and to the airport; and worsening airport accessibility. Since the second half of the 1990s, there have been conjectures that a significant amount of the EDCs near Schiphol is non-Schiphol-dependent. Yet, this assumption has never really been investigated in depth.

> *The first aim of this study is to analyze and explain the clustering of EDCs around Schiphol.*

EDCs that are settled in the Schiphol area are confronted with increasing airport and road congestion. At Schiphol, restrictions on noise and runway slots together with the high growth of air traffic can easily result in: congestion of airspace and air traffic control delays; inadequate runway capacity; and congested terminals for passengers and freight. Furthermore, accessing Schiphol airport is becoming increasingly difficult as surface traffic congestion grows. In the wider Schiphol region, the road network suffers from heavy congestion.

Transport speeds have fallen on the transport links with the airport as well as other national and international cities. Congestion is an important pressure to change, however, EDCs that are settled in the Schiphol area can become locked into their transport mode and/ or their location. That is, high thresholds are formed producing inertia that can make pressures to change –such as declining location conditions or policy interventions- ineffective when it comes to modal shift or relocation. From the viewpoint of the company location policy for the Schiphol area as developed by the Dutch government it is highly undesirable when non-Schiphol-dependent EDCs become locked into their Schiphol location.

The second aim of this study is to gain insight in locked-in logistics and its threshold values. Specifically, to examine the need and abilities of the EDCs that are settled in the Schiphol area to compensate for congestion impacts on their business operations by making a modal shift for freight or relocation of the warehouse.

The explanation of why economic activities cluster around airports is important for both, location theory and location policy regarding airport regions.

The third aim of this study is to find additional options for governmental steering that can help to control the location allocation of EDCs in the Schiphol area.

Sketching the context

The rise of EDCs, decisions on where to locate EDCs, and decisions on how to organize their in- and outbound logistics, it all takes place within the wider context of supply chains. This context is addressed in chapter 2. Many international logistics companies have organized their European distribution network according to the concept of central European distribution. Within this concept, EDCs fulfill a main role. In an EDC, goods from mainly overseas production locations such as Japan or the USA are stored before being distributed throughout Europe, the Middle-East and Africa (EMEA-countries). In most cases, delivery lead times from the EDC to a customer somewhere in Europe range from 24 to 72 hours. The Netherlands is an attractive location for EDCs. The well known slogan “The Netherlands, gateway for Europe”, promotes The Netherlands as a perfect location for EDCs. Approximately one-half of all EDCs in Europe is located in The Netherlands. And, approximately 20% of all EDCs in The Netherlands is located in the wider Schiphol region.

As a first step towards analyzing and explaining the clustering of EDCs around Schiphol it is important not only to discuss the business logistics context but also the policy context. The latter is addressed in chapter 3. There we show how regional governments, local governments and airport Schiphol work together in the Schiphol Area Development Company (SADC) and attempt to manage and control the allocation of scarce land, just outside the airport, to EDCs. SADC is a land development company. We describe the goals and instruments of the EDC location policy from the start of SADC in 1987 until 2000.

Theoretical framework

The theoretical framework of this study is presented in chapter 4 and 5. By initially attracting firms and activities to an area in sufficient numbers, airport development can lead to a favorable economic environment. The regional economy can feed on this and accelerate its growth. This type of dynamic economic impact of an airport has been little researched and is the focal point of this thesis. It reflects an increasingly widely accepted school of thought that argues that economic growth, once started in a region, can become self-sustaining and may accelerate. We apply the theoretical framework of New Economic Geography to develop a new model of spatial economic development of the Schiphol area. In the model, the following location forces interplay in the making of the EDC cluster:

- location endowments;
- agglomeration economies;
- locked-in logistics.

Location endowments

Location endowments stress the location benefits of the Schiphol region due to differences in physical geography. For the Schiphol region –or an airport region in general- we introduce the following categorization of location endowments:

- Specific airport endowments, such as: number of flight destinations; international flight destinations; opportunities of linking to other major airports; direct flight destinations; flight frequencies; opportunities for same day return flights; rate of flights that departure as scheduled; rate of flights that arrive as scheduled; airport charges and landing fees; air fares; waiting time spent in terminals; time and costs of getting to and from the airport.
- Non-airport endowments, such as: availability of fertile land; availability of natural resources; climate; access to the sea; labor costs; land prices; transportation costs.

Agglomeration economies

Specific airport and non-airport endowments stress the differences in physical geography of the Schiphol region as reason for the concentration of firms. Economies of agglomeration stress the location benefits of being close to other firms and concentrations of industry. These may be due to the sharing of information, the existence of a large pool of labor, or the existence of specialized suppliers. There are economies of agglomeration if the benefits of being in a location together with other firms increase with the number of firms in that location.

We apply the idea that spatial configuration of economic activity is the outcome of a process involving location endowments and economies of agglomeration. That is not new. It has its roots firmly in early work of economic geography and is also accepted in New Economic Geography. However, it is new that we disentangle the location forces exerted by the location endowments of the Schiphol region and the economies of agglomeration operating in that

region. To understand the clustering of economic activity in airport regions, it is essential to know whether the firms are attracted into the airport region due to the specific airport endowments or due to economies of agglomeration.

Locked-in logistics
Following the economic literature, we model that airport development and growth of the Schiphol agglomeration can not only result in economies but also in diseconomies in terms of location endowments and agglomeration economies. The Schiphol agglomeration is the airport together with the firms that are located at and around the airport. We concentrate on diseconomies of the growing Schiphol agglomeration that create worsening location conditions for EDCs that are settled in the Schiphol area. We introduce the following categorization of these diseconomies:

- Worsening location conditions that mainly can be attributed to the growing EDC cluster in the Schiphol area. Examples are: overcrowded business parks; rising land costs resulting in higher costs for renting or leasing warehouse space; congested routes from the business parks to connecting roads and to Schiphol; growing demand for logistics staff resulting in higher recruitment costs.
- Worsening location conditions that only for a minor part can be attributed to the growing EDC cluster in the Schiphol area. Examples are: increasing road congestion in the wider Schiphol region; increasing congestion at airport Schiphol (congested runways, congested terminals, and congestion in the air).

In our model, we incorporate that established EDCs can make logistics adjustments in response to changes in their business environment. In this thesis, we examine the need and abilities of EDCs that are settled in the Schiphol area to compensate for congestion impacts on their business operations. We look at all spatial-organizational changes, but focus on two logistics adjustment possibilities:

- making a modal shift for freight;
- relocating the entire EDC facility.

Generally speaking, we model pressures to change on one hand and resistance to change on the other hand. Following the literature, we say that resistance to change refers to threshold values and threshold effects. Once the pressures to change cross the threshold, EDCs will change. Thresholds produce inertia that can make small policy interventions –or other pressures to change such as worsening location conditions- ineffective. Consequently, we introduce two lock-in logistics situations for individual EDCs which refer to very high threshold values. Namely, EDCs that are settled in the Schiphol area can become locked into:

- The transport mode used;
- Their Schiphol location.

Data collection method

Due to economies of agglomeration and locked-in logistics, our model has a number of properties that makes it very different compared to standard neoclassical location models. In order to assess the empirical relevance and explanatory power of the model, we performed empirical research. The method for data gathering and analysis is addressed in chapter 6. We conducted a cross-sectional survey and collected data at the year 2000 over two populations:

- national-EDC-population;
- Schiphol-EDC-population.

The Schiphol-EDC-population is the warehouse cluster at the business parks of the Schiphol Area Development Company (SADC). The SADC business parks are situated in Schiphol's surrounding areas. The national-EDC-population consists of the warehouses that are located elsewhere in The Netherlands.

About 75% of the EDCs in The Netherlands are contracted out to a Logistics Service Provider or LSP (subcontractor). The distribution center of a LSP can contain one or more EDCs. Therefore, we used the following construct as being sampling unit and unit of analysis: "warehouses that contain one or more EDCs". Thus, warehouses instead of individual EDCs form the sampling unit as well as the unit of analysis.

For gathering data from the national-EDC-population we used postal self-completion questionnaires. In cooperation with Holland International Distribution Council (HIDC) we composed a list of addresses. HIDC organizes regular survey research among EDCs in The Netherlands. We aimed at a full 100% sample. The response rate was 20%. We addressed the questionnaire to logistics managers because of their thorough knowledge of, and insight in, all logistics aspects on warehousing and distribution. For the Schiphol-EDC-population we accomplished the survey work through structured face-to-face interviews with logistics managers. We composed a list of addresses in cooperation with SADC. We interviewed 27 respondents, that is the total Schiphol-EDC-population.

For the Schiphol-EDC-population we used the personal interview mode. This offered the possibility to ask complex questions which required a good deal of thought of the respondents. For example, we asked the logistics managers to break down the inbound and outbound goods flow of their warehouse. Through these data we could answer the question whether a distribution center is Schiphol- or non-Schiphol-dependent. Our definition of a Schiphol-dependent EDC comprises criteria on volumes (by weight or units) of air cargo shipped and the transport mode used. Another example is that we included a hypothetical "what-if" game to gain insight in locked-in logistics and its threshold values. We confronted the logistics managers with hypothetical future situations of increasing congestion and asked them to state their logistics adaptations to compensate for the congestion impacts on their business operations.

Results

Chapter 7 and 8 present the research findings. EDCs can be attracted into the Schiphol area because of location endowments and economies of agglomeration. The traditional answer to the question why EDCs cluster around Schiphol is that EDCs are attracted to the airport due to the importance of having air transport services at their disposal. In other words, that they are attracted due to the specific airport endowments of Schiphol. However, we show that this is only a partial answer and that almost 40% of the warehouses representing the EDC population in the SADC area is non-Schiphol-depenent. We uncovered that economies of agglomeration operating in the Schiphol region are the most important location factors. Not the specific airport endowments of Schiphol. This outcome yields important implications for the EDC location policy aimed at the Schiphol area.

Economies of agglomeration play a key role. Hence, attracting firms and activities in sufficient numbers into the Schiphol area can lead to a favorable economic environment for EDCs which, in turn, supports further growth of the EDC cluster. Growth of the Schiphol agglomeration can lead to the crossing of important thresholds in terms of location endowments and economies of agglomeration, triggering a self-reinforcing growth process. Below the threshold, a marginal variation in location policy can result in a small effect on the growth rate of the EDC cluster. From that, policy makers may conclude that the clustering of EDCs is not much affected by policy changes. However, a marginal policy variation can have a large effect when the threshold is crossed. The possibility of such non-linear responses makes it much more difficult to forecast the effect of a given policy change. The implication of this message for the EDC location policy becomes even stronger in the light of our results on locked-in logistics.

We show that 30% of the warehouses in the SADC area is locked into its location. Furthermore, we reveal that there are much more of these quasi-permanent EDC location effects around Schiphol than elsewhere in The Netherlands. Thus, a bad EDC location policy for the Schiphol area may have significant long-lasting bad effects.

We show that EDC location policy not only exhibits phenomena of irreversibility when it comes to warehouse location but also when it comes to the transport mode that is used. In 2000, when we collected our empirical data, the EDCs in the Schiphol area had two modal shift options for freight: a shift from air to road and a shift from road to air. Options for freight transport by rail to and from Schiphol were still in their infancy. We stress that within Europe much of the air freight is transported by road, carried on air waybills and with a flight number. This is called airport trucking. We show that the goods flows of the EDC cluster at the SADC business parks offer a significant potential for a modal shift from air to road that will be used as adjustment possibility in response to increasing airport congestion at Schiphol (congested runways, congested terminals, and congestion in the air). In contrast, under increasing road congestion in the Schiphol region a modal shift for freight from road to air is hardly considered. The EDCs in the SADC area can thus become locked into the transport mode road. A policy intervention that is ineffective in terms of relocation of EDCs can, however, result in a modal shift for freight. If it results in a modal shift from air to road, there may thus be significant long-lasting effects.

The main message of our study is that the clustering of EDCs near Schiphol needs to be accompanied by new insights concerning location policy. That is, policy makers should be aware of the powerful role threshold effects play in the airport region. In this connection, we discuss two lines of new options for governmental steering that can help to control the location allocation of EDCs around Schiphol. Both utilize the phenomena of locked-in logistics.

The first line of new steering options utilizes location lock-in. Suppose that we increase the administrative measures for the SADC business parks near Schiphol so that from now on less EDCs are permitted to locate there. At the same time we lift the administrative measures for an EDC business park elsewhere in the wider Schiphol region. Although this new EDC location does not offer proximity to Schiphol, it attracts Schiphol-dependent warehouses due to the economies of agglomeration operating in the Schiphol region. Over time, the spatial structure of the Schiphol region will be transformed from a mono location system for Schiphol-dependent EDCs into a duo location system. Due to location lock-in the two clusters will continue to exist. Even when we lift the administrative measures for the cluster that is close to Schiphol. By lifting and increasing the administrative measures we can change the growth rate of the clusters.

The second line of new steering options utilizes lock-in regarding the transport mode road. In a wide variety of ways, different levels of the Dutch government can affect congestion at airport Schiphol (congested runways, congested terminals, and congestion in the air) and road congestion in the wider Schiphol region. The spreading force of congestion can alter the nature of the EDC cluster at the SADC business parks in three ways; (a) Increasing airport and road congestion can change the growth rate of the EDC cluster because it causes warehouses to leave; (b) Increasing airport congestion can affect the mix of Schiphol-dependent and non-Schiphol-dependent warehouses. Warehouses that are not driven away from the SADC area –that are the warehouses with high threshold values in terms of relocation- may decide to make a modal shift for freight from air to road to escape from the worsening airport congestion. Such a modal shift can easily turn Schiphol-dependent warehouses into non-Schiphol-dependent warehouses. Due to lock-in regarding the transport mode road, this effect can be quasi-permanent; (c) Increasing road congestion can result in a time shift. Warehouses that are not driven away from the SADC area may opt for off-peak transportation, for instance night distribution, to avoid traffic jams.

In chapter 9, we address the limits on generalizing the results of this study and give suggestions on what new research is now appropriate. Our model explains the making of the EDC cluster near Schiphol. However, we argue that the mechanisms underlying the clustering of EDCs around Schiphol are also the most important forces at work in the surrounding areas of other major airports and major seaports.

Samenvatting (Dutch summary)

Dit proefschrift gaat over de sturende krachten en mechanismen achter het clusteren van Europese Distributie Centra (EDCs) rondom de luchthaven Schiphol. Nederland is een aantrekkelijke vestigingsplaats voor EDCs. Ongeveer de helft van alle EDCs in Europa zijn gevestigd in Nederland. In 2002 was de bijdrage van de EDC sector aan de Nederlandse economie ongeveer 95.000 voltijd banen (fte's) en 1% van het Bruto Binnenlands Product (BBP). Schiphol is een belangrijke vestigingsplaats voor EDCs.

Hoeveel distributie centra aan te trekken en van welke soort zijn twee belangrijke aandachtspunten bij het ruimtelijk-economisch overheidsbeleid voor het gebied rondom Schiphol. Hiervoor zijn twee redenen. Aan de ene kant betekent het aantrekken van EDCs het aantrekken van allerlei internationale goederenstromen, investeringen en werkgelegenheid. Aan de andere kant moeten we bedenken dat een EDC relatief veel vestigingsruimte vraagt terwijl de hoeveelheid beschikbare ruimte rondom Schiphol beperkt is. Het gebied rond de luchthaven is door de overheid geoormerkt voor op Schiphol georiënteerde bedrijven (ook wel luchthavengerelateerde of luchthavengebonden bedrijvigheid genoemd). Het is echter niet bekend of rond Schiphol de "juiste" locaties zijn toegewezen aan de "juiste" distributie centra en of een "verkeerd" locatiebeleid langdurige niet gewenste effecten met zich brengt.

Het kunnen verklaren, en daarmee begrijpen, waarom bedrijvigheid graag clustert rondom luchthavens is belangrijk voor locatietheorie en locatiebeleid dat betrekking heeft op luchthavenregio's. Het traditionele antwoord op de vraag waarom distributie centra graag clusteren rondom Schiphol is dat ze worden aangetrokken door de luchthaven omdat het belangrijk voor ze is om gebruik te kunnen maken van luchtvervoer. We laten echter zien dat

dit slechts een deel van het antwoord is. In dit proefschrift presenteren we een nieuw model van het clusteren van EDCs rondom de luchthaven Schiphol. In het model werken de volgende locatiekrachten op elkaar in:

- locatiekwaliteiten;
- agglomeratievoordelen;
- locked-in logistics.

We hebben de empirische relevantie en de verklaringskracht van het model getest. Ons model biedt nieuwe inzichten voor het EDC locatiebeleid van de overheid voor het gebied rond Schiphol. We hebben ontdekt dat er belangrijke "drempeleffecten" zijn in het gebied rond de luchthaven en dat ze een sterk sturende rol hebben. Drempeleffecten worden vaak niet meegenomen in standaard neoklassieke locatiemodellen. Ons model laat zien dat een beperkte beleidsinterventie van de overheid nauwelijks effect zal hebben op de groei van het EDC cluster zolang het beleidsinstrument dat wordt ingezet onder de drempelwaarde functioneert maar dat dezelfde beleidsinterventie een groot effect kan hebben als de drempel wordt overschreden. De mogelijkheid dat zulke niet-lineaire effecten kunnen optreden, maakt het moeilijk om het effect van een voorgestelde beleidsverandering te voorspellen. Verder laat het model zien dat bepaalde beleidseffecten onomkeerbaar kunnen zijn.

Probleembeschrijving en doelen van het onderzoek

Hoofdstuk 1 begint met de probleembeschrijving en de doelen van deze studie. Schiphol is een grote Europese luchthaven met voortdurend groeiende volumes van passagiers- en vrachtstromen. Dit geldt ook voor vraag naar bedrijfslocaties in de buurt van de luchthaven. Echter, de ruimte rondom Schiphol die kan worden gebruikt voor de bouw van kantoren en distributie centra is beperkt. De ontwikkeling van het gebied rond Schiphol wordt door de overheid geaccommodeerd maar ook gebonden aan grenzen. De overheid wil een beheerste ruimtelijk-economische ontwikkeling. Daarom mogen rondom de luchthaven alleen op Schiphol georiënteerde bedrijven worden gevestigd. Onbeheerste ruimtelijk-economische ontwikkeling van het gebied kan leiden tot het toewijzen van de schaarse vestigingslocaties aan niet-luchthavengerelateerde bedrijven. Met als gevolg dat later arriverende op Schiphol georiënteerde bedrijven geconfronteerd kunnen worden met volle bedrijventerreinen waardoor ze moeten uitwijken naar een locatie naast een andere, maar kleinere, Nederlandse luchthaven, een locatie in Nederland zonder luchthaven, of een locatie bij een grote Europese luchthaven buiten Nederland. Verder kan onbeheerste ontwikkeling van het gebied makkelijk resulteren in: overvolle bedrijventerreinen; stijgende grondprijzen; congestie op de routes van de bedrijventerreinen naar de verbindingswegen en naar de luchthaven; en dus een verslechterende bereikbaarheid van Schiphol. Sinds de tweede helft van de jaren-90 bestaat het vermoeden dat veel van de EDCs die gevestigd zijn rond Schiphol niet-luchthavengerelateerd zijn. Maar, deze aanname is nooit echt goed onderzocht.

> *Het eerste doel van deze studie is het analyseren en verklaren van het clusteren van EDCs rondom Schiphol.*

EDCs die zijn gevestigd rond Schiphol worden geconfronteerd met toenemende congestie op de luchthaven en op de weg. Op de luchthaven kunnen de geluidsgrenzen en het systeem van toewijzen van "slots" (de rechten om te landen of op te stijgen op een bepaald tijdstip) samen met de hoge groei van luchtvervoer makkelijk leiden tot: congestie in het luchtruim en vertragingen bij het opstijgen en landen; onvoldoende capaciteit op de start- en landingsbanen; en congestie in de passagiers- en vrachtterminals. De landzijdige bereikbaarheid van Schiphol wordt steeds slechter door congestie op de weg. Door de toenemende wegcongestie in de grotere Schiphol-regio zijn de reistijden naar de luchthaven en van de luchthaven naar andere nationale en internationale steden toegenomen. Voor de EDCs kan congestie een belangrijke reden zijn om hun logistieke systeem aan te passen. Maar, nadat EDCs zich hebben gevestigd rond Schiphol kunnen ze in een zogenaamde "lock-in" situatie terecht komen met betrekking tot hun transportmodaliteit en/ of hun locatie. Er zijn dan hoge drempels ontstaan die inertie veroorzaken waardoor krachten die aanzetten tot verandering –zoals verslechterende condities van de vestigingslocatie door congestie of beleidsinterventies van de overheid- geen effect hebben als het gaat om het kiezen voor een andere transportmodaliteit of een andere locatie. Gezien vanuit het gezichtspunt van de overheid en het locatiebeleid voor de gebieden rond Schiphol is het zeer onwenselijk als niet-luchthavengerelateerde EDCs in een lock-in situatie komen waardoor ze verankerd raken op hun Schiphol-locatie.

> *Het tweede doel van deze studie is het verkrijgen van inzicht in locked-in logistics en de daaraan gekoppelde drempelwaarden. Het gaat hier specifiek om het onderzoeken van de behoeften en mogelijkheden van de EDCs rond Schiphol om de gevolgen van congestie voor hun bedrijfsprocessen te kunnen compenseren door het kiezen van een andere transportmodaliteit of een andere vestigingslocatie.*

Het kunnen verklaren en begrijpen waarom bedrijvigheid graag clustert rondom luchthavens is belangrijk voor zowel locatietheorie als locatiebeleid dat betrekking heeft op luchthavenregio's.

> *Het derde doel van deze studie is het vinden van nieuwe mogelijkheden voor overheidssturing die kunnen bijdragen aan een betere beheersing van de toewijzing van vestigingslocaties rond Schiphol aan EDCs.*

De context

Om de opkomst van EDCs, besluiten over waar EDCs moeten worden gevestigd, en besluiten over hoe hun in- en uitgaande goederenstromen moeten worden georganiseerd goed te kunnen begrijpen, moeten we kijken naar de bredere context van integrale logistieke ketens. Deze context wordt besproken in hoofdstuk 2. Veel internationaal opererende logistieke bedrijven hebben hun Europese distributienetwerk ingericht volgens het concept van centrale Europese distributie. Bij dit concept spelen EDCs een hoofdrol. De goederen die in een EDC liggen opgeslagen, zijn vaak geproduceerd in overzeese fabrieken. Denk hierbij met name aan fabrieken in Japan en de USA. Vanuit een EDC worden de goederen vervolgens gedistribueerd door heel Europa, het Midden-Oosten en Afrika (EMEA-landen). Nadat een

klant, met locatie ergens in Europa, een bestelling bij het EDC heeft geplaatst, bedraagt de levertijd meestal 24 tot 72 uur. Nederland is een aantrekkelijke vestigingsplaats voor EDCs. De bekende slogan "The Netherlands, gateway for Europe" promoot Nederland als optimale vestigingsplaats voor EDCs. Ongeveer de helft van alle EDCs in Europa zijn gevestigd in Nederland. En ongeveer 20% van de EDCs die in Nederland zijn gevestigd, staan in de grotere Schiphol-regio.

Om het clusteren van EDCs rondom Schiphol te kunnen begrijpen, moeten we niet alleen naar de private logistieke context kijken maar ook naar de publieke beleidscontext. De publieke beleidscontext wordt besproken in hoofdstuk 3. Daar laten we zien hoe regionale overheden, locale overheden en luchthaven Schiphol samenwerken in de Schiphol Area Development Company (SADC, een ontwikkelingsmaatschappij) en hoe ze de ontwikkeling van bedrijventerreinen rond de luchthaven en de toewijzing van locaties aan EDCs coördineren. We beschrijven de doelen en instrumenten van het EDC locatiebeleid vanaf de oprichting van SADC in 1987 tot 2000.

Theoretisch kader

Het theoretisch kader van deze studie wordt beschreven in hoofdstuk 4 en 5. Locaties op en rond een luchthaven zijn een aantrekkelijke vestigingsplaats voor allerlei bedrijven. Als de aangetrokken bedrijvigheid een behoorlijke omvang bereikt heeft, treden binnen het bedrijvencluster allerlei positieve feedbacks van kostenverlagende en winstverhogende aard op. Dit maakt de luchthaven een nog aantrekkelijkere vestigingsplaats. Er ontstaat een kracht tot steeds verdere versterking van de omvang en differentiatie van de luchthaven-agglomeratie. Deze dynamische economische effecten van luchthavens zijn nog maar weinig onderzocht en vormen de kern van dit proefschrift. Het sluit aan bij de steeds breder geaccepteerde economische theorie die zegt dat binnen een agglomeratie, nadat een bepaalde omvang is bereikt, zichzelf versterkende processen op gang kunnen komen. Dat wil zeggen dat naarmate de agglomeratie groeit, wordt het steeds aantrekkelijker voor bedrijven om zich daar ook te vestigen waardoor de agglomeratie steeds harder gaat groeien. We gebruiken theoretische concepten uit het vakgebied van de "nieuwe economische geografie" om een nieuw model te ontwikkelen van het clusteren van EDCs rondom Schiphol. De sturende krachten in het model zijn:

- locatiekwaliteiten;
- agglomeratievoordelen;
- locked-in logistics.

Locatiekwaliteiten

Bij locatiekwaliteiten gaat het om de voordelen die de Schiphol-regio biedt doordat de regio verschillend is ten opzichte van andere regio's. Voor de Schiphol-regio –of een luchthavenregio in het algemeen- introduceren we de volgende soorten locatiekwaliteiten:

- Specifieke luchthavenkwaliteiten, zoals: aantal vliegbestemmingen; internationale vliegbestemmingen; verbindingen met andere grote luchthavens; directe vliegbestemmingen; vliegfrequenties; mogelijkheden om nog dezelfde dag weer terug te kunnen vliegen; percentage vluchten dat op tijd vertrekt; percentage vluchten dat op tijd aankomt; luchthaventarieven; tarieven voor luchtvervoer; wachttijd in de terminals; tijd en kosten om naar en van de luchthaven te komen.
- Niet-luchthavenkwaliteiten, zoals: beschikbaarheid van vruchtbare grond; aanwezige grondstoffen; klimaat; toegang tot de zee (er is een zeehaven); loonkosten; grondprijzen; transportkosten.

Agglomeratievoordelen
Bij locatiekwaliteiten gaat het om regionale verschillen als reden waarom bedrijven kiezen voor de Schiphol-regio. Dat is anders bij agglomeratievoordelen. Dan gaat het om de voordelen die ontstaan doordat bedrijven zich dicht bij elkaar vestigen. Een bedrijvencluster kan voordelen opleveren voor de individuele bedrijven die het cluster vormen. In de literatuur worden vaak de volgende voorbeelden van agglomeratievoordelen genoemd: kostenbesparingen door het leren van elkaar door onderlinge contacten of door imitatie; het beschikbaar zijn van geschoolde arbeidskrachten omdat ze al in de andere bedrijven van het cluster zijn opgeleid; en het ontstaan van gespecialiseerde toeleveranciers. Deze voorbeelden laten zien dat groei van het bedrijvencluster kan leiden tot meer agglomeratievoordelen. Als er agglomeratievoordelen zijn, hebben bedrijvenclusters een natuurlijke kracht tot steeds verdere en sterkere groei in omvang.

Wij gaan uit van het idee dat de aantrekkelijkheid van een bedrijfslocatie wordt bepaald door zowel de locatiekwaliteiten als de agglomeratievoordelen. Dat is niet nieuw. Dit idee is stevig geworteld in de traditionele economische geografie en is ook geaccepteerd in de nieuwe economische geografie. Wel nieuw is dat we de aantrekkingskracht die wordt uitgeoefend door locatiekwaliteiten van de Schiphol-regio en de aantrekkingskracht die wordt uitgeoefend door de agglomeratievoordelen van de Schiphol-regio uit elkaar rafelen. Om het clusteren van bedrijvigheid rondom luchthavens te kunnen begrijpen, is het essentieel te weten of bedrijven zijn aangetrokken door de specifieke luchthavenkwaliteiten of door de agglomeratievoordelen.

Locked-in logistics
We volgen de economische literatuur en modelleren dat groei van de Schiphol-agglomeratie (dat is de luchthaven met de bedrijvigheid daarop en rondom) niet alleen kan leiden tot betere locatiekwaliteiten en agglomeratievoordelen maar ook kan resulteren in verslechterende locatiekwaliteiten en agglomeratienadelen. We concentreren ons op de EDCs die zijn gevestigd rond Schiphol en kijken naar afnemende locatiecondities die kunnen ontstaan door groei van de Schiphol-agglomeratie. Hiervoor introduceren we de volgende categorieën:

- Afnemende locatiecondities die voor een groot deel worden veroorzaakt door groei van het EDC cluster rond Schiphol. Voorbeelden zijn: overvolle bedrijventerreinen; stijgende grondprijzen resulterend in hogere kosten voor het huren of leasen van

magazijnruimte; congestie op de routes van de bedrijventerreinen naar de verbindingswegen en naar Schiphol; groeiende vraag naar logistiek personeel resulterend in hogere zoek- en selectiekosten.
- Afnemende locatiecondities die voor een klein deel worden veroorzaakt door groei van het EDC cluster rond Schiphol. Voorbeelden zijn: toenemende congestie op de weg in de grotere Schiphol-regio; toenemende congestie op luchthaven Schiphol (congestie op de start- en landingsbanen, congestie in de terminals, en congestie in de lucht).

We modelleren dat EDCs, nadat ze voor een vestigingsplaats hebben gekozen, hun logistieke systeem kunnen aanpassen als antwoord op veranderingen in hun omgeving. In dit proefschrift onderzoeken we de behoeften en mogelijkheden van de EDCs rondom Schiphol om de gevolgen van congestie voor hun bedrijfsprocessen te kunnen compenseren. We kijken naar alle, maar focussen op twee logistieke aanpassingsmogelijkheden:

- het kiezen van een andere transportmodaliteit –ofwel een modal shift;
- verhuizen van het EDC.

In het algemeen kunnen we zeggen dat we aan de ene kant de krachten die aanzetten tot verandering modelleren en aan de andere kant de weerstand tegen verandering. Op basis van de literatuur zeggen we dat weerstand tegen verandering samenhangt met drempelwaarden en drempeleffecten. Als de veranderkrachten boven de drempel uitkomen, zullen de EDCs veranderen. De drempels veroorzaken als het ware inertie waardoor beperkte beleidsinterventies van de overheid –of andere veranderkrachten zoals verslechterende locatiecondities- geen effect kunnen hebben. In dit kader introduceren we twee “lock-in logistics” situaties voor individuele EDCs waarbij er zeer hoge drempelwaarden zijn. Namelijk, we modelleren dat EDCs die gevestigd zijn rondom Schiphol locked-in kunnen raken met betrekking tot hun:

- transportmodaliteit;
- Schiphol-locatie.

Methode van dataverzameling
Door de belangrijke rol van agglomeratievoordelen en locked-in logistics heeft ons model een aantal eigenschappen die standaard neoklassieke locatiemodellen niet hebben. We hebben de empirische relevantie en verklaringskracht van het model getest door het doen van empirisch onderzoek. De methode van dataverzameling en –analyse wordt besproken in hoofdstuk 6. We hebben een cross-sectie onderzoek uitgevoerd in het jaar 2000. Dat bestaat uit een survey die is gehouden onder de volgende twee populaties:

- nationale-EDC-populatie;
- Schiphol-EDC-populatie.

De Schiphol-EDC-populatie is het cluster van distributie centra dat staat op de bedrijventerreinen van de Schiphol Area Development Company (SADC). De SADC-bedrijventerreinen liggen rondom Schiphol. De nationale-EDC-populatie bestaat uit de distributie centra die elders in Nederland zijn gevestigd.

Ongeveer 75% van de EDC-operaties in Nederland is uitbesteed aan een logistieke dienstverlener. Het distributie centrum van een logistieke dienstverlener kan meer dan één EDC onder zijn dak hebben. Daarom hebben we als eenheid van analyse gekozen voor: "een distributie centrum met daarbinnen één of meer EDCs". Dus distributie centra vormen de eenheid van analyse, niet individuele EDCs.

De survey onder de nationale-EDC-populatie bestond uit het per post toesturen van de vragenlijst. Gevraagd werd deze in de bijgevoegde retourenvelop terug te sturen. De adressenlijst is opgesteld in samenwerking met Nederland Distributieland (NDL). NDL verricht regelmatig survey-onderzoek onder de EDCs in Nederland. We hebben er naar gestreefd om een zo compleet mogelijke adressenlijst samen te stellen. Het response percentage was 20%. De vragenlijsten werden geadresseerd aan de logistieke managers. Daar hebben we voor gekozen vanwege hun kennis van en inzicht in de logistieke processen van hun distributie centrum. De survey onder de Schiphol-EDC-populatie bestond uit interviews met de logistieke managers met behulp van een vragenlijst. De adressenlijst is opgesteld in samenwerking met SADC. We hebben 27 respondenten geïnterviewd. Dat is de totale Schiphol-EDC-populatie.

De Schiphol-EDC-populatie is onderzocht aan de hand van gestructureerde interviews waarbij we de logistieke managers hebben bezocht. Dit bood de mogelijkheid om moeilijke vragen voor te leggen. We vroegen de logistieke managers bijvoorbeeld de in- en uitgaande goederenstromen van hun distributie centrum te ontleden. Aan de hand van deze informatie konden wij antwoord geven op de vraag welk distributie centrum wel of niet op Schiphol is georiënteerd. In onze definitie van een op Schiphol georiënteerd EDC staan criteria voor de hoeveelheid luchtvracht (gemeten in volume) die wordt ontvangen en verzonden en de transportmodaliteit die daarvoor wordt gebruikt. Een ander voorbeeld is dat we mogelijke toekomst scenario's hebben voorgelegd om inzicht te krijgen in locked-in logistics en bijbehorende drempelwaarden. We hebben de logistieke managers mogelijke toekomstige situaties met toenemende congestie voorgelegd en gevraagd welke logistieke veranderingen ze zouden doorvoeren om de gevolgen van de congestie voor hun bedrijfsprocessen te kunnen opvangen.

Resultaten

In hoofdstuk 7 en 8 worden de onderzoeksresultaten besproken. EDCs worden tot Schiphol aangetrokken door zowel de locatiekwaliteiten als de agglomeratievoordelen. Het traditionele antwoord op de vraag waarom EDCs graag clusteren rondom Schiphol is dat EDCs worden aangetrokken door de luchthaven omdat het belangrijk voor ze is om gebruik te kunnen maken van luchtvervoer. Met andere woorden, dat ze worden aangetrokken door de specifieke luchthavenkwaliteiten van Schiphol. We laten echter zien dat dit slechts een deel van het antwoord is en dat bijna 40% van de distributie centra, die de EDC populatie op de SADC-bedrijventerreinen representeert, niet op Schiphol is georiënteerd. We hebben gevonden dat de

agglomeratievoordelen van de Schiphol-regio de meest belangrijke locatiefactor is. Niet de specifieke luchthavenkwaliteiten van Schiphol. Deze uitkomst is van grote betekenis voor het EDC locatiebeleid van de overheid voor het gebied rond de luchthaven.

Agglomeratievoordelen spelen een hoofdrol. Dus het aantrekken van bedrijvigheid naar Schiphol kan, als een behoorlijke omvang bereikt is, resulteren in een aantrekkelijk vestigingsklimaat voor EDCs waardoor weer verdere en sterkere groei van het EDC cluster kan ontstaan. Door groei van de Schiphol-agglomeratie kunnen de locatiekwaliteiten en de agglomeratievoordelen toenemen. Als daarbij belangrijke drempels worden gehaald, begint het zelfversterkende groeiproces te werken. Onder de drempel zal een beperkte beleidsverandering van de overheid nauwelijks effect hebben op de groei van het EDC cluster. De overheid zou daaruit kunnen concluderen dat het EDC cluster nauwelijks wordt beïnvloed door beleidsveranderingen. Een beperkte beleidsinterventie kan echter een groot effect hebben als de drempel wordt overschreden. De mogelijkheid dat zulke niet-lineaire effecten kunnen optreden, maakt het moeilijk om het effect van een voorgestelde beleidsverandering te voorspellen. De betekenis hiervan voor het EDC locatiebeleid wordt nog duidelijker als we kijken naar onze uitkomsten met betrekking tot locked-in logistics.

Het blijkt dat 30% van de distributie centra op de SADC-bedrijventerreinen in een “lock-in” situatie terecht is gekomen met betrekking tot hun locatie. Verder laten we zien dat deze quasi-onomkeerbare locatie-effecten veel meer rondom Schiphol voorkomen dan elders in Nederland. Een “verkeerd” EDC locatiebeleid voor het gebied rond Schiphol kan dus langdurige niet gewenste effecten met zich brengen.

We tonen aan dat het EDC locatiebeleid naast onomkeerbare locatie-effecten ook onomkeerbare effecten met zich kan brengen als het gaat om de transportmodaliteit die wordt gebruikt. In 2000, het jaar waarin we ons survey-onderzoek hebben verricht, hadden de EDCs die rond Schiphol staan twee modal shift opties voor vracht: een shift van lucht (vliegtuig) naar weg (vrachtwagen) en een shift van weg naar lucht. Mogelijkheden om vracht van en naar Schiphol te vervoeren via het spoor stonden nog in de kinderschoenen. We benadrukken dat op Europese trajecten veel luchtvracht over de weg wordt vervoerd met “air waybills” en onder een vluchtnummer. Dit wordt airport trucking genoemd. We laten zien dat veel van de EDCs op de SADC-bedrijventerreinen zeggen een deel van hun goederenstromen te gaan verschuiven van het vliegtuig naar de weg als ze worden geconfronteerd met toenemende congestie op luchthaven Schiphol (congestie op de start- en landingsbanen, congestie in de terminals, en congestie in de lucht). Als daarentegen de wegcongestie in de Schiphol-regio toeneemt, wordt een modal shift van weg naar lucht nauwelijks overwogen. De EDCs op de SADC-bedrijventerreinen kunnen dus locked-in raken met betrekking tot de transportmodaliteit weg. Een beleidsinterventie van de overheid die niet leidt tot het verhuizen van EDCs kan er echter wel toe leiden dat EDCs besluiten tot een modal shift voor een deel van hun goederenstromen. Als dit resulteert in een modal shift van lucht naar weg, kan dat dus grote langdurige effecten met zich brengen.

De hoofdboodschap van onze studie is dat het EDC locatiebeleid van de overheid voor het gebied rond Schiphol moet worden verrijkt met nieuwe inzichten. Daarmee bedoelen we dat beleidsmakers zich bewust zouden moeten zijn van de krachtige en sturende rol van

drempeleffecten in de Schiphol-regio. In dit verband bespreken we twee nieuwe mogelijkheden voor overheidssturing die kunnen bijdragen aan een betere beheersing van de toewijzing van vestigingslocaties rondom Schiphol aan EDCs. Beide opties maken gebruik van locked-in logistics situaties.

De eerste nieuwe optie voor overheidssturing maakt gebruik van lock-in met betrekking tot de vestigingslocatie. Stel dat we de toelatingscriteria voor de SADC-bedrijventerreinen naast Schiphol strenger maken. Zodanig dat vanaf nu minder EDCs worden toegelaten om zich daar te vestigen. Op hetzelfde moment maken we de toelatingscriteria voor een ander bedrijventerrein, ergens anders in de grotere Schiphol-regio, minder streng. Hoewel deze nieuwe EDC locatie niet dichtbij Schiphol ligt, is het toch een aantrekkelijke locatie voor op Schiphol georiënteerde distributie centra vanwege de agglomeratievoordelen die de Schiphol-regio biedt. Na verloop van tijd zal de ruimtelijke structuur van de Schiphol-regio zijn veranderd van een één-locatiesysteem voor op Schiphol georiënteerde EDCs in een twee-locatiesysteem. Verschillende EDCs zullen locked-in raken op hun vestigingslocatie. Dankzij deze lock-in situaties zullen de twee bedrijvenclusters blijven bestaan. Zelfs als we de toelatingscriteria voor het cluster naast Schiphol minder streng maken. Door het meer en minder streng maken van de toelatingscriteria kunnen we de groeisnelheid van de clusters bijsturen.

De tweede nieuwe optie voor overheidssturing maakt gebruik van lock-in met betrekking tot de transportmodaliteit weg. Op veel manieren kan de overheid de congestie op luchthaven Schiphol (congestie op de start- en landingsbanen, congestie in de terminals, en congestie in de lucht) beïnvloeden. Hetzelfde geldt voor de wegcongestie in de grotere Schiphol-regio. Congestie kan het EDC cluster dat naast de luchthaven staat op drie manieren veranderen: (a) Een toename van de congestie op de luchthaven en op de weg kan de groeisnelheid van het EDC cluster veranderen omdat er distributie centra zullen besluiten te verhuizen; (b) Meer congestie op de luchthaven kan de mix van wel en niet op Schiphol georiënteerde distributie centra veranderen. Distributie centra die niet gaan verhuizen (dat zijn de distributie centra die locked-in zijn geraakt op hun Schiphol-locatie) zouden kunnen besluiten tot een modal shift voor een deel van hun goederenstromen van lucht naar weg om zo te ontsnappen aan de toenemende congestie op de luchthaven. Zo'n modal shift kan er makkelijk toe leiden dat luchthavengerelateerde distributie centra veranderen in niet-luchthavengerelateerd. Lock-in situaties met betrekking tot de transportmodaliteit weg kunnen dit effect quasi-permanent maken; (c) Meer congestie op de weg kan resulteren in een zogenaamde "time shift". Dat wil zeggen dat distributie centra die niet gaan verhuizen, besluiten hun vrachtwagens buiten de piektijden te laten rijden om de files te vermijden. Denk bijvoorbeeld aan nachtdistributie.

In hoofdstuk 9 wordt stilgestaan bij de generaliseerbaarheid van de resultaten van deze studie en worden suggesties gedaan voor verder wetenschappelijk onderzoek. Ons model gaat over de sturende krachten en mechanismen achter het clusteren van EDCs rondom de luchthaven Schiphol. We zijn echter van mening dat deze krachten en mechanismen precies zo bepalend zijn bij het clusteren van bedrijvigheid rondom andere grote luchthavens en grote zeehavens.

About the author

Pim Warffemius was born on the 2th of January 1965, in Reeuwijk, The Netherlands. He studied Industrial Engineering at the Technical College in Dordrecht (1983-1988) and Business Administration at the Erasmus University Rotterdam (1989-1994). His majors were in Logistics Management. At the Erasmus University Rotterdam he also was employed as a research assistant.

After graduating he worked as a business consultant for one year. Then, he started as an assistant professor at the Faculty of Business Administration at the Erasmus University Rotterdam. And, he worked at the Technical College in Rijswijk. He lectured and supervised students writing their master's thesis.

In 1998 he started with his PhD research at the Department of Public Administration of the Erasmus University Rotterdam. The research was embedded in TRAIL The Netherlands Research School for Transport, Infrastructure and Logistics, and was sponsored by AVV Transport Research Centre of the Dutch Ministry of Transport, Public Works and Water Management. Next to his PhD study, he was chairman of the TRAIL PhD Council.

In 2003 he started as a senior advisor in the field of transport economics at the Dutch Ministry of Transport, Public Works and Water Management. On a part-time basis, he continued working on his PhD research. Since September 2006, he works as a researcher at KiM Netherlands Institute for Transport Policy Analysis.

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