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Business ICT Adoption and Open Access: The Example of SMEs at Industrial Parks in the Netherlands[1]

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Abstract

Information and Communication Technologies (ICT) provide small- and medium-sized enterprises (SMEs) with an option to create and exploit strategic opportunities. Prior investment in ICT infrastructure can lead to follow-up decisions to adopt new ICT services, but there is no guarantee that SMEs will also use emerging strategic opportunities in adopting these services. In this context, the paper examines whether or not the adoption of advanced ICT infrastructure and advanced ICT services by SMEs has been inter-related and was depending on number of firm-specific, market-specific and location-specific factors. In contrast to previous studies, the focus is on the extent to which the adoption of ICT infrastructure and ICT services has been driven by expectations about open access by SMEs. Open access was conceptualized as expectations by these companies about cheaper prices in the future, better quality of service and more competition on the infrastructure. The research uses data from a survey undertaken among 247 SMEs on different industrial parks in the Netherlands in February 2011. The results of the analysis show that SMEs value open access factors very high with respect to their choice to opt for new ICT infrastructure *and* new ICT services.

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Introduction

In the growing literature on the business adoption of Information- and Communication Technologies (ICT)(Colombo, Croce, & Grilli, 2013; Fichman, 1992, 2000), the effects of broadband infrastructure on the adoption of advanced ICT has just recently been investigated with rather diverse results (Grimes, Ren, & Stevens, 2012). As a digital divide has been a key characteristic of business ICT adoption (Forman, 2005), research has focused on the differences in ICT adoption and the strategic opportunities it can create (Forman & Goldfarb, 2005; B. Sadowski, Maitland, & van Dongen, 2002). Research has furthermore shown that small- and medium-sized enterprises (SME) are not only lagging in ICT adoption but are also slower in the use of advanced ICT services, compared to their larger counterparts (Fichman, 1992, 2000; Forman & Goldfarb, 2005). However, differences in the adoption of ICT infrastructure and ICT services have just recently addressed in the literature.

As general purpose technologies (Bresnahan & Trajtenberg, 1995), ICT technologies are applied in variety of ways across companies. As compatibility decisions affect the technological sophistication of companies (Forman, 2005), these decisions are interrelated but not necessarily linked. Apart from firm-internal specific factors such as company size (B. Sadowski, et al., 2002), the location of companies in industrial parks plays an important role in ICT adoption by SMEs. If companies are located in industrial parks, a number of additional variables are becoming important for ICT adoption related to e.g. effects generated by complementarities with the establishment location (Forman, 2005) or critical mass effects, i.e. the number of firms adopting a similar infrastructure at a particular location (e.g. an industrial park).

With the growth of initiatives from public entities and private parties to set up new ICT infrastructure at industrial parks, the specific form of access to the ICT infrastructure has been discussed. Closed forms of infrastructure access where companies have been locked-in to one single supplier have been contrasted to open forms of access based on a greater variety of suppliers and lower changes of becoming locked into single supplier environment. In order to avoid lock-in situations (Klemperer, 1987; Weizsäcker, 1984), open access requirements have been imposed in expecting cheaper prices in the future, better service quality and more competition of service suppliers on the infrastructure (Berkman Center, 2009).

Currently different broadband technologies evolve in parallel and are able to provide ICT infrastructure. The most future-proof technologies are considered as next generation access (NGA) technologies with fiber technologies are being the infrastructure with the highest potential in the long term in terms of bandwidth and service quality provided (OECD, 2008). Other broadband technologies based on cable modems, DSL or wireless technologies still evolve in competition with fibre infrastructure improving their technological characteristics. In this context, the decision of SMEs to adopt ICT infrastructure and ICT services is complex and affected by a number of firm-internal, market-specific and location-specific determinants.

The paper addresses these complex decisions of SMEs in adopting ICT services and relates these decisions to changes in the underlying ICT infrastructure environment. The paper investigates a sample of 247 companies with respect to determinants affecting their adoption of ICT infrastructure and advanced ICT services in the Netherlands. In contrast to previous studies, we focus on open access (i.e., the extent to which expectations about cheaper prices, better service quality and more competition) has facilitated the adoption of ICT infrastructure and ICT services. In the literature, rarely a distinction is made between ICT services and infrastructure and there is a common belief that with building ICT infrastructure new applications will come (Marcus & Elixmann, 2013). Furthermore, most literature takes for granted that open access is a pre-condition for ICT adoption without including it in the analysis.

In the following, the paper discusses the theoretical literature on the adoption of ICT infrastructure and ICT services. In deriving from the literature an empirical model for the analysis of the ICT adoption behaviour of SMEs in industrial parks, we examine the model using a survey data generated at industrial parks in the Eindhoven area in the Netherlands. The paper closes with a summary and draws some theoretical and strategy conclusions.

2 The Adoption of ICT by Small- and Medium-Sized Enterprises

2.1 ICT as a General Purpose Technology (GPT)

Information and communication technologies have been considered as a general purpose technology (GPT) which Bresnahan and Traijtenberg (1995) define as "capabilities whose adaptation to a variety of circumstances raises the marginal returns to inventive activity in each of these circumstances" (Bresnahan & Trajtenberg, 1995). Both authors (2001) propose that the economic rate of technical progress depends on the rate of co-invention, not just simply invention (Bresnahan & Greenstein, 2001). Co-invention involves not only time-consuming and expensive activities, but they require also organizational changes as well as technical adaptation of an organization. The cost of co-invention can be a significant barrier to technology adoption (Bresnahan & Greenstein, 1996) and technologies requiring significant co-invention are likely to face resistance.

ICT technologies face barriers to adoption as decisions to adopt ICT infrastructure and ICT services can be interlinked but are not necessarily so. The adoption of a particular ICT infrastructure provides new strategic opportunities for using this infrastructure, but follow-up decisions on adopting new services are embedded in changes within the organization (Bresnahan & Greenstein, 2001). The implementation of advanced ICT services such as customer relationship management (CRM) or enterprises resource planning (ERP) systems require adaptations of firm strategies and organizational changes within the company. This can lead to situations in which an advanced ICT infrastructure is not necessarily accompanied by an adoption of advanced ICT services by companies.

2.2.1. Complementarity and technological sophistication

As has been shown firms often face strategic trade-offs if they decide whether (or not) and when they adopt new ICT technologies. On the basis of a high speed broadband infrastructure, a variety of new ICT services can operate at the same time as the bandwidth does not impose any restrictions on the operations of these services. With the use of a large variety of new ICT services bandwidth requirements and quality of service is increasing, these developments do not necessarily require currently to adopt a particular infrastructure technology, i.e. in favour of fiber vis-à-vis any other high speed broadband infrastructure.

However, interoperability between ICT infrastructure and ICT services is a technical requirement for the operation of new ICT services. Compatibility requirements with respect to specific standards and interface are important (Farell & Saloner, 1985, 1986) to foster the growth of new ICT services. If there are problems with interoperability due to incompatibility, users can have an installed base which does not allow them to switch easily to new technologies and services. If compatibility is guaranteed, the variety of new ICT services used gives an indication about the technological sophistication of a company (Forman, 2005). With higher technological sophistication companies create also new strategic opportunities in their product markets.

H1: High ICT investment in ICT infrastructure will increase the likelihood of adopting advanced ICT services.

2.2.2 Exploration and adoption of ICT services

With the adoption of new ICT services, companies create strategic opportunities for exploring new options at their product markets. These new ICT services comprise a large variety of systems ranging from customer relationship management (CRM), enterprise resource planning (ERP), supply chain management (SCM) to e-procurement or knowledge management systems. With CRM systems, companies are more cost-efficiently able to serve their customer base. Based on ERP systems, the whole firm-internal value chain can be better organized leading to cost savings. Supply Chain Management (SCM) systems enable firms to better communicate with suppliers, allow better processing of orders and enable a closer interaction with suppliers. Other advanced ICT services such as e-procurement facilitate the digitalization of value chain within the company (Bauer, Gai, Muth, & Wildman, 2002). Even if these advanced ICT services represent a higher degree of technological sophistication, they have to be cost-efficiently used within a company. Therefore companies would adopt these services to explore new strategic opportunities to interact with customers or suppliers but cost-efficiencies define the particular choice in favor or against a particular advanced ICT service.

H2: Conditional on the decision to adopt ICT infrastructure, investments in ICT infrastructure will have effects on the decision to adopt ICT services.

2.2.3 Open access and the adoption of ICT

Open access to infrastructure has been considered as important for the business use of ICT as it should generate cheaper prices, higher quality of service provision, more competition by service providers and higher degree of innovation on the network. Based on open access to ICT infrastructure, new service providers can more easily enter and compete in ICT markets by requiring existing carriers to lease access to their networks to their competitors, mostly at regulated rates. In this way, the cost of replicating the underlying physical plant will be reduced due lower costs related to digging trenches, laying ducts and/or pulling copper/cable/fiber. These costs can deter competitors from entering the market in ICT services. By requiring that capacity to be shared, through leasing, with competitors, open access rules are intended to encourage entry by those competitors, who can then focus their own investments and innovation on ICT services that use that basic ICT infrastructure. The theory underlying the discussion of open access has postulated that a more competitive ICT market might emerge from a more competitive environment and will lead to higher capacity, at lower prices, directed to more customers (Berkman Center, 2009).

H3: Open access requirements are important for the likelihood of adopting advanced ICT services and ICT infrastructure.

2.2.4 Complementarity with Establishment Location and ICT Adoption

For SMEs, the decision to adopt access to ICT infrastructure and ICT services is related to the area where the establishment is located. If the company has different locations, well-established communication links between the parts of the company which are located elsewhere are important (Forman, 2005). Close proximity of the location increases the probability of company to choose advanced ICT access and ICT services.

H4: Complementarity with establishment location increases the likelihood of adopting advanced ICT services and infrastructure.

2.2.5 Critical Mass and ICT Adoption

In order to establish a new ICT infrastructure at an industrial park, high fixed investment is necessary. This can be generated by a sufficient level of critical mass of business users enrolling into the new network. This critical mass of business users consists of companies coming from different industries. The critical mass should be high for access to ICT infrastructure, for adoption of ICT services this should be not important

H5A: A critical mass of business users is important for the adoption of advanced ICT infrastructure.
H5B: A critical mass of business users is not important for the adoption of advanced ICT infrastructure and advanced ICT services.

3 The Adoption of ICT infrastructure and ICT services by SMEs: Empirical Model and Data

3.1 Empirical Model on Business ICT adoption

A discrete choice model (Greene, 2003; McFadden, 1986, 1981) is used to model the joint decisions of companies to adopt ICT infrastructure and ICT services. In the following an adoption model is used first developed by Forman (2005) which characterizes the decision of a company to invest in ICT infrastructure and ICT services as an interrelated decision. It starts with the assumption that each firm, *i*, is expected to adopt any form of infrastructure access, $j = 1$, denotes a decision to adopt infrastructure access only and; $j = 2$ denotes a decision to adopt ICT infrastructure access plus ICT services (Forman, 2005).

The utility generate from these decisions than take the form of a random utility model, $U_{ij} = u_{ij} + \varepsilon_{ij}$. In other words, the firm's utility to choose between ICT infrastructure and ICT services has two components: (1) a deterministic component, u_{ij}, which is a function of firm-specific and other characteristics and (2) a random error term, ε_{ij}, capturing the effects of unmeasured variables.

Due to well-known problems with multinominal logit models (Greene, 2003)[2], a nested logit model is used to allow for correlation in the unobservables. As a result, a tree structure in the decision-making process of managers in SMEs can be developed as shown in Figure 1. The Figure describes the adoption decision for a company and assumes that the utility is additively separable into different components varying with the decision to adopt access and the decision to adopt a set of different services (Forman, 2005):

$$Uij = Vik + Wij + \varepsilon ij \qquad (1)$$

In equation (1), the variable V_{ik} depends now only on variables that affect the access decision, *k*, while W_{ij} depends only on variables that affect the decision to adopt services, *j.* On the basis of the nested logit model, Forman (2005) assumes the error term, ε_{ij}, follows a generalized extreme value distribution. Under this distribution, errors within a nest are positively correlated and errors across nests are uncorrelated.

[2] Related to the assumption of independence of irrelevant alternatives (IIA) (Greene, 2003)

As the result, the joint probability of a choice *j* is represented by $P_{ij} = P_{ik} P_{ij|k}$, with P_{ij} is denoting the joint probability of an infrastructure / service decision, P_{ik} refers to the marginal probability of the choice of getting access to infrastructure and, and $P_{ij|k}$ is the probability of an service choice conditional on an infrastructure decision (Forman, 2005).

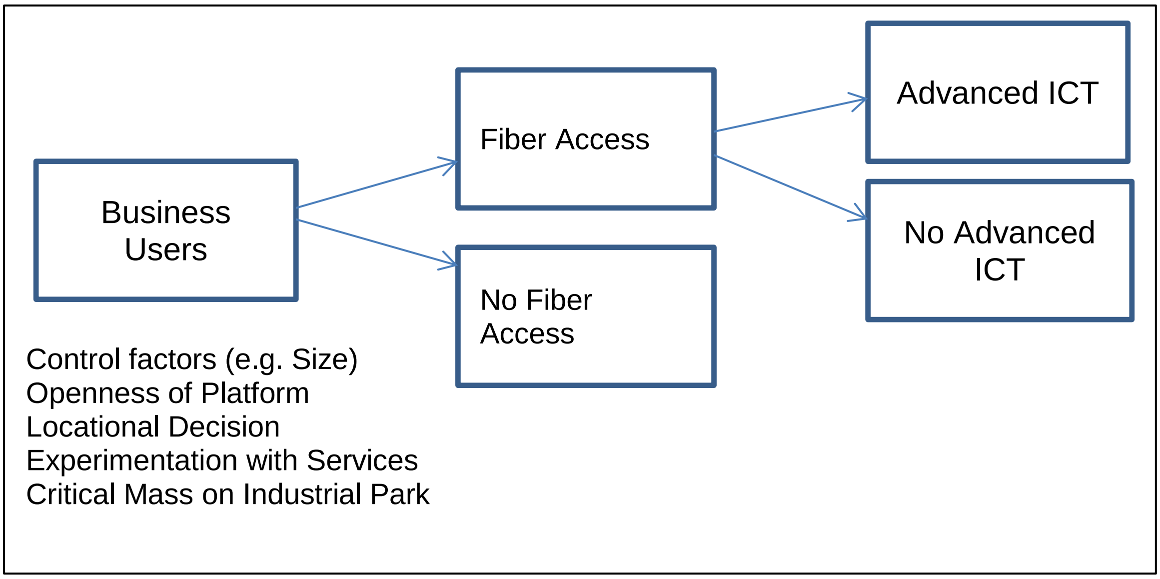

Figure 1: Business Users opting for Access to ICT Infrastructure and ICT services

3. The Data

In 2013, the Netherlands had one of the highest broadband penetration levels in the world with 79.5 percent of (wired) broadband subscriptions per 100 household (broadband penetration levels in Norway and Sweden were slightly higher with 82.6 percent). Within the different broadband technologies, fiber infrastructure contributed four percent to the total subscriptions (53 percent DSL and 43 cable connections) (OECD, 2012). Similarly most companies had broadband access (95 percent) in the Netherlands, but the diffusion of advanced ICT services within companies was lagging in some areas. For example, just 15 percent of Dutch companies used in 2012 Supply Chain Management systems (EU 27 average: 23 percent). In contrast, 29 percent Dutch companies were using CRM (customer relationship management) systems (26 percent EU 27 average) and 26 percent Enterprise Resource Planning (ERP) systems (EU27 average: 22 percent) (Eurostat, 2013).

The implementation of fiber infrastructure in the Netherlands started in 2005 with first municipal fiber network in Nuenen, a small town in neighborhood of Eindhoven. Since 2006, the number of fiber infrastructure initiatives has increased dramatically accounting currently for about 10 percent of all broadband connections in the Netherlands. Similar to the development of fiber infrastructure to households, the installation of fiber infrastructure at industrial parks has been growing since 2006. However, estimates on the exact number of fiber network initiatives in different industrial parks have been scarce. For Noord-Brabant, a large province in the South of the Netherlands, from 52 industrial parks in the province twelve parks had already implemented fiber infrastructure by 2010 (B Sadowski, 2010). One of the first areas in Noord-Brabant implementing fiber networks at different industrial parks has been at Eindhoven which has been the focus of this study.

Based on the cooperation with Glasvezel Eindhoven, the Municipality Eindhoven and the management at the different industrial parks (Esp, de Hurk, Eindhoven Airport (Flight Forum), GDC Acht and Kabelbeemd, De Kade, Achtse Barrier), a questionnaire has been designed and has been send off in February 2011. Responsibility for sending off the questionnaire has been taken by BIO (Beleidsinformatie en Onderzoek) of the Municipality of Eindhoven. Glasvezel Eindhoven (short GVE) is a social enterprise aimed at providing fiber infrastructure to commercial parties at different industrial parks in Eindhoven. GVE is based on the collaboration of a number of commercial users (who are also shareholders of GVE). The company provides fiber infrastructure at 5 industrial parks in Eindhoven (De Hurk, Esp, Goods Distribution Centre Eight (OV8), Kapelbeemd (OCK), Flight Forum / Eindhoven Airport (OKEA)). GVE has been set up in 2008 at the different industrial parks in Eindhoven by entrepreneurs to connect companies using fiber infrastructure. At the industrial park in Esp and OBE installation started in July 2008, in Hurk in October 2008), in the Goods Distribution Centre Eight (OV8) and Kapelbeemd in March 2009. Since July 2009, in the industrial park in Flight Forum / Eindhoven Airport (OKEA) the fiber infrastructure has been operational.

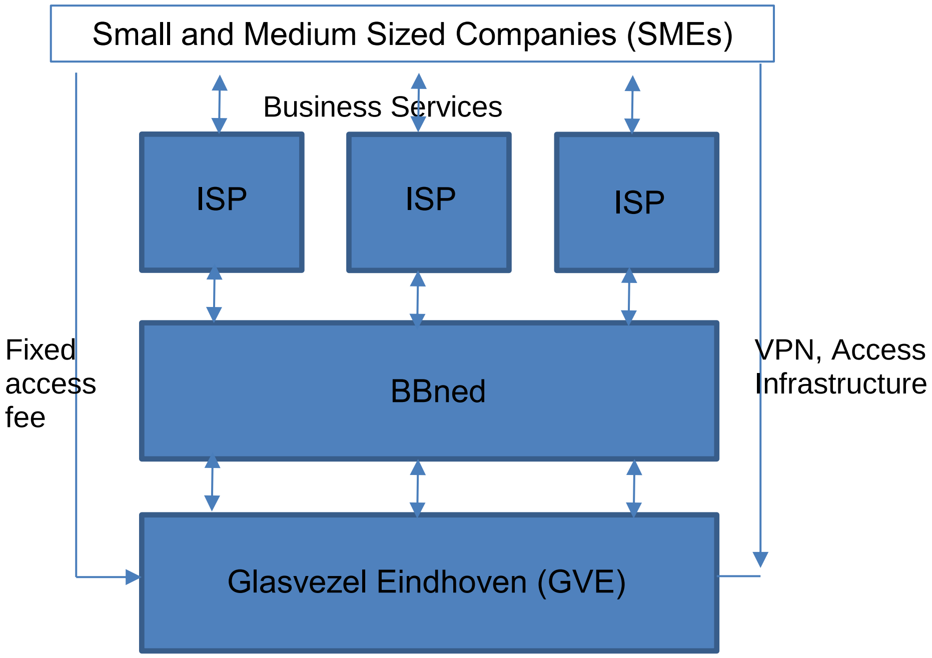

Figure 1: Structure of the company providing Infrastructure access

GVE provides fiber infrastructure at the passive layer of the network. At the active layer, BBned (providing access to the active layer of the network) has been selected to operate the network until 2013. BBned allowed a variety of Internet Service Providers to provide ICT services to its customers (SMEs).

Data for the survey were based on company information available at local municipality, which generated information on approximately 1300 enterprises indicating the location, the size and the industry the enterprise is in. Unfortunately, for a number of companies there was no information on the contact person and/or the email address. In order to complement this information, contact information provided by Glasvezel Eindhoven and the different park management (Esp, de Hurk, Eindhoven Airport (Flight Forum), GDC Acht and Kabelbeemd, De Kade, Achtse Barrier) was used. This combined information provided a sample of about 900 companies at different industrial park locations. In February 2011, a mail was sent to companies asking managers to respond to a number of questions on the website of the Municipality of Eindhoven. The response rate per industrial park has been rather high with 27 percent as indicated below (Table 1).

#	Industrial Park	With FttX	# of Companies Approached	Response	In %
1	Airport	Yes	100	24	24
2	De Hurk	Yes	440	114	26
3	De Kade	No	65	24	37
4	Esp	Yes	101	23	23
5	Flight Forum	Yes	34	10	29
6	GDC Acht	Yes	53	17	32
7	Kabelbeemd	Yes	105	29	28
	Total		898	241	27

Table 1: Response according to different industrial parks in Eindhoven, the Netherlands

From the companies which did respond to the questionnaire, 31 percent (or 75 companies) was/were using a fiber infrastructure (see Table 2).

#	Industrial Park	Capacity Fiber network In*	Capacity Fiber network Out*	Companies	With Fiber connection	In %
1	Airport	32,56	14,2	24	13	54
2	De Hurk	30,81	47,95	114	36	32
3	De Kade			24	0	0
4	Esp	46,36	71,8	23	7	30
5	Flight Forum	4,04	4,34	10	2	20
6	GDC Acht	19,71	36,34	17	6	35
7	Kabelbeemd	1,14	0,42	29	11	38
	Total			241	75	31

(* Data provided by GVE)

Table 2: Companies with fiber connection in different industrial parks in Eindhoven, the Netherlands

With respect to sectors, most SMEs in the sample provided business services, followed by companies from different industrial sectors and transport/logistics (see Table 3).

	All firms	With broadband	In %	Fiber connection	In %	All Companies in Netherland with Broadband (in %) *
Industry	34	32	94	19	56	92
Utility	4	3	75	1	25	97
Wholesale	38	29	76	18	47	91
Retail	3	1	33	1	33	92
Transport/Logistics	5	5	100	3	60	91
Financial Services	9	6	67	3	33	89
Business Services	42	39	93	13	31	87
Other Services	3	2	67	2	67	94
Total	138	117	85	60	43	91

(* CBS 2009)

Table 3: Companies with fiber connection according to sector, the Netherlands

In order to examine the reasons why companies choose for ICT infrastructure and ICT services, a confirmatory factor analysis was used. It was expected that a number of variables can be related to specific factors (Jae-On & Mueller, 1994). According to the hypotheses, four factors were specified: 1) an open access factor (denoted as *OA*) which should measure the extent to which companies have chosen ICT infrastructure and ICT services based on open access; 2) an exploration factor (*Exp*) which should characterize the extent to which SMEs have been interested in new strategic opportunities opened up by new ICT technologies; 3) a critical mass factor (*CM*) responsible for measuring the extent to which user have collectively switched to the ICT services and ICT infrastructure and 4) a location factor (*Loc*) which should explain the extent to which users require access to different locations in their firm network. It was expected that these four factors will be sufficient to explain the incentives of SMEs to opt for advanced ICT services and ICT infrastructure.

For each of the items, a five point Likert scale was used. This enabled users to indicate the extent to which certain incentives have been important for them described in the item. The scale was ranging from "totally agree", "agree", "neutral", "disagree" to "totally disagree". Given that scale scores of these items possess sufficient reliability and validity, a vector of the averages for the factors can be used to profile an individual's actual level of incentives to adopt ICT infrastructure and ICT services. In order to get the factor loadings, a direct oblimin rotation has been used to make sure that the resulting factors are orthogonal and not depending on the method of rotation (Jae-On & Mueller, 1994).

Appendix 1 shows that the confirmatory factor analysis created four factors with sufficient internal consistency. The analysis was highly significant with a KMO measure of 0.733. For all four factors, the coefficient alpha was above 0.70 which has been considered as sufficient in a confirmatory factor analysis (Jae-On & Mueller, 1994). The factor loadings are similar to expectations.

In addition to the four factors derived from the confirmatory analysis, a number of control variables were introduced in the empirical model outlined above. Similar to a number of empirical studies, a size variable was used (denoted by *Siz*) based on total employment. The literature has shown that greater size of companies is related to higher probability of business ICT adoption (Forman & Goldfarb, 2005; B. Sadowski, et al., 2002). Furthermore, a variable for ICT expenditure indicated by *IExp* was used to control for total ICT investment. In line with previous research, higher ICT expenditure has been associated with higher probability of business ICT adoption (Forman & Goldfarb, 2005). As a last control variable, an indicator for the innovativeness of the firm (denoted by *Inn*) was created to account for the extent to which the firm has introduced a product or process innovation over the past two years. It is expected that innovativeness of the company will positively affect the probability that companies adopt business ICT (Polder, Leeuwen van, Mohnen, & Raymond, 2010) (for an overview over the variables used see Appendix 3).

Based on the four variables derived from the confirmatory analysis (*OA, Exp, CM, Loc*) and the three control variables (*Siz, IExp, INN*), the statistical model was developed. The underlying regression has been defined as:

$$_{ij} = ß_{ij} + ß_2 OA_{ij} + ß_3 Exp_{ij} + ß_4 CM_{ij} + ß_5 Loc_{ij} + ß_6\, Siz_{ij} + ß_7 IExp_{ij} + ß_8 Inn_{ij} + \varepsilon_{ij} \qquad (2)$$

where ß are the estimated coefficients and ε_{IJ} is a normally distributed error term (Greene, 2003). We observe

$$AccessUse_{ij} f(x) = \begin{cases} 1\ if\ AccessUse * & > 0 \\ 0 & otherwise \end{cases} \qquad (3)$$

where $InfraServ_{ij}$ = 1 represents the probability that a firm will adopt ICT infrastructure and/or services and $InfraServ_{ij}$ = 0 if it does not. In other words, there is a critical threshold of the index called *InfraServ** in a way that if $InfraServ_{ij}$ exceeds *InfraServ** the firm will access ICT infrastructure and ICT services otherwise it will not. The application of a logit model allows to estimate the probability that companies adopt ICT services and infrastructure conditional on a number of independent variables. This equation represents the utility from investing in ICT infrastructure and ICT services (The results of the analysis can be found in Table 4).

	ICT Infra Access (1)	ICT Infra Access (2)	ICT Infra Access & Services (3)	ICT Infra Access & Services (4)
Constant	-3.874 (0.918)	-3.821 (0.991)	-3.951 (0.923)	-4.200 (1.030)
Siz	0.332** (0.100)	0.342*** (0.108)	0.390*** (0.129)	0.427*** (0.142)
Inn	0.805 (0.565)	0.887 (0.595)	1.233* (0.607)	1.336* (0.651)
IExp	0.703* (0.316)	0.561 (0.108)	0.440* (0.234)	0.340 (0.257)
OA		0.603*** (0.184)		0.533*** (0.204)
Exp		-0.390* (0.174)		-0.299 (0.189)
CM		-0.194 (0.149)		-0.184 (0.175)
Loc		-0.022 (0.143)		-0.172 (0.177)
Observations	187	187	118	118
Sign.	0.000	0.000	0.000	0.000
MacFadden R2	0.139	0.267	0.221	0.332
-2LL	231.532	210.745	137.606	125.508
Chi-Square	20.336	41.123	21.061	33.259
Prediction	56.7	63.6	65.1	71.2

Note: *** = significant at 1 %; ** = significant at 5 %; * = significant at 10%. Standard errors are in parentheses. The estimates are robust maximum-likelihood logit estimates.

Table 4: Business ICT adoption according to choice

The Table 4 indicates the utility for adopting ICT infrastructure access only (regression 1 and 2) and Infrastructure access plus ICT services (regressions 3 and 4). The models are estimated using full information maximum likelihood. First, a restricted model was introduced based only on the control variables (regression 1 and 3) before a full model is presented including all variables under consideration (regression 2 and 4). As expected the explanatory power increases from the restricted models to the full models from 0.139 to 0.267 (regression 1 and 2) and from 0.221 to 0.332 (regression 3 and 4) indicating that the four variables derived from the confirmatory analysis adding to the explanatory power of the statistical model. In general, all models have been significant.

As expected, positive effects of open access (*OA*) on the probability of adoption advanced ICT infrastructure and ICT services by SMEs have been found in all four models. This is what has been expected and verifies hypothesis H3. In addition, the positive sign of the size variable (*Siz*) indicates positive effects of firm size of SMEs on the probability to adopt ICT infrastructure and ICT services. This is in line with previous research on firm size and ICT adoption (B. Sadowski, et al., 2002). Interestingly, the variable *Inn* indicating the innovativeness of company is only positive and significant for the joint adoption of ICT infrastructure and ICT services. Other variables expected to be positive according to the hypotheses developed remained insignificant (*CM*, Loc, *Exp*). This shows that there is no support for the hypotheses H2 and H4. With respect to the hypotheses on the effects of the locational factors on ICT business ICT adoption, the hypotheses H5a has to be rejected. As no significant effects of the locational factors on the joint adoption of ICT infrastructure and ICT services have been found, the hypothesis H5b had to be accepted.

Interestingly, the variable for Exploration (*Exp*) was even negative for infrastructure access only. The variable for IExp was positive in the restricted models but lost the significance in the full model.

Summary and Conclusions

The paper has shown that the probability of SMEs adopting Information and Communication Technologies is affected by SMEs if they expect open access, i.e. cheaper prices, better quality and more competitive providers. Furthermore, investment in ICT infrastructure is linked to the adoption of new ICT services. By using a discrete choice model to examine the joint decisions of companies to adopt ICT infrastructure and ICT services (Forman 2005), the paper uses data from a survey undertaken among 247 SMEs on different industrial parks in the Netherlands. The analysis shows that SMEs take open access factors into account in their choice to opt for new ICT infrastructure and new ICT services. The paper could not confirm hypotheses proposing that complementarity with establishment location, a critical mass of business users and the new strategic opportunities for SMEs are important determinants to explain the adoption behaviour of SMEs with respect to ICT infrastructure and ICT services.

Limitations of the analysis are related to the cross-sectional nature of the data which make it difficult to assess the effects of prior ICT investment on adoption of ICT infrastructure and ICT services in greater detail.

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Appendix 1: The distribution of ICT Services according to similar studies

	Total* (in % of all companies)	Own system (in % of all companies)	CBS (2009)**	Koellinger (2008) (in %)
E-learning	35 (26)	13 (10)	-	8
Customer Relationship Management (CRM) system	82 (60)	67 (48)	72	9
E-purchasing	55 (40)	37 (27)	70	38
E-sales	45 (33)	33 (24)	-	14
Enterprise Resource Planning (ERP) system	58 (42)	49 (35)	54**	9
Knowledge Management Systems (KMS)	37 (27)	33 (15)	-	6
Supply Chain Management (SCM) Systems	27 (19)	20 (14)	19***	3
Financial Administration	108 (78)	82 (59)	-	-
Total	138	138	67000	7302

(* includes own, hosted and outsourced systems, ** CBS 2009, *** SMEs larger than 250 employees)

Appendix 2: Choice for ICT Infrastructure and ICT services: Constructs and loadings

Factor items	Factor Loadings
Open Access factor (Alpha – 0.846)	
Monthly tariffs	0.736
Access costs	0.740
Quality of service provision	0.770
Access of existing provider on the industrial park	0.613
Number of service providers	0.665
Number of services provided	0.615
Perspective of cost reductions of new services	0.685
Exploration factor (Alpha – 0.772)	
ICT pilot projects are necessary to get more information	0.747
New ICT applications provide more options for organizations	0.850
New ICT application the competitive position of companies	0.798
New ICT applications make it more difficult for competitors to imitate	0.543
New ICT applications require new ICT competencies within companies	0.720
Time is necessary to learn new ICT applications	0.688
Critical Mass factor (Alpha – 0.833)	
Coverage of industrial park	0.759
Choice of other companies in the industrial park to opt for fiber	0.758
Unrestricted choice for other service providers	0.607
Relationship with park management at industrial park	0.757
Possible collective service procurement for companies at industrial park	0.863
Locational factor (Alpha – 0.705)	
Links with companies or subsidiaries at own or linked industrial park	0.771
Links with companies at locations at other locations	0.852

Appendix 3 Variables in the empirical model

Variable	Interpretation	Mean	SD
InfraServ	4Extent to which adopt ICT infrastructure and/or advanced ICT services	0.41	0.49
Siz	Size related to the total employment in the firm	4.64	1.69
IExp	Expenditure on ICT in relation to total turnover of the firm in percent	1.76	0.46
Inn	Innovativeness of the firm based on the extent to which the firm has introduced a product, process or organizational innovation over the past two years	0.84	0.27
CM	Critical Mass factor indicates the extent to which the decision of other firms have been important for the adoption decision	0.13	0.83
OA	Open Access factor denotes the extent to which cheaper prices, higher quality, more competition has been important for adoption decisions	0.12	0.82
Exp	Exploration factor indicates the extent to which firms considered the adoption of new ICT services and ICT infrastructure as providing them with new strategic opportunities	0.12	1.22
Loc	Location factor indicates the extent to which firms considered the adoption of ICT services and ICT infrastructure as depending on links to other locations of affiliated firms, etc.	0.12	1.19

Appendix 4: Correlation Matrix

		OA	Exp	Loc	CM	Inn	Size	IExp	Use1	Use
OA	Pearson Correlation	1	-.120	.223**	.049	.024	.060	.018	.266**	.267**
	Sig. (2-tailed)		.059	.000	.440	.711	.345	.779	.000	.000
Exp	Pearson Correlation	-.120	1	-.127*	-.096	.030	-.040	-.207**	-.223**	-.218**
	Sig. (2-tailed)	.059		.045	.133	.643	.530	.001	.002	.001
Loc	Pearson Correlation	.223**	-.127*	1	.065	-.036	-.005	-.070	-.012	.053
	Sig. (2-tailed)	.000	.045		.305	.572	.938	.273	.865	.407
CM	Pearson Correlation	.049	-.096	.065	1	-.091	-.052	.102	.001	-.028
	Sig. (2-tailed)	.440	.133	.305		.154	.412	.110	.991	.666
Inn	Pearson Correlation	.024	.030	-.036	-.091	1	.095	.050	.134	.159*
	Sig. (2-tailed)	.711	.643	.572	.154		.137	.429	.068	.012
Siz	Pearson Correlation	.060	-.040	-.005	-.052	.095	1	-.005	.259**	.225**
	Sig. (2-tailed)	.345	.530	.938	.412	.137		.934	.000	.000
IExp	Pearson Correlation	.018	-.207**	-.070	.102	.050	-.005	1	.161*	.208**
	Sig. (2-tailed)	.779	.001	.273	.110	.429	.934		.027	.001
InfraServ	Pearson Correlation	.266**	-.223**	-.012	.001	.134	.259**	.161*	1	.769**
	Sig. (2-tailed)	.000	.002	.865	.991	.068	.000	.027		.000
Infra	Pearson Correlation	.267**	-.218**	.053	-.028	.159*	.225**	.208**	.769**	1
	Sig. (2-tailed)	.000	.001	.407	.666	.012	.000	.001	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).