Estimation Models for the Adoption and Use of Information Technology:

Internet-Related Technologies at Firm Level in the Portuguese and European Context

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Abstract

Nowadays it is consensual that information technology (IT) has a significant effect in the productivity of firms. However, this contribution can only be accomplished if, and when, the new IT are widely spread and used. Understanding the determinants of adoption and use is a fundamental question, not only for economists, but also for society in general.

With this dissertation we intend to contribute to a better understanding of the determinants of adoption and use of IT, particularly Internet-related technologies, at firm level; for that we developed eight studies. The first one (Chapter 2) is a review of literature of IT adoption models at firm level. We also developed four studies in the Portuguese context. The first was a comparison between the determinants of adoption of a simple technology (web site) and a complex technology (e-commerce) (Chapter 3). The second was a comparison of the determinants of web site adoption in small and large firms (Chapter 4). In the third study, we analysed the factors that explain three levels of adoption (Internet, web site and e-commerce) in small firms (Chapter 5). In the last study in the Portuguese context, we developed a model for understanding Internet business solutions (Chapter 6). For the European context, we developed three studies. In the first study we characterized e-business by clusters in EU27 context (Chapter 7). In the second, we compared the determinants of e-business adoption in tourism and telecommunications industries, by a model that combined two theoretical models (technology, organization, and environment (TOE) model and the Iacovou et al. model) (Chapter 8). In the last study (Chapter 9) of the dissertation, we presented an in depth understanding of business-to-business (B2B) e-commerce adoption and usage in 27 European countries. The research was informed by contextualist theory to organize our proposed research model.

In epistemological terms, we adopted a posture characteristic of positivism. With regard to research methodologies we used the deductive method. The theoretical framework of initial studies was base on the TOE framework. The penultimate study combined TOE and Iacovou et al. models, and the last study used the theory of contextualist.

We concluded that the TOE framework is a solid theoretical basis, with consistent empirical support, and the potential of application to information systems (IS) adoption. This model is a good theoretical starting point for our work. The first important result is that Internet, web site and e-commerce adoption decisions are taken at different stages. Moreover, the factors have distinct effects on the different stage. The size of the firms is a variable that has a controversial impact on IT adoption decision, because some empirical studies indicate that there is a positive relationship, while other studies have evidence against this positive relationship. In our context it is an important factor. Moreover, comparing “directly” large and small firms, we conclude that these two groups behave differently and large firms tend to have advantages in early stages (Internet and web site), but they face critical challenges in later ones (e-commerce, B2B e-commerce, and e-business). Based on European data, the industry context seems to be more important than the country context. Furthermore, the relative importance of all drivers for e-business adoption in the telecommunications industry differs from the tourism industry, the only exception is competitive pressure. A new conceptual approach to IT adoption models based on contextualist theory seems to be a valid approach, namely on the B2B e-commerce adoption and usage.

Keywords: Information technology (IT); IT adoption; technology-organization-environment (TOE); Internet; web site; e-commerce; e-business; B2B e-commerce; positivism; Europe; Portugal.

Resumo

Actualmente é consensual que as tecnologias de informação (TI) têm um efeito significativo na produtividade das empresas. Contudo, esta contribuição pode apenas ser conseguida se, e quando, as novas TI estiverem largamente difundidas e em uso. Compreender os determinantes da adopção e uso é uma questão fundamental, não apenas para economistas, mas também para a sociedade em geral.

Com esta dissertação pretendemos contribuir para uma melhor compreensão dos determinantes da adopção e uso das TI, particularmente tecnologias relacionadas com a Internet, ao nível das empresas, para tal desenvolvemos oito estudos. O primeiro (Capítulo 2) é uma revisão da literatura dos modelos de adopção de TI ao nível da empresa. Desenvolvemos também quatro estudos no contexto português. O primeiro apresentou uma comparação entre os determinantes de adopção de uma tecnologia simples (web site) e uma tecnologia complexa (e-commerce) (Capítulo 3). O segundo comparou os determinantes de adopção do web site entre as pequenas e grandes empresas (Capítulo 4). No terceiro estudo, analisámos os factores que explicam três níveis de adopção (Internet, web site e e-commerce) nas pequenas empresas (Capítulo 5). No último estudo no contexto português, desenvolvemos um modelo para compreender as soluções de negócio através da Internet (Capítulo 6). Para o contexto europeu, desenvolvemos três estudos. No primeiro estudo caracterizámos o e-business por clusters no contexto dos 27 países da EU (Capítulo 7). No segundo, comparámos os determinantes de adopção de e-business nos sectores do turismo e das telecomunicações, através de um modelo que combinou dois modelos teóricos (o modelo de tecnologia, organização e ambiente (TOE) e o modelo de Iacovou et al.) (Capítulo 8). No último estudo (Capítulo 9) da dissertação, apresentámos uma análise exaustiva da adopção e uso do B2B e-commerce em 27 países europeus. O modelo de investigação proposto foi baseado na teoria do contextualismo.

Em termos epistemológicos, adoptámos uma postura característica do positivismo. No que diz respeito às metodologias de investigação usámos o método dedutivo. Os estudos

iniciais basearam-se no contexto TOE. O penúltimo estudo combinou o modelo TOE e o modelo de Iacovou et al., o último estudo usou a teoria do contextualismo.

Concluímos que o contexto TOE é uma base teórica sólida, com apoio empírico consistente, e um potencial de aplicação à adopção de sistemas de informação (SI). Este modelo é um bom ponto de partida teórico para o nosso trabalho. O primeiro resultado importante é que as decisões de adopção da Internet, do Web site e do e-commerce são realizadas em diferentes fases. Além disso, os factores têm efeitos distintos nas diferentes fases. A dimensão das empresas é uma variável que tem um impacto controverso na decisão de adopção de TI, porque alguns estudos empíricos indicam que existe uma relação positiva, ao passo que outros estudos apresentam evidências contra esta relação positiva. No nosso contexto é um factor importante. Além disso, comparando "directamente" pequenas e grandes empresas, concluímos que estes dois grupos se comportam de forma diferente, as grandes empresas tendem a ter vantagens nas fases inicias (Internet e web site), mas enfrentam desafios críticos em fases mais avançadas (e-commerce, B2B e-commerce e e-business). Com base em dados europeus, o sector de actividade parece ser mais importante que o país a que a empresa pertence. Além disso, a importância relativa de todos os determinantes para a adopção de e-business no sector das telecomunicações difere do sector do turismo, a única excepção é a pressão competitiva. Uma nova abordagem conceptual aos modelos de adopção de TI com base na teoria do contextualismo parece ser uma abordagem válida, nomeadamente em termos de adopção e uso do B2B e-commerce.

Palavras-chave: Tecnologias de informação (TI); adopção de TI; tecnologia-organização-ambiente (TOE); Internet; web site; e-commerce; e-business; B2B e-commerce; positivismo; Europa; Portugal.

Publications

List of publication resulting from this dissertation

Papers:

Oliveira, T. and M. F. Martins (2010) "Firms Patterns of e-Business Adoption: Evidence for the European Union- 27," *The Electronic Journal Information Systems Evaluation* (13) 1, pp. 47-56. Selected from ECIME 2009.

Oliveira, T. and M. F. Martins (2010) “Understanding e-business adoption across industries in European countries,” *Industrial Management & Data Systems* (110) 9, pp. 1337-1354.

Oliveira, T. & Martins, M. F. (2011) Information Technology Adoption Models at Firm Level: Review of Literature. *The Electronic Journal Information Systems Evaluation* (in press). Selected from ECIME 2010.

Oliveira, T. and M. F. Martins “Determinant Factors of Internet Business Solutions Adoption the Case of Portuguese firms,” *Applied Economics Letters* (conditional accepted – minor revision).

Oliveira, T. and G. Dhillon “Understanding B2B e-Commerce Adoption and Usage in Europe: Findings from 27 European Countries,” *Journal of the Association for Information Systems* (submitted).

ISI Proceedings:

Oliveira, T. and M. F. O. Martins (2008) A comparison of web site adoption in small and large Portuguese firms, in *Ice-B 2008: Proceedings of the International Conference on E-Business*, pp. 370-377.

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Oliveira, T. and M. F. Martins (2009) Firms Patterns of e-Business Adoption: Evidence for the European Union-27, in D. Remenyi, J. Ljungberg, and K. Grunden (Eds.) *Proceedings of the 3rd European Conference on Information Management and Evaluation*, Gothenburg, pp. 371-379.

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Oliveira, T. and M. F. Martins (2010) Information Technology Adoption Models at firm Level: Review of Literature, in D. Remenyi, J. Ljungberg, and K. Grunden (Eds.) *Proceedings of the 4th European Conference on Information Management and Evaluation*, Lisbon, pp. 312-323.

Others proceedings:

Oliveira, T. (2008) Bivariate probit model with sample selection - Determinants of the Adoption of Electronic Commerce (EC). Modelo Probit Bivariado com Selecção - Factores Determinantes da Adopção do Comércio Electrónico (CE), in SPE edition M. M. Hill, M. A. Ferreira, J. G. Dias, M. d. F. Salgueiro et al. (Eds.) *Actas do XV Congresso Anual da Sociedade Portuguesa de Estatística,* Lisboa, pp. 401-414.

Oliveira, T. and M. F. Martins (2010) Estimation Model for the Adoption and Use of Information Technology in the Portuguese and European Context, in, vol. II Á. Rocha, C. F. Sexto, L. P. Reis, and M. P. Cota (Eds.) *Actas de la 5ª Conferencia Ibérica de Sistemas y Tecnologías de Información*, Santiago de Compostela, pp. 434-437.

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Para:

a Mãe

o Pai

a Sara

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Abbreviations

AITSF – Access to the IT System of the Firm

AUC – Area under the Curve

B2B – Business-to-Business

B2C – Business-to-Customer

CA – Cluster Analysis

CATI - Computer-Aided Telephone Interview

CFA – Confirmatory Factor Analyses

CP – Competitive Pressure

DOI – Diffusion of Innovations

EBOEB – Expected Benefits and Obstacles of e-business

ECOMP – E-commerce Competitive Pressure

EDI – Electronic Data Interchange

ERP – Enterprise Resource Planning

EU – European Union

EU15 – 15 European Union countries

EU27 – 27 European Union countries

FA – Factor Analysis

IBS – Internet Business Solutions

ICT – Information and Communication Technology(ies)

IEN – Internet and e-mail Norms

INE – National Institute of Statistics

IOSs – Interorganizational Systems

IP – Internet Penetration

IPSIP – Improved Products or Services or Internal Processes

IT – Information Technology(ies)

ITTP – IT Training Programs

IS – Information Systems

IUTICE – The Use of Communication and Information Technologies in Firms

KMO – Kaiser-Meyer-Olkin

KMS – Knowledge Management Systems

KR-20 – Kuder-Richardson Formula 20

LAN – Local Area Network

MCA – Multiple Correspondence Analyses

MRP – Material Requirements Planning

OLS – Ordinary Least Squares

PBEC – Perceived Benefits of Electronic Correspondence

PLS – Partial Least Squares

SA – Security Applications

SAS – Statistical Analysis System

SEM – Structural Equation Modelling

SER – Service Sector

SIZE – Firm Size

SMEs – Small and Medium-sized Enterprises

TAM – Technology Acceptance Model

TI – Technology Integration

TOE – Technology, Organization, and Environment

TPB – Theory of Planned Behaviour

TR – Technology Readiness

UTAUT – Unified Theory of Acceptance and Use of Technology

VIF – Variance Inflation Factor

WAN – Wide Area Network

WEBP – Web site Competitive Pressure

As Day [1998] wrote:

“The goal of scientific research is publication… A scientific experiment, no matter how spectacular the results, is not completed until the results are published.”

Chapter 1 - Introduction

1.1. Motivation

Today, information technology (IT) is universally regarded as an essential tool in enhancing the competitiveness of a country's economy. Hence, the XVII Portuguese Constitutional Government recognized the importance of explicitly defining a technology plan for Portugal. As pointed out in that programme, "Our backwardness in terms of IT use negatively penalizes our overall competitiveness index" [Portuguesa, 2005]. In this context, it is extremely important to identify the drivers of Portuguese firms to adopt and use IT. This is not only a problem of Portuguese firms. The European Commission [Communities, 2005] claims that more efforts are needed to improve e-business in European firms if the Lisbon targets of competitiveness are to be achieved. Under the pressure of their main international competitors, European firms need to find new opportunities to reduce costs and improve performance. IT is an important tool to increase firms' competitiveness, but this can only be achieved if firms adopt and use IT. Thus, it is fundamental to understand IT adoption by Portuguese and European firms. In order to understand the determinants of adoption of IT, particularly Internet-related technologies, in the Portuguese and European context, this study will use a quantitative approach. In this dissertation, there are four main motivating factors:

- The issue of IT adoption is a key theme in the current Portuguese national ("Technology Shock") and European ("i2010") context;
- There is consensus today that IT has significant effects on the productivity of firms [Black and Lynch, 2001, Brynjolfsson and Hitt, 2000]. These effects will only be realized if, and when, IT are widely spread and used [Pohjola, 2003]. It is fundamental to understand the determinants of adoption of IT;
- The importance of IT adoption in the national and global economy;
- An understanding of which factors contribute the most to IT adoption in Portugal and throughout Europe will not only enable the development of policies to promote it but also the development of an overview of the rationale behind IT adoption.

1.2. Adoption theories in information systems

There are several theories of adoption in information systems (IS) [Wade, 2009]. The most used theories are: technology acceptance model (TAM) [Davis et al., 1989], theory of planned behaviour (TPB) [Ajzen, 1985, Ajzen, 1991], unified theory of acceptance and use of technology (UTAUT) [Venkatesh et al., 2003], diffusion of innovations (DOI) [Rogers, 1995], technology, organization, and environment (TOE) theory [Tornatzky and Fleischer, 1990], institutional theory, and the Iacovou et al. [1995] model. In this dissertation, in Chapter 2, we will develop only DOI, TOE, institutional theory, and Iacovou et al. [1995] model because they are the only ones that operate at the firm level. The TAM, TPB, and UTAUT are at the individual level.

1.3. Research focus

The focus of this dissertation is on understanding the drivers for IT adoption, particularly Internet-related technologies, such as: Internet, web site, e-commerce, business-to-business (B2B) e-commerce, and e-business adoption (the inside of the dashed rectangle of Figure 1.1). We are interested in developing the first two phases of the process. The impact of IT adoption (firms' performance) is not the issue of interest.

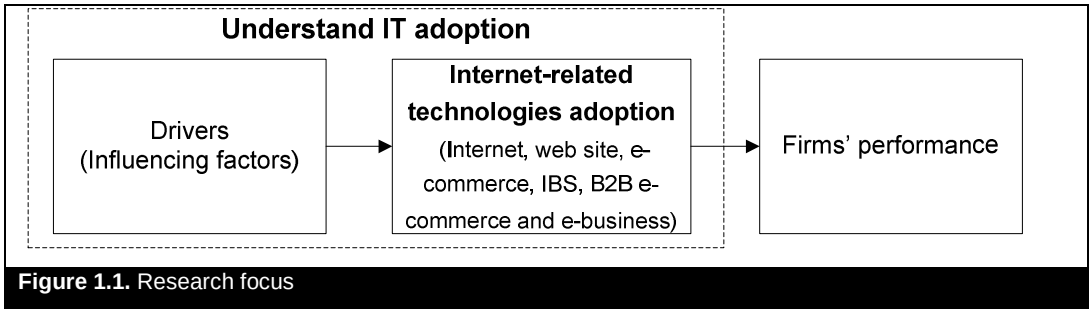

Figure 1.1. Research focus

We define the following Internet-related technologies adoption:

- Internet, if firms have access to the Internet;
- web site, if firms own a web site;
- e-commerce, if firms are doing sales online.
- B2B e-commerce, if firms are buying and selling products and services amongst businesses as defined by Teo and Ranganathan [2004];

- E-business, if firms are doing “transactions along the value chain (including purchasing from upstream suppliers and selling products and services to downstream customers) by using the Internet platform (e.g. TCP/IP, HTTP, XML) in conjunction with the existing IT infrastructure” as defined by Zhu et al. [2006a, page 601].
- Internet business solutions (IBS) was defined according to Varian et al.’s [2002] terminology and is a set of IT that includes: firms that have web site, customer development/e-marketing, customer service & support, and digital e-commerce.

To understand IT adoption, particularly Internet-related technologies adoption, it is critical to study different contexts, industries, firm size, and theoretical frameworks. We expect that this dissertation will contribute to improving knowledge in IT adoption. Figure 1.2 presents the different topics covered in our approach. We develop four studies for the Portuguese context and three more for the 27 European Union countries (EU27) contexts.

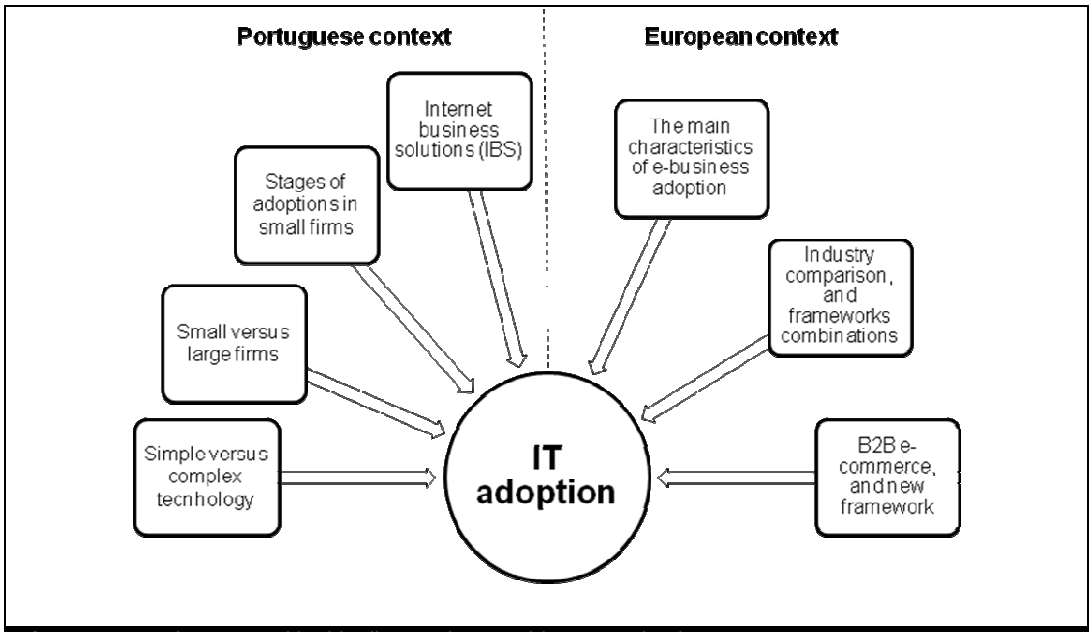

Figure 1.2. Topics covered in this dissertation to address IT adoption

1.4. Goals

The main goal of this dissertation is to understand IT adoption, particularly Internet-related technologies adoption, by firms. For that we separate our aims by chapter. In Chapter 2 we will review the main IT adoption models at firm level that have been proposed in the literature.

In the third chapter we analyse determinants of web site and e-commerce adoption in Portugal. The main purposes are the following: to examine the importance of TOE-related factors as fundamental determinants of web site and e-commerce adoption; to analyse the extent to which there are significant differences in the factors driving these two types of IT.

In the fourth chapter we compare web site adoption in small and large Portuguese firms. The two main purposes are the following: to examine the importance of TOE-related factors as fundamental determinants of web site adoption for small and large firms, and to compare the relative importance of such factors.

In the fifth chapter we concentrate our attention on small firms. The main purposes are the following: to examine the importance of TOE-related factors as fundamental determinants of Internet (first phase), web site (second phase), and e-commerce (third phase) adoption; to analyse the extent to which the drivers of TOE factors vary with the phase of adoption.

In the sixth chapter we explore the determinant factors of IBS adoption for Portuguese firms. The purposes are the following: to develop an integrated model of IBS adoption, taking into account the sample selection issue; to determine the major drivers of IBS adoption at the two adoption stages and the extent to which their magnitudes differ with the stage of the adoption.

In the seventh chapter we analyse firms' patterns of e-business adoption: evidence for the EU27. The main objectives are: to identify distinct clusters of e-business adoption; to characterize the pattern of e-business adoption by firms across these clusters; and to understand the extent to which industry e-business adoption characteristics are more or less important than country-specific characteristics.

In the eighth chapter we analyse e-business adoption across sectors in Europe. Recent findings reveal that in the European context the most important is characterizing e-business adoption is the industry and its specific characteristics, and not the country to which the firms belong [Oliveira and Martins, 2010a]. For this reason, it is important to understand e-business adoption by industry throughout the EU 27 context. The purpose is to identify the factors that explain the variation in e-business adoption by two different industries (telecommunications (telco), and tourism).

In the ninth chapter we analyze B2B e-commerce adoption and usage in Europe. By 2012, there will be more than 1 billion online buyers worldwide, making B2C e-commerce transactions worth $1.2 trillion. Although, B2B e-commerce, which has been identified as an emerging trend [Claycomb et al., 2005], it will be ten times larger, totaling $12.4 trillion worldwide in 2012 [IDC, 2008]. This is one of our reasons for focusing this chapter only on B2B e-commerce. The other reason is that several studies [Gibbs and Kraemer, 2004, Hsu et al., 2006, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b] tend to aggregate B2B and B2C e-commerce, believing that both have the same drivers, which may not be correct. The purpose of this study is to understand B2B e-commerce adoption and usage in European countries, and for this we use an adaptation of the theory of contextualist by Pettigrew and Whipp [1991] to organize our initial theoretical/conceptual model.

1.5. Methods

The diversified nature of the objectives and conceptual frameworks of this dissertation demand a combination of several methodological approaches. In philosophical perspectives, based on Caldeira [2000] and taking into account the main characteristics of positivism, realism and interpretivism, we can consider that this work presents characteristics very consistent with those of positivism. With regard to research methodologies we used the deductive approaches [Saunders et al., 2009]. The theoretical framework and quantitative approach will be described below.

1.5.1. Theoretical frameworks

The first five studies are based on the TOE framework (Chapters 3 through 7). Chapter 8 is based on a combination of TOE, the Tornatzky and Fleischer [1990] model, and the Iacovou et al. [1995] model. The last study (Chapter 9) is based on the theory of contextualist by Pettigrew and Whipp [1991]. We suggest a new research model to understand B2B e-commerce adoption and usage.

1.5.2. Quantitative research methods

In Chapter 3 we use Portuguese data (firms with more than 9 employees, n=2,626) to analyse web site and e-commerce adoption. Taking into account the fact that e-commerce adoption is observed only for those firms that own a web site, we use a bivariate probit model with sample selectivity. The hypothesis of uncorrelated errors ($\rho=0$) is not rejected, so we estimate two sequential models [Greene, 2008], one probit regression for web site adoption and another probit regression for e-commerce adoption only for firms that adopt web site.

In Chapter 4 we also use Portuguese data (large firms with more than 249 employees n=637, and small firms with fewer than 50 employees n=3,155). In this study we have a binary decision if firms decided to adopt a web site or not. For that we use a probit regression. We estimate one probit regression for small firms and another for large firms, and we compare the marginal effects of both regressions.

In Chapter 5 we analyse only small Portuguese firms (firm with fewer than 50 employees, n=3,155) and we have a decision at three adoption stages (Internet, web site, and e-commerce). For that we use a sequential logistic regression and we compare the marginal effects of the three regressions.

In Chapter 6 we also use Portuguese data (firms with more than 9 employees, n=2,626) to define two adoption stages: first stage - web site adoption decision, and second stage - level of IBS adoption decision. Once more we conclude that the errors are not correlated, so we specify two sequential regressions. We estimate one probit regression for web site adoption with all firms and one ordered probit regression for the

level of IBS only with firms that had adopted web site. We also compute the marginal effects for both regressions.

In Chapter 7 we use EU27 data (n=6,964). As a first step, we group the items to reduce the number of variables of the survey; for that we apply a factor analysis (FA). Then, to determine homogenous groups of firms in terms of e-business adoption, we apply a cluster analysis (CA). At the end, we compare the clusters' patterns using statistical tests.

In Chapter 8 we also use EU27 data (telco n=1,019 and tourism n=1,440). As a first step, we also perform an FA. We estimate three different logistic regressions to test the research model: one for the full sample and two for industries (telco and tourism). We also compute marginal effects of independent variables and use a two-tailed test to estimate if there are statistically significant differences across industries.

In the last study, we also use EU27 data (n=6,973) and we perform an FA. The dependent variables are B2B e-commerce adoption and usage. For B2B e-commerce adoption we apply a logistic regression. For B2B e-commerce usage, which is an ordered variable, an ordered logistic regression is developed. CA is used to identify how many groups of countries are with similar information communication technology (ICT) patterns. At the end, we also estimate a logistic regression for B2B e-commerce adoption and an ordered logistic regression for B2B e-commerce usage for all groups of countries obtained by cluster analysis. This analysis allows us to validate our research model in different contexts of ICT readiness.

1.6. Path of research

This dissertation gathers the findings of several research projects, reported separately, including journals with double blind review process, one proceeding in a national conference, six proceedings in international conferences (five indexed in ISI web of knowledge conferences), two paper in an international journal, and two more papers currently submitted in international journals.

Chapter 2 addresses the literature review of adoption and use theories in IS, where we explain the adoption theories used in IS at firm level, and also make an in-depth analysis of the TOE framework.

In the initial stage we presented a statistical approach for understanding web site and e-commerce adoption for Portuguese firms with 2005 data [Oliveira, 2008]. It was the first scientific contribution within this dissertation. This was the first step to make Chapter 3, the final work was presented in Milan in an International Conference on e-Business (ICE-B 2009) [Oliveira and Martins, 2009a].

Chapter 4 was presented in Porto in an International Conference on e-Business (ICE-B 2008) [Oliveira and Martins, 2008]. Chapter 5 was presented in Gothenburg in the 3rd European Conference on Information Management and Evaluation (ECIME 2009) [Martins and Oliveira, 2009]. Chapter 6 is the last paper with Portuguese data, and has been in the submission process since September 2008.

Chapter 7 is the first within the EU27 context. It was also presented in ECIME 2009 [Oliveira and Martins, 2009b] and selected for Electronic Journal of Information Systems Evaluation [Oliveira and Martins, 2010a]. Based on the findings of this chapter, we made Chapter 8. This work was accepted for publication in Industrial Management & Data Systems [Oliveira and Martins, 2010b].

As a result of the doctoral program coursework, the author met Professor Gurpreet Dhillon, showing him the initial draft of Chapter 9, and asked him to accept the challenge of improving this chapter. This work is in the review process in an international journal.

In the last chapter are the conclusions, i.e. the summary of conclusions presented in Chapters 2 to 9. The majority of the chapters were accepted or are in the submission process to conferences and/or journals, which can be considered a positive indication of quality of the work developed.

Chapter 2 – Information technology adoption models at firm level: review of literature

2.1. Introduction

These days, information technology (IT) is universally regarded as an essential tool in enhancing the competitiveness of the economy of a country. It is commonly accepted today that IT has significant effects on the productivity of firms. These effects will only be fully realized if, and when, IT are widely spread and used. It is crucial, therefore, to understand the determinants of IT adoption and the theoretical models that have arisen addressing IT adoption. There are not many reviews of literature about the comparison of IT adoption models at the individual level, and to the best of our knowledge there are a smaller number at the firm level. This review will fill this gap.

In this study, we review theories for adoption models at the firm level used in information systems (IS) literature and discuss two prominent models, presented in Section 2. The two models reviewed are: diffusion of innovation (DOI) [Rogers, 1995]; and the technology, organization, and environment (TOE) framework [Tornatzky and Fleischer, 1990], since most studies on IT adoption at the firm level are derived from theories such as these two [Chong et al., 2009]. Section 3 presents an extensive analysis of the TOE framework, analysing the studies that used only this theory and the studies that combine the TOE framework with other theories such as: DOI, institutional theory, and the Iacovou *et al.* [1995] model. In the last section, we present the conclusions.

2.2. Models of IT adoption

There are many theories used in IS research [Wade, 2009]. We are interested only in theories about technology adoption. The most used theories are the technology acceptance model (TAM) [Davis, 1986, Davis, 1989, Davis et al., 1989], theory of planned behaviour (TPB) [Ajzen, 1985, Ajzen, 1991], unified theory of acceptance and use of technology (UTAUT) [Venkatesh et al., 2003], DOI [Rogers, 1995], and the TOE

framework [Tornatzky and Fleischer, 1990]. We will develop only the DOI, and especially the TOE framework, because they are the only ones that are at the firm level. The TAM, TPB and UTAUT are at the individual level.

2.2.1. DOI

DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system [Rogers, 1995]. Individuals are seen as possessing different degrees of willingness to adopt innovations, and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time [Rogers, 1995]. Breaking this normal distribution into segments leads to the segregation of individuals into the following five categories of individual innovativeness (from earliest to latest adopters): innovators, early adopters, early majority, late majority, laggards [Rogers, 1995]. The innovation process in organizations is much more complex. It generally involves a number of individuals, perhaps including both supporters and opponents of the new idea, each of whom plays a role in the innovation-decision.

Based on DOI theory at firm level [Rogers, 1995], innovativeness is related to such independent variables as individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization (Figure 2.1). (a) *Individual characteristics* describes the leader attitude toward change. (b) *Internal characteristics of organizational structure* includes observations according to Rogers [1995] whereby: “centralization is the degree to which power and control in a system are concentrated in the hands of a relatively few individuals”; “complexity is the degree to which an organization’s members possess a relatively high level of knowledge and expertise”; “formalization is the degree to which an organization emphasizes its members’ following rules and procedures”; “interconnectedness is the degree to which the units in a social system are linked by interpersonal networks”; “organizational slack is the degree to which uncommitted resources are available to an organization”; “size is the number of employees of the organization”. (c) *External characteristics of organizational* refers to system openness.

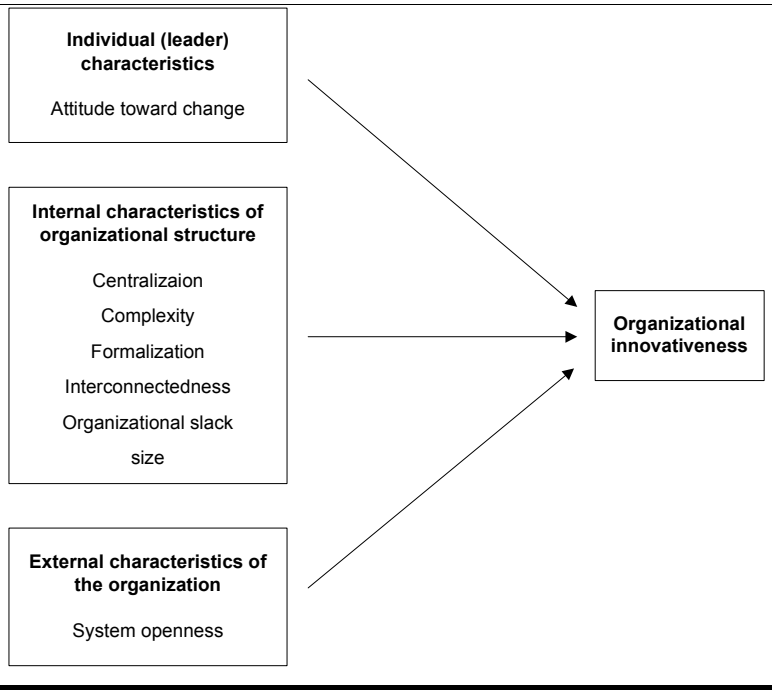

Figure 2.1. Diffusion of innovations [Rogers, 1995]

Since the early applications of DOI to IS research, the theory has been applied and adapted in various ways. Some examples are presented in Table 2.1.

Table 2.1: Some studies based on DOI theory [Rogers, 1995]

IT Adoption	Author(s)
Material requirements planning (MRP)	[Cooper and Zmud, 1990]
IS adoption (uses at least one major software application: accounting; inventory control; sales; purchasing; personnel and payroll; CAD/CAM; EDI; MRP), and extent of IS (number of personal computers and the number of software applications)	[Thong, 1999]
Intranet	[Eder and Igbaria, 2001]
Web site	[Bradford and Florin, 2003]
Enterprise resource planning (ERP)	[Beatty et al., 2001]
E-procurement	[Li, 2008]
E-business	[Zhu et al., 2006a]
E-business	[Hsu et al., 2006]

2.2.2. Technology, organization, and environment context

The TOE framework was developed in 1990 [Tornatzky and Fleischer, 1990]. It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context (Figure 2.2). (a) *Technological context* describes both the internal and external technologies relevant to the firm. This

includes current practices and equipment internal to the firm [Starbuck, 1976], as well as the set of available technologies external to the firm [Hage, 1980, Khandwalla, 1970, Thompson, 1967]. (b) *Organizational context* refers to descriptive measures about the organization such as scope, size, and managerial structure. (c) *Environmental context* is the arena in which a firm conducts its business—its industry, competitors, and dealings with the government [Tornatzky and Fleischer, 1990].

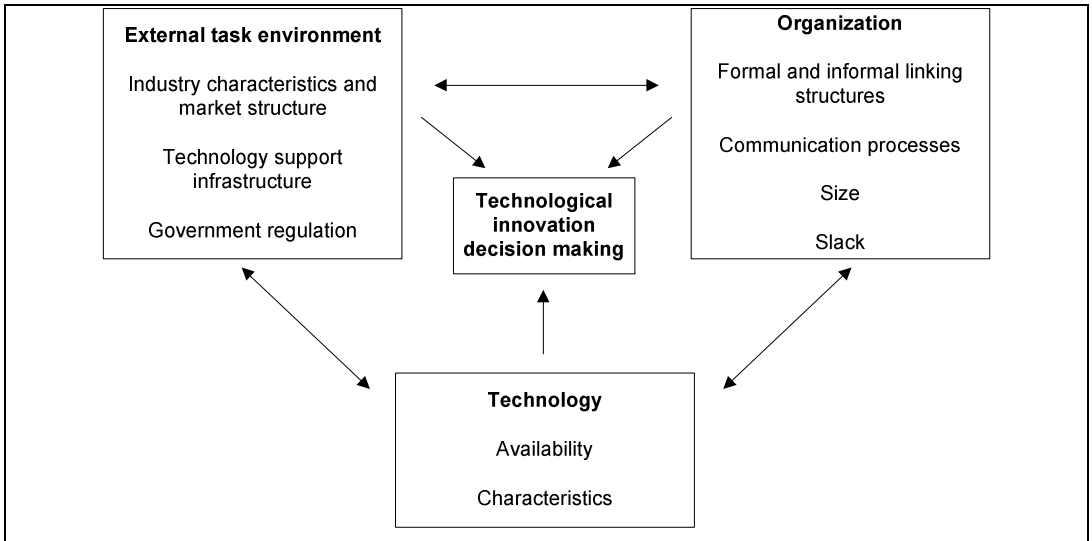

Figure 2.2. Technology, organization, and environment framework [Tornatzky and Fleischer, 1990]

The TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation. The TOE framework has a solid theoretical basis, consistent empirical support (see Tables 2.2 and 2.3), and the potential of application to IS innovation domains, though specific factors identified within the three contexts may vary across different studies.

This framework is consistent with the DOI theory, in which Rogers [1995] emphasized individual characteristics, and both the internal and external characteristics of the organization, as drivers for organizational innovativeness. These are identical to the technology and organization context of the TOE framework, but the TOE framework also includes a new and important component, environment context. The environment context presents both constraints and opportunities for technological innovation. The TOE framework makes Rogers' innovation diffusion theory better able to explain intra-firm innovation diffusion [Hsu et al., 2006]. Thus, the next Section analyses the studies that adopted TOE framework.

2.3. Empirical literature of the TOE framework

We thoroughly analyse the TOE framework and present an exhaustive description of studies that draw on this theory. Section 3.1 discusses the relevant papers that used only the TOE framework as a theoretical model (Table 2.2), while Section 3.2 includes some papers that combined the TOE framework with other theoretical models (Table 2.3).

2.3.1. Studies that used only the TOE framework

Several authors used only the TOE framework to understand different IT adoptions, such as: electronic data interchange (EDI) [Kuan and Chau, 2001]; open systems [Chau and Tam, 1997]; web site [Oliveira and Martins, 2008]; e-commerce [Liu, 2008, Martins and Oliveira, 2009, Oliveira and Martins, 2009a]; enterprise resource planning (ERP) [Pan and Jang, 2008]; business to business (B2B) e-commerce [Teo et al., 2006]; e-business [Lin and Lin, 2008, Oliveira and Martins, 2010a, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b]; knowledge management systems (KMS) [Lee et al., 2009]. The variables analysed, methods used, data, and context of empirical studies are presented in Table 2.2.

Table 2.2: Some studies based only on Tornatzky and Fleischer [1990]

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
EDI	Technological context → perceived direct benefits; perceived indirect benefits. Organizational context → perceived financial cost; perceived technical competence. Environmental context → perceived industry pressure; perceived government pressure.	Factor analysis (FA), and Logistic regression	Letter with questionnaires was sent; 575 small firms Hong Kong	[Kuan and Chau, 2001]
Open systems	Characteristics of the "Open Systems Technology" Innovation → perceived Benefits; perceived barriers; perceived Importance of compliance to standards, interoperability, and Interconnectivity. Organizational technology → complexity of IT infrastructure; satisfaction with existing systems; formalization of system development and management. External environment → market uncertainly	T-test, FA, logistic regression	Face-to-face interview, 89 firms Hong Kong	[Chau and Tam, 1997]
Web site	Technological context → technology readiness; technology integration; security applications.	Multiple correspondence analyses	3155 small and 637 large firms	[Oliveira and Martins,

Table 2.2: Some studies based only on Tornatzky and Fleischer [1990]

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
	Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; Internet and e-mail norms. Environmental context → web site competitive pressure Controls → Services sector.	(MCA), and probit model	Portuguese	2008]
Web site E-commerce	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; Internet and e-mail norms. Environmental context → web site competitive pressure; e-commerce competitive pressure. Controls → Services sector.	MCA, and probit model	2626 firms Portuguese	[Oliveira and Martins, 2009a]
Internet Web site E-commerce	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; Internet and e-mail norms. Environmental context → Internet competitive pressure; web site competitive pressure; e-commerce competitive pressure. Controls → Services sector.	MCA, and logit model	3155 small firms Portuguese	[Martins and Oliveira, 2009]
e-commerce development level (0-14)	Technological → support from technology; human capital; potential support from technology. Organizational → management level for information; firm size. Environmental → user satisfaction; e-commerce security. Controls → firm property.	FA and ordinary least squares (OLS)	e-mail survey, online survey and telephone interview during 2006; 156 firms. Shaanxi, China	[Liu, 2008]
ERP	Technological context → IT infrastructure; technology readiness. Organizational context → size; perceived barriers. Environmental context → production and operations improvement; enhancement of products and services; competitive pressure; regulatory policy.	FA, and Logistic regression	Face-to-face interview, 99 firms Taiwan	[Pan and Jang, 2008]
Deployment of B2B e-commerce: B2B firms versus non-B2B firms	Technological inhibitors → unresolved technical issues; lack of IT expertise and infrastructure; lack of interoperability. Organizational inhibitors → difficulties in organizational change; problems in project management; lack of top management support; lack of e-commerce strategy; difficulties in cost-benefit assessment. Environmental inhibitors → unresolved legal issues; fear and uncertainty.	FA, t-tests and discrimination analysis	249 firms North America and Canada	[Teo et al., 2006]
E-business	Technology competence → IT infrastructure; e-business know-how. Organizational context → firm scope, firm size. Environmental context → consumer readiness; competitive pressure; lack of trading partner readiness. Controls (industry and country effect)	Confirmatory factor analysis (CFA), second-order factor modelling, logistic regression, and cluster analysis (CA)	Telephone interview during 2000; 3552 firms European (Germany, UK, Denmark, Ireland, France, Spain, Italy, and Finland)	[Zhu et al., 2003]

Table 2.2: Some studies based only on Tornatzky and Fleischer [1990]

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
E-Business usage	Technological context →technology competence. Organizational context → size; international scope; financial commitment. Environmental context → competitive pressure; regulatory support. e-Business functionalities → front-end functionality; back-end integration.	CFA, second-order factor modelling, and structural equation modelling (SEM)	Telephone interview during 2002, 624 firms across 10 countries Developed (Denmark, France, Germany, Japan, Singapore, U.S.) and developing (Brazil, China, Mexico and Taiwan) countries	[Zhu and Kraemer, 2005]
E-Business initiation E-Business adoption E-Business routinization	Technological context →technology readiness; technology integration. Organizational context → firm size; global scopes; trading globalization; managerial obstacles. Environmental context → competition intensity; regulatory environment.	CFA, and SEM	Telephone interview during 2002, 1857 firms across 10 countries Developed (Denmark, France, Germany, Japan, Singapore, U.S.) and developing (Brazil, China, Mexico and Taiwan) countries	[Zhu et al., 2006b]
E-business	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; Internet and e-mail norms. Environmental context → web site competitive pressure Controls → Services sector.	T-test, FA, and CA	Telephone interview during 2006, 6964 firms across 27 countries UE27 countries	[Oliveira and Martins, 2009b, Oliveira and Martins, 2010a]
Internal integration of e-business External diffusion of use of e-business	Technological context → IS infrastructure; IS expertise. Organizational context → organizational compatibility; expected benefits of e-business. Environmental context → competitive pressure; trading partner readiness.	CFA, and SEM	e-mail survey during 2006; 163 large firms Taiwan	[Lin and Lin, 2008]
KMS	Technology aspect → Organizational IT competence; KMS characteristics (compatibility, relative advantage and complexity). Organizational aspect → top management commitment; hierarchical organizational structure. Environmental aspect → With external vendors; among internal employees.	Not empirical work	Not empirical work. Chinese	[Lee et al., 2009]

2.3.2. Studies that used the TOE framework combined with other theories

Some authors used the TOE framework with other theories to understand IT adoption [Chong et al., 2009, Gibbs and Kraemer, 2004, Hsu et al., 2006, Li, 2008, Soares-Aguiar and Palma-Dos-Reis, 2008, Thong, 1999, Zhu et al., 2006a]. In Table 2.3 we can see that DOI, institutional theory, and the Iacovou *et al.* [1995] model were used in combination with the TOE framework to better understand IT adoption decisions.

Studies combining the TOE framework and DOI theories include the following. Thong [1999] joins CEO characteristics from DOI to the TOE framework. Chong *et al*. [2009] add innovation attributes (relative advantage, compatibility, and complexity) from DOI and an additional new factor in the adoption study called information sharing culture characteristics to the TOE framework. Zhu *et al*. [Zhu et al., 2006a] combined relative advantage, compatibility, cost, and security concern from DOI with the TOE framework.

Additional theories include those listed below.

Institutional theory

Institutional theory emphasizes that institutional environments are crucial in shaping organizational structure and actions [Scott, 2001, Scott and Christensen, 1995]. According to the institutional theory, organizational decisions are not driven purely by rational goals of efficiency, but also by social and cultural factors and concerns for legitimacy. Institutions are transported by cultures, structures, and routines and operate at multiple levels. The theory claims that firms become more similar due to isomorphic pressures and pressures for legitimacy [Dimaggio and Powell, 1983]. This means that firms in the same field tend to become homologous over time, as competitive and customer pressures motivate them to copy industry leaders. For example, rather than making a purely internally driven decision to adopt e-commerce, firms are likely to be induced to adopt and use e-commerce by external isomorphic pressures from competitors, trading partners, customers, and government.

Several recent studies have taken an institutional approach to e-commerce or EDI diffusion and assimilation [Chatterjee et al., 2002, Purvis et al., 2001, Teo et al., 2003].

It is well known that mimetic, coercive, and normative institutional pressures existing in an institutionalized environment may influence organizations' predisposition toward an IT-based interorganizational system [Teo et al., 2003]. Mimetic pressures are observed when firms adopt a practice or innovation imitating competitors [Soares-Aguiar and Palma-Dos-Reis, 2008]. Coercive pressures are a set of formal or informal forces exerted on organizations by other organizations upon which the former organizations depend [Dimaggio and Powell, 1983]. Normative pressures come from dyadic relationships where companies share some information, rules, and norms. Sharing these norms through relational channels amongst members of a network facilitates consensus, which, in turn, increases the strength of these norms and their potential influence on organizational behaviour [Powell and DiMaggio, 1991].

Some studies combine the TOE framework with the institutional theory [Gibbs and Kraemer, 2004, Li, 2008, Soares-Aguiar and Palma-Dos-Reis, 2008]. The institutional theory adds to the environmental context of the TOE framework external pressures, which include pressure from competitors and pressure exerted by trading partners.

Iacovou et al. [1995] model

Iacovou et al. [1995] analysed interorganizational systems (IOSs) characteristics that influence firms to adopt IT innovations in the context of EDI adoption. Their framework is well suited to explain the adoption of an IOS. It is based on three factors: perceived benefits, organizational readiness, and external pressure (see Figure 2.3). Perceived benefits is a different factor from the TOE framework, whereas organizational readiness is a combination of the technology and organization context of the TOE framework. Hence, IT resources is similar to technology context and financial resources is similar to organizational context. The external pressure in the Iacovou *et al.* [1995] model adds the trading partners to the external task environmental context of the TOE framework as a critical role of IOSs adoptions.

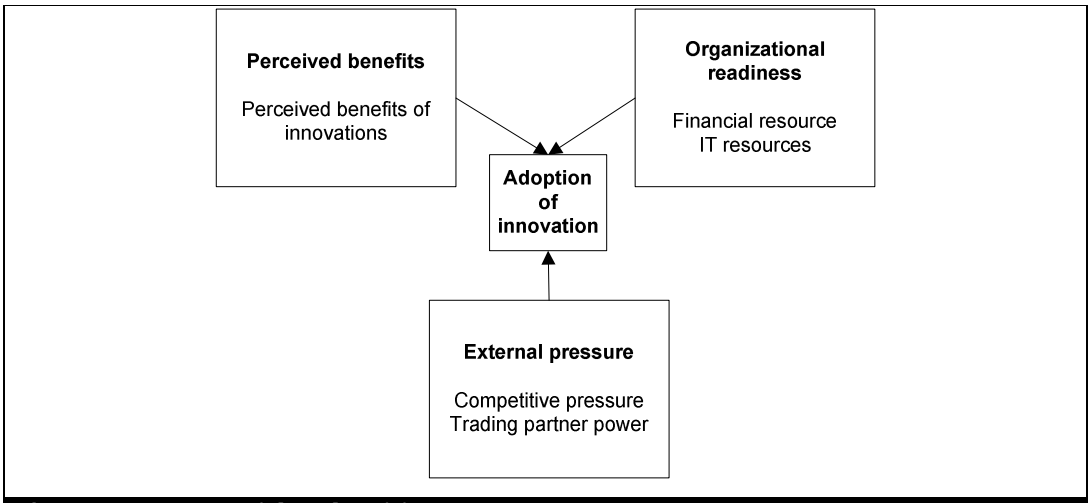

Figure 2.3. Iacovou et al. [1995] model

Hsu *et al*. [2006] used the DOI theory, the TOE framework, and the Iacovou *et al*. [1995] model to explain e-business use. Their model proposed four constructs (perceived benefits, organizational readiness, external pressure, and environment). Organization readiness, is consistently used in all three frameworks in the literature. Environment is from the TOE framework. Perceived benefits and external pressure are from the Iacovou *et al*. [1995] model.

Table 2.3: Some studies that combine Tornatzky and Fleischer [1990] with other theoretical models

Theoretical Model	IT Adoption	Analysed variables	Methods	Data, and Context	Author(s)
TOE and DOI	Uses at least one major software application: accounting; inventory control; sales; purchasing; personnel and payroll; CAD/CAM; EDI; MRP. Number of personal computers and software applications	CEO characteristics → CEO's innovativeness; CEO's IS knowledge. IS characteristics → relative advantage of IS; compatibility of IS; complexity of IS. Organizational characteristics → business size; Employees' IS knowledge; information intensity. Environmental characteristic → competition.	T-tests, FA, discrimina-tory analysis, and partial least squares (PLS)	Letter with questionnaires sent during 2005, 166 small firms; Singapore	[Thong, 1999]
TOE and DOI	Collaborative commerce (c-commerce)	Innovation attributes → relative advantage; compatibility; complexity. Environmental → expectations of market trends; competitive pressure. Information sharing culture → trust; information distribution; information interpretation. Organizational readiness → top management support; feasibility; project champion characteristics	FA, and OLS	e-mail survey; 109 firms Malaysian	[Chong et al., 2009]

Table 2.3: Some studies that combine Tornatzky and Fleischer [1990] with other theoretical models

Theoretical Model	IT Adoption	Analysed variables	Methods	Data, and Context	Author(s)
TOE and DOI	E-Business usage E-business impact	Relative advantage Compatibility Costs Security concern Technological context → technology competence. Organizational context →organization size. Environmental context → competitive pressure; partner readiness.	CFA, second-order factor modelling, and SEM	Telephone interview during 2002; 1415 firms across 6 EU countries European (Finland, France, Germany, Italy, Spain, and U.K.)	[Zhu et al., 2006a]
TOE, DOI and institutional theory	E-procurement	Technological context → relative advantage; complexity; compatibility. Organizational context → financial slacks; top management support. Environmental context → external pressure; external support; government promotion.	FA, and logistic regression	Telephone interview during 2006; 120 firms; 50-2000 employees China; manufacturing firms	[Li, 2008]
TOE and Institutional theory	Scope of e-commerce use	Technology context → Technology resources Organizational context → perceived benefits; lack of organizational compatibility; financial resources; firm size. Environmental context → External pressure; government promotion; legislation barriers. Controls → countries (Brail, China, Denmark, France, Germany, Japan, Mexico, Singapore, Taiwan, and U.S.A.); industries (distribution, finance, and manufacture).	FA, and OLS	Telephone interview during 2002; 2139 firms 3 sectors (manufacturing, distribution, and finance); 10 countries (Brazil, China, Denmark, France, Germany, Japan, Mexico, Singapore, Taiwan, and U.S.A.)	[Gibbs and Kraemer, 2004]
TOE and Institutional theory	Electronic procurement systems (EPSs)	Technological context → Technology competence; IT expertise; B2B know how. Organizational context → firm size; firm scope. Environmental context → trading partner readiness; extent of adoption amongst competitors; perceived success of competitor adopters. Controls → Industry effects.	T-test, and logistic regression	e-mail survey; 240 large firms Portugal	[Soares-Aguiar and Palma-Dos-Reis, 2008]
DOI, TOE and Iacovou *et al*. [1995] model	E-business use: diversity, and volume.	Perceived benefits → perceived of innovations. Organizational readiness → firm size; technology resources; globalization level. External pressure → trading partners' pressure; government pressure. Environment → regulatory concern; competition intensity. Controls → Industry effects.	CFA, and SEM	Telephone survey during 2002; 294 firms U.S. market (manufacturing, wholesale/retail distribution, banking and insurance.	[Hsu et al., 2006]

2.4. Conclusions

In this chapter, we made a review of literature of IT adoption models at the firm level. Most empirical studies are derived from the DOI theory and the TOE framework. As the TOE framework includes the environment context (not included in the DOI theory), it becomes better able to explain intra-firm innovation adoption; therefore, we consider this model to be more complete. The TOE framework also has a solid theoretical basis, consistent empirical support, and the potential of application to IS adoption. For this reason an extensive analysis of the TOE framework was undertaken, analysing empirical studies that use only the TOE model, and empirical studies that combine this model with the DOI theory, the institutional theory, and the Iacovou *et al*. [1995] model, and concluding that the same context in a specific theoretical model can have different factors.

In terms of further research, we think that for more complex new technology adoption it is important to combine more than one theoretical model to achieve a better understanding of the IT adoption phenomenon.

Chapter 3 – Determinants of web site and e-commerce adoption in Portugal

3.1. Introduction

Literature on information technology (IT) adoption and diffusion at firm level [Hong and Zhu, 2006] suggests that when analyzing this topic, one should consider the nature of the IT. For simple technologies, like the Internet or web site, the adoption process is expected to be inexpensive and easy and probably will not bring about fundamental changes to the firm. However, for advanced technologies, especially those related to online transactions, the adoption process may be complicated and costly. That is perhaps why, in 2006, even though most firms in Portugal are Internet adopters (83%), only 35% owned a web site and a limited part of them, 7%, have adopted e-commerce. These national figures are clearly below the 15 European Union countries (EU15) mean level, where 94% of firms are Internet users, 66% own a web site and 16% have adopted e-commerce practices.

The two main purposes of this study are the following:

- To examine the importance of technology-organization-environment (TOE) related factors as fundamental determinants of web site and e-commerce adoption;
- To analyze the extent to which there are significant differences in the factors driving these two types of IT.

To achieve these research objectives, we used a rich data set of 2,626 firms that are representative of Portuguese firms with more than 10 employees in 2006, (excluding the financial service sector).

In this study, as suggested by Hong and Zhu (2006), we defined e-commerce as any application of web technologies that enables revenue generating business activities over the Internet.

3.2. Theorical framework and conceptual model

The TOE model [Tornatzky and Fleischer, 1990] identifies three aspects that may possibly influence web site and e-commerce adoption: technological context (technology readiness, technology integration and security applications); organizational context (firm size, perceived benefits of electronic correspondence, IT training programs, access to the IT system of the firm, Internet and e-mail norms and main perceived obstacle); and environmental context (competitive pressure). In accordance with the TOE theory, we developed in the next subsection a conceptual framework for web site and e-commerce adoption (see Figure 3.1).

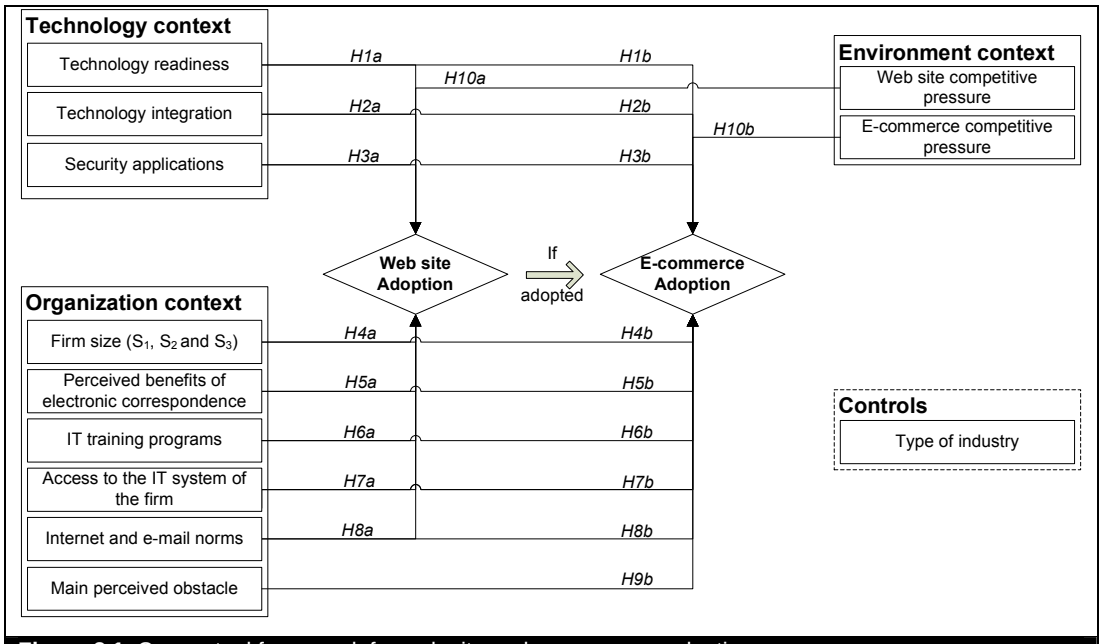

Figure 3.1. Conceptual framework for web site and e-commerce adoption

3.2.1. Technology Context

Technology readiness can be defined as technology infrastructure and IT human resources. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Theoretical assertions are supported by several empirical studies [Hong and Zhu, 2006, Iacovou et al., 1995,

Kwon and Zmud, 1987, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b, Zhu et al., 2004].

H1a and H1b. The level of technology readiness is positively associated with web site and e-commerce adoption

Evidence from the literature suggests that integrated technologies help improve firm performance by reduced cycle time, improved customer service, and lowered procurement costs [Barua et al., 2004]. As a complex technology, e-commerce demands close coordination of various components along the value chain. Correspondingly, a greater integration of existing applications and the Internet platform represent a greater capacity of conducting business over the Internet [Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003].

H2a and H2b. The level of technology integration is positively associated with web site and e-commerce adoption

The lack of security may slow down technological progress. For example, for Portugal in 2002 this was the greatest barrier to Internet use [Martins and Oliveira, 2005] and in China it is one of the most important barriers to the adoption of e-commerce [Tan and Ouyang, 2004].

H3a and H3b. Security applications is positively associated with web site and e-commerce adoption

3.2.2. Organization Context

Firm size is one of the most commonly studied determinants of IT adoption [Lee and Xia, 2006]. Several empirical studies indicate that there is a positive relationship between the two variables [Pan and Jang, 2008, Premkumar et al., 1997, Thong, 1999, Zhu et al., 2003]

H4a and H4b. Firm size is positively associated with web site and e-commerce adoption

Empirical studies consistently found that perceived benefits have a significant impact in IT adoption [Beatty et al., 2001, Gibbs and Kraemer, 2004, Iacovou et al., 1995].

H5a and H5b. Perceived benefits of electronic correspondence is positively related with web site and e-commerce adoption

We used IT training programs as a proxy of employees' education level, because in our survey we do not have this variable. The presence of skilled labour in a firm increases its ability to absorb and make use of an IT innovation, and therefore it is an important determinant of IT diffusion [Caselli and Coleman, 2001, Hollenstein, 2004, Kiiski and Pohjola, 2002].

H6a and H6b. IT training programs are positively associated with web site and e-commerce adoption

The fact that workers can have access to the IT system from outside of the firm reveals that the organization is prepared to integrate its technologies [Mirchandani and Motwani, 2001].

H7a and H7b. The level of access to the IT system from outside of the firm is positively associated with web site and e-commerce adoption

Regulatory environment has been acknowledged as a critical factor influencing innovation diffusion [Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b, Zhu et al., 2004]. Firms often refer inadequate legal protection for online business activities, unclear business laws, and security and privacy as concerns in using web technologies [Kraemer et al., 2006].

H8a and h8b. The presence of Internet and e-mail norms is positively associated with web site and e-commerce adoption

Research into IT adoption and implementation suggests that when the technology is complex, as is the case for e-commerce, the main perceived obstacles are particularly relevant because in this case, the adoption process may be complicated and costly [Hong and Zhu, 2006].

H9b. Main perceived obstacle is negatively associated with e-commerce adoption

3.2.3. Environment Context

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Porter and Millar (1985) analyzed the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by using a new innovation, firms might be able to alter the rules of competition, affect the industry

structure, and leverage new ways to outperform rivals, thus changing the competitive landscape. This analysis can be extended to IT adoption. Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion [Al-Qirim, 2007, Gibbs and Kraemer, 2004, Hollenstein, 2004, Iacovou et al., 1995, Mehrtens et al., 2001, Zhu et al., 2003].

H10a. The level of web site competitive pressure is positively associated with web site adoption

H10b. The level of e-commerce competitive pressure is positively associated with e-commerce adoption

3.3. Data and methodology

3.3.1. Data

The data used in this study were provided by National Institute of Statistics (INE) and result from the survey on the Use of Communication and Information Technologies in Firms (IUTICE) in 2006. We used a sample of 2,626 firms with more than 9 employees that is statistically representative of the whole private business sector in Portugal at January 2006, excluding the financial sector.

3.3.2. Methodology

In our model we examine the influence of several TOE factors on the adoption decision at two adoption stages (see Figure 3.2).

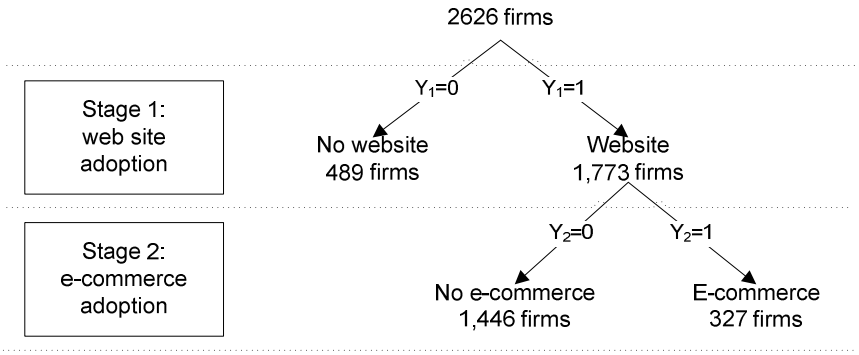

Figure 3.2. Stage of adoption by firms

We estimated the following probit model, for stage adoption *i*:

$$P(y_i=1/\mathbf{x}_i)=\Phi(\mathbf{x}_i\boldsymbol{\beta}_i) \quad \text{for } i=1,2 \qquad (3.1)$$

Where $y_1=1$ is web site adoption, $y_2=1$ is e-commerce adoption, $\mathbf{x}_i$ is the vector of the explanatory variables, $\boldsymbol{\beta}_i$ the vector of unknown parameters to be estimated, and $\Phi(.)$ is the normal cumulative distribution.

Within our context, the e-commerce adoption decision (stage 2) should be modelled jointly with the decision on web site adoption (stage 1), taking into account the fact that e-commerce adoption decision is observed only for those firms who own a web site. As it is usual in statistical analysis, we use a bivariate probit model with sample selectivity that estimates simultaneously the system of two nonlinear equations, in our case, two probit models taking into account sample selection. If the hypothesis of uncorrelated errors ($\rho=0$) is not rejected then we can proceed as usual by specifying two sequential models [Greene, 2008]. This means that we can compute, without the existence of selectivity bias, one binary model (probit or logit) for web site adoption with all firms and another binary model (probit or logit) for e-commerce only with firms that had adopted web site.

The probit or logit model has been used in the IT literature to study the following adoptions: computer-mediated communication technologies [Premkumar, 2003], Internet [Martins and Oliveira, 2007], web site [Oliveira and Martins, 2008] and e-business [Pan and Jang, 2008, Zhu et al., 2003].

Definition of explanatory variables

A technology readiness (TR) index was built by aggregating 8 items on technologies used by the firm (on a yes/no scale): computers, e-mail, intranet, extranet, own networks that are not the Internet (own exclusive networks), wired local area network (LAN), wireless LAN, wide area network (WAN), and one item standing for the existence of IT specific skills in the firm (on a yes/no scale) [Zhu et al., 2004]. The first 8 items represent the penetration of traditional information technologies, which formed the technological infrastructure [Kwon and Zmud, 1987]. The last item represents IT human resources [Mata et al., 1995]. To aggregate these 9 items measured in yes/no scale, we used multiple correspondence analyses (MCA). The MCA is a method of "multidimensional exploratory statistic" that is used to reduce the dimension when the variables are binary [Johnson and Wichern, 1998]. The first dimension explains 38% of inertia. In the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. This resulting variable reflects the technology readiness.

Technology integration (TI) was measured by the number of IT systems for managing orders that are automatically linked with other IT systems of the firm. The variable ranges from 0 to 5. This variable reflects how well the IT systems are connected on a common platform.

Security applications (SA) was measured by the number of existing security applications in the firms. The variable ranges from 0 to 6. Firm size was measured by three binary variables: small firms (S_1) (10 up to 49 employees); medium-size firms (S_2) (50 up to 249 employees); large firms (S_3) (more than 249 employees).

Perceived benefits of electronic correspondence (PBEC) was measured by the shift from traditional postal mail to electronic correspondence as the main standard for business communication, in the last 5 years (on a yes/no scale).

IT training programs (ITTP) is also binary variable (yes/no) related to the existence of professional training in computer/informatics, available to workers in the firm.

Access to the IT system of the firm (AITSF) was measured by the number of places from which workers access the firms information systems. The variable ranges from 0 to 4.

Internet and e-mail norms (IEN) was measured by whether firms have defined norms about Internet and e-mail (on a yes/no scale).

Main perceived obstacles was measured by five dummy variables reflecting the main problems faced in the implementation of e-commerce solution.

Web site competitive pressure (WEBP) and e-commerce competitive pressure (ECOMP) are computed as the percentage of firms in each of the 9 industries that had already adopted a web site/e-commerce two years before the time of the survey, i.e. in 2004. As in Zhu et al. [Zhu et al., 2003] the rationale underlying our model is that an observation of the firm on the adoption behaviour of its competitors influences its own adoption decision.

To control for type of industry we used a binary variable (yes/no), representing the service sector (SER).

We made an analysis of reliability for variables that were obtained by multi-item indicators. We used the standardized Kuder-Richardson Formula 20 (KR-20) estimated, which is a special form of coefficient alpha that is applicable when items are dichotomous [Kuder and Richardson, 1937]. The KR-20 obtained are: for technology readiness (KR-20 = 0.78), technology integration (KR-20 = 0.92), security applications (KR-20 = 0.71) and access to the IT system of the firm (KR-20 = 0.73). All of KR-20 are higher than the generally accepted level of adequacy of 0.60 [Nunnally and Bernstein, 1994]. These results suggest that all of the factors are considered to be satisfactory for the reliability of multi-item scale.

3.4. Estimation results

Initially we estimated a bivariate probit model with sample selectivity. No support was found to the existence of selectivity in our sample, at the usual 5% significance level (p-value=0.12). Since the two adoption decisions are uncorrelated, we can estimate our

model with two single probit models. Table 3.1 reports the estimation results. We also estimated two logit models. As expected, the results are analogous.

Goodness-of-fit is assessed in three ways. First, to analyze the joint statistical significance of the explanatory variables we computed the likelihood ratio test. Secondly, we use the Hosmer-Lemeshow test [Hosmer and Lemeshow, 2000], which compares the fitted expected values of the model to the actual values. For web site adoption and for e-commerce adoption, there is no support to reject both models. Finally, the discrimination power of the model is evaluated using the area under the ROC curve, which is equal to 83% and 75% for web site and e-commerce adoption, respectively. This reveals an excellent discrimination for both models [Hosmer and Lemeshow, 2000]. The three statistical procedures reveal a substantive model fit, a satisfactory discriminating power and there is evidence to accept an overall significance of the model.

Table 3.1: Estimated results

Explanatory variables	Probit (sequential equations)	
	Web site (y_1)	E-commerce (y_2)
	Coef.	Coef.
Technology context		
- Technology readiness (TR)	0.699***	-0.055
- Technology integration (TI)	0.008	0.087***
- Security applications (SA)	0.087***	0.040
Organization context		
Firm size (S_1 is reference variable):		
- medium-size firms (S2)	0.064	-0.056
- large firms (S3)	0.263***	0.158
- Perceived benefits of electronic correspondence (PBEC)	0.166**	0.168**
- IT training (ITTP)	0.274***	0.112
- Access to the IT system of the firm (AITSF)	0.170***	0.099**
- Internet and e-mail norms (IEN)	0.152**	0.024
Main perceived obstacle [+]:		
- Goods and services are not susceptible of being sold through the Internet	nc	-0.707***
Competitive pressure		
- site competitive pressure (WEBP)	0.021***	nc
- e-commerce competitive pressure (ECOMP)	nc	0.029***
Controls		
- service sector (SER)	-0.122*	0.299***
Constant	-1.367***	-1.792***
Sample size	n_1=2,626	n_2=1,773

Note: nc means that the variable is not considerate; * p-value<0.10; ** p-value<0.05; *** p-value<0.01;
[+]the other main perceived obstacles are not statistically significant in the model.

Hypotheses H1a-H10a and H1b-H10b were tested analyzing the sign and the statistical significance of the coefficients of the two adoption decision models. As can be seen from Table 3.1, for the web site adoption decision model all the coefficients have the expected signs and the only explanatory variable that is not statistically significant is technology integration. We can identify eight relevant drivers of web site adoption; technology readiness and security application reflecting the technological context; firm

size, perceived benefits of electronic correspondence, IT training programs, access to the IT system of the firm and Internet and e-mail norms, representing the organization context; web site competitive pressure characterizing the environmental context. We can conclude that hypothesis H1a, H3a, H4a, H5a, H6a, H7a, H8a and H10a are confirmed and no support was found for H2a. For the e-commerce adoption model, the estimated coefficients also have the anticipated signs: technology integration has a positive effect on the e-commerce adoption probability; perceived benefits of electronic correspondence, access to the IT system of the firm and e-commerce competitive pressure are also important drivers of e-commerce adoption. Moreover, our results indicate that goods and/or services provided by the company that are not susceptible of being sold through the Internet is the most important obstacle of e-commerce adoption. As a whole, the results substantiate all hypotheses formulated for the e-commerce adoption model except H1b, H3b, H4b, H6b and H8b.

3.5. Conclusions

In this study we have proposed a conceptual model based on TOE theoretical framework to analyze the determinants of two different adoption decisions. At the basic level, we considered the adoption of a simple information technology, the web site and at the more advanced level, a complex technology is contemplated: e-commerce. While IT adoption models have been widely discussed and studied in theory and practice, few empirical publications exist for southern European countries like Portugal.

We examined 2,626 firms representative of the Portuguese private economic sectors (except the financial one) and the major findings are the following: (1) from our empirical results, by statistical tests, we conclude that the two adoption decisions are taken at different stages; (2) the relevant facilitators and inhibitors of web site and e-commerce adoption decision found in our study for Portuguese firms are, in general, similar to those obtained in other IT adoption studies [Al-Qirim, 2007, Hong and Zhu, 2006, Zhu et al., 2006b]; (3) in particular, our results suggest that organizational factors like perceived benefits and access to firms IT system contribute to both adoption decision process. Similarly, competitive pressure, an environmental factor, significantly influences both adoption decisions, meaning that competitive pressure is an important innovation-diffusion driver in these two stages of adoption; (4) other variables have limited influence: technology readiness as a component of technological factors, firm

size, IT training programs and Internet and e-mails norms as organizational factors, had a significant effect on web site adoption decision but had no effect on e-commerce adoption. This indicates that once a firm decides to own a web site, these variables become less important for e-commerce purpose. On the other hand, technology integration has a relevant impact on e-commerce adoption decision but is not important within the web site adoption model, meaning that for e-commerce adoption technologies that help improve firm performance by reduced cycle time, improved customer service, and lowered procurement costs are needed [Barua et al., 2004].

In terms of policy implications, the above findings suggest that a key factor is the improvement of IT skills at the basic and higher levels. This can be achieved by lowering, through different types of policy instruments, the IT training cost, and by promoting a closer relationship between firms, associations and education institutions. With the cost of infrastructure technology decreasing, the lack of qualified IT human resources is probably one of the major constraints for Portuguese firms' technology readiness improvement.

Our study also has important implications for managers who are involved in processes of introducing simple and complex IT innovations into their organizations. First, managers should be aware that technology readiness constitutes both physical infrastructure and intangible knowledge such as IT skills. This urges top leaders to foster managerial skills and human resources that possess knowledge of these new information technologies. Secondly, our study sought to help firms become more effective in moving from a traditional channel to the Internet by identifying the profile of early web site and e-commerce adopters. For non-adopters, it provides a mechanism for self-evaluation. For firms that are already web site adopters, in the development of strategies for e-commerce adoption, it is fundamental to recognize that e-commerce requires enhanced technology integration between the existing applications and the Internet platform.

The cross-sectional nature of this study does not allow knowing how this relationship will change over time. To solve this limitation the future research should involve panel data.

Chapter 4 – A comparison of web site adoption in small and large Portuguese firms

4.1. Introduction

New information technology (IT), such as Internet enables firms to do businesses in a different way [Porter, 2001]. In order to strength the potential of the Internet, firms are establishing their presence on the Web: in 2005, the overall percentage of enterprises in the European Union (EU) with a web site is 61%, but notably higher for larger firms (90%) than for small firms (56%). Significantly differences also exist between Member States: while the leader countries, Sweden and Denmark, are already reaching the saturation level for large firms (97%), countries like Portugal (75%) and Latvia (65%) are far away from this adoption level. For small firms, this difference is greater: the web site adoption level is 80% for Sweden compared with the 33% level for Portugal [Eurostat, 2006]. Do Portuguese small firm managers realize the strategic value of owning a web-site in the same manner as large firm managers? Or have they encountered specific barriers to its implementation? Some studies have been done to understand the differences in IT adoption among European Countries [Zhu et al., 2003] and much research attempted to comprehend the relationship between firms size and IT adoption decision [Lee and Xia, 2006]. Some authors [Grandon and Pearson, 2004, Premkumar, 2003] suggested that the research findings on large businesses cannot be generalized to small and medium-sized enterprises (SMEs) because of the unique characteristics of SMEs as for example the lack of business and IT strategy, limited access to capital resources and poor information skills. While there exist an interesting and growing literature addressing the determinants of IT adoption in the specific context of SMEs [Harindranath et al., 2008, Parker and Castleman, 2007] and a limited research for micro firms [Clayton, 2000], only a reduced number of studies [Daniel and Grimshaw, 2002] attempt to compare directly the approaches of small and large firms to this new domain. Our work seeks to fill this gap in the literature, by analysing the relative importance of the factors that enable or inhibit web site adoption by small firms compared with large firms. The two main purposes of this study are the following:

- To examine the importance of technology-organisation-environment (TOE) related factors as fundamental determinants of web site adoption;

- To analyze if the relative importance of such factors is different for small and large firms.

To achieve these research objectives we used a rich data set of 637 large firms and 3,155 small firms that are representative of Portuguese economy. The understanding of the determinants of web site adoption, at firm level, may be a useful tool in addressing the right type of policy measures to stimulate the use of Internet business solutions, with the aim of enhancing the competitiveness and productivity of Portuguese firms [Bertschek et al., 2006, Black and Lynch, 2001, Bresnahan et al., 2002, Brynjolfsson and Hitt, 2000, Dedrick et al., 2003, Konings and Roodhooft, 2002, Martins and Raposo, 2005, Zhu and Kraemer, 2002]. This is particularly needed in the case of Portugal which, for several reasons, has been suffering from a serious lack of competitiveness in comparison to other industrialized economies. Our work has two important contributions: the first is related to the very limited research on comparing the determinants of IT adoption in small and large firms. Secondly, we present useful results for Portugal where there are few published studies on the subject [Parker and Castleman, 2007]. The next section presents the theoretical framework based on TOE approach. Then, the proposed hypotheses are tested using an econometric model. Finally, we present major findings and conclusions.

4.2. Theoretical framework and conceptual model

In this study we used the TOE framework, developed by Tornatzky and Fleisher (1990) and applied in many empirical studies related to IT innovations. The TOE model identifies three aspects that influence the adoption and implementation of technical innovations by firms: technological characteristics including factors related to internal and external technologies of firms; organizational factors relating to firm size and scope, characteristics of the managerial structure of the firm, quality of human resources; and environmental factors that incorporate industry competitiveness features. This theoretical background is the one used by Kuan and Chau [2001] and Premkumar and Ramamurthy [1995] to explain electronic data interchange (EDI) adoption and by Thong [1999] to explain information systems (IS) adoption and Hong and Zhu [2006] to explain e-commerce adoption. Empirical findings from these studies confirmed that TOE methodology is a

valuable framework to understand the IT adoption decision. In accordance with TOE theory, we developed in the next subsection a conceptual framework for web site adoption (see Figure 4.1).

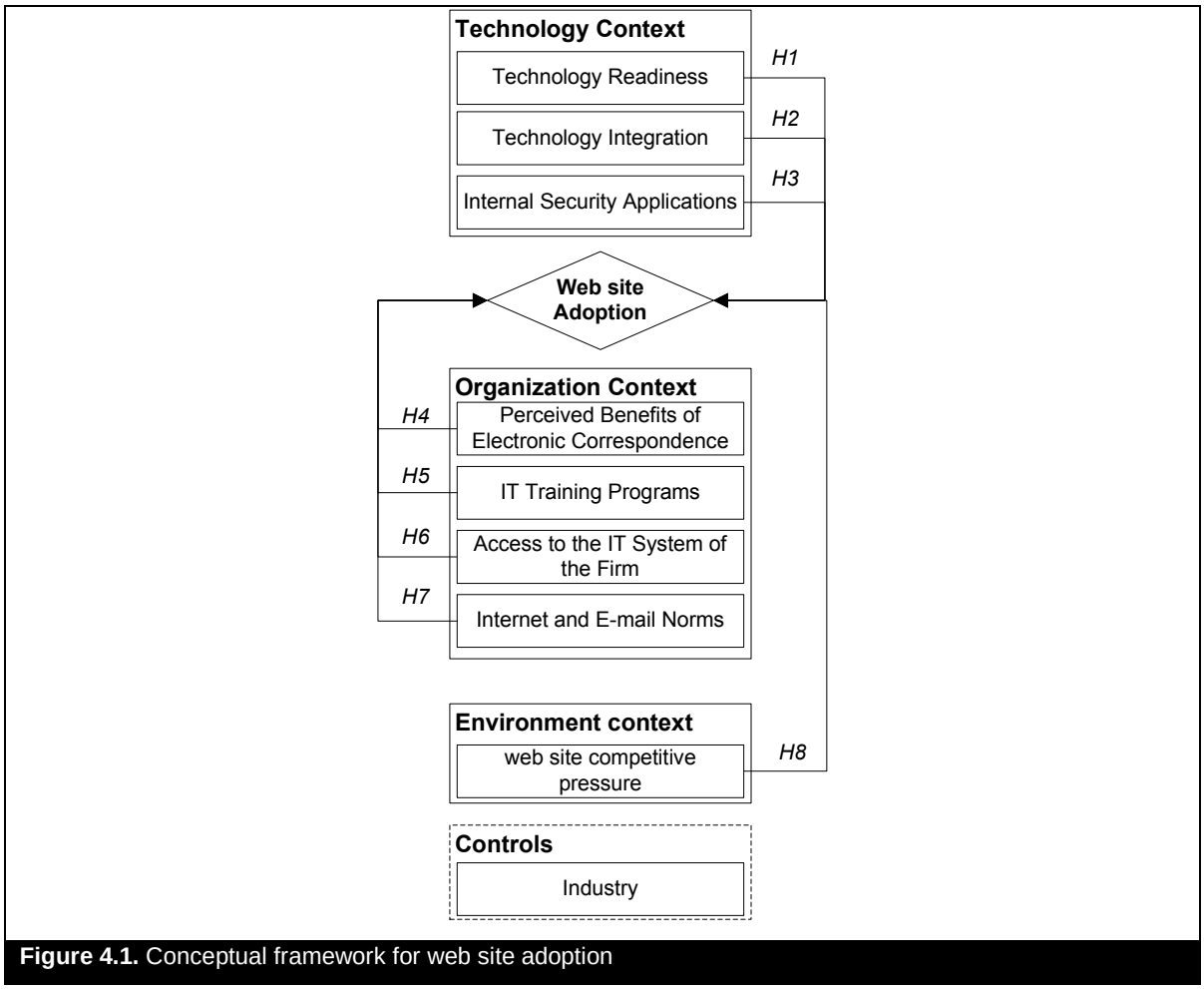

Figure 4.1. Conceptual framework for web site adoption

4.2.1. Technology context

Technology readiness can be defined as technology infrastructure and IT human resources. Technology readiness "is reflected not only by physical assets, but also by human resources that are complementary to physical assets" [Mata et al., 1995]. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Theoretical assertions on the impact of Technology readiness

on IT adoption are supported by several empirical studies, based on data sets representative of all sizes of firms [Hong and Zhu, 2006, Zhu et al., 2003, Zhu et al., 2006b]. These results were also confirmed within the specific context of SMEs [Al-Qirim, 2007, Dholakia and Kshetri, 2004, Kuan and Chau, 2001, Mehrtens et al., 2001]. Therefore, in general we expected that firms with greater technology readiness are in a better position to adopt web sites. However, as suggested by others authors [Daniel and Grimshaw, 2002, Parker and Castleman, 2007, Premkumar, 2003], this factor will probably affect in a different way small and large firms.

H1: The level of technology readiness is positively associated with web site adoption but the impact will vary between large and small firms

Before the Internet, firms had been using technologies to support business activities along their value chain, but many were ‘‘islands of automation’’— they lacked integration across applications [Hong and Zhu, 2006]. The characteristics of the Internet may help eradicate the incompatibilities and rigidities of legacy information systems (IS) and accomplish technology integration among various applications and databases. Evidence from the literature suggests that integrated technologies may enhance firm performance by reducing cycle time, improving customer service, and lowering procurement costs [Barua et al., 2004]. We define technology integration as the systems for managing orders that are automatically linked with other IT systems of the firm. This type of factor where also identified by Al-Qirim [2007] for the specific case of SMEs. Therefore, we expect firms with a higher level of technology integration to be those who adopt web sites sooner. However, probably there will be significantly differences between small and large firms [Daniel and Grimshaw, 2002]. These reflections lead to the following hypothesis:

H2: The level of technology integration is positively associated with web site adoption, but the impact will vary between small and large firms

The lack of security may slow down technological progress. For example, for Portugal in 2002 this was the greatest barrier to Internet use [Martins and Oliveira, 2005] and in China it is one of the most important barriers to the adoption of e-commerce [Tan and Ouyang, 2004]. We expect firms with a higher level of internal security applications to be more probable web site adopters. Within this context, there is no empirical evidence suggesting a same behaviour between small and large firms. Therefore we stipulate the following:

H3: Internal security applications are positively associated with web site adoption, but the impact will probably vary between small and large firms

4.2.2. Organization context

Empirical studies consistently found that perceived benefits have a significant impact in IT adoption. This result is validated for medium to large firms [Beatty et al., 2001], for SMEs [Iacovou et al., 1995, Kuan and Chau, 2001] and for all size firms [Gibbs and Kraemer, 2004]. However, as suggested by Daniel and Grimshaw [2002] small firms and large firms perceived these benefits in a different. We examine perceived benefits of electronic correspondence and we postulate that:

H4: Perceived benefits of electronic correspondence is positively related with web adoption, but the impact will vary between small and large firms

The presence of skilled labour in a firm increases its ability to absorb and make use of an IT innovation, and therefore is an important determinant of IT diffusion [Caselli and Coleman, 2001, Hollenstein, 2004, Kiiski and Pohjola, 2002]. Since the successful implementation of new IT usually requires complex skills, we expect firms with more IT training programs to be more likely to adopt web site. However, there will probably be differences between firms due to the limited IT budgets of small firms. We postulate the following:

H5: IT training programs are positively associated with web site adoption, but the impact will vary between small and large firms

The fact that workers can have access to the IT system from outside of the firm reveals that the organisation is prepared to integrate its technologies. However, this factor is expected to influence in a different way small firms, where the number of employees is small and their presence at the place of work is more important than for large firms. We postulate that:

H6: The level of access to the IT system from outside of the firm is positively associated with web site adoption, but the impact will vary between small and large firms

Regulatory environment has been acknowledged as a critical factor influencing innovation diffusion [Zhu et al., 2003, Zhu et al., 2006b, Zhu et al., 2004]. Firms often refer inadequate legal protection for online business activities, unclear business laws, and security and privacy as concerns in using web technologies [Kraemer et al., 2006]. We postulate that for small firms, this concern will probably be different from their large counterparts.

H7: The presence of Internet and e-mail norms is positively associated with web site adoption, but the impact will vary between small and large firms

4.2.3. Environment context

Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion [Gibbs and Kraemer, 2004, Hollenstein, 2004, Zhu et al., 2004] and this fact is also verified in small business research [Al-Qirim, 2007, Dholakia and Kshetri, 2004, Grandon and Pearson, 2004, Iacovou et al., 1995, Kuan and Chau, 2001]. Therefore, we expect the probability of adopting a web site to be positively influenced by the proportion of web site adopters in the industry or sector to which the specific firm is affiliated. However, some studies suggested that competitive pressure will be more significant in causing small firms to adopt an IT than for larger firms, since they need to protect their competitive position [Daniel and Grimshaw, 2002]. Therefore, we assume that:

H8: The level of web site competitive pressure is positively associated with web site, but the impact will vary between small and large firms

4.2.4. Controls

We control, as usual, for industry or economic sector effects. We used a dummy variable to control for data variation that would not be captured by the explanatory variables mentioned before.

4.3. Data and methodology

4.3.1. Data

The data used in this study were provided by National Institute of Statistics (INE) and result from the survey on the Use of Communication and Information Technologies in Firms (IUTICE) in 2006. In our study we defined that small firms have less than 50 employees and large firms have more than 250 employees. Our sample consists on 3,155 small and 637 large firms and is representative of the Portuguese private sector excluding the financial one.

4.3.2. Methodology

We estimated the following Probit Model:

$$P(y=1/\mathbf{x})=\Phi(\mathbf{x\beta}) \quad (4.1)$$

Where y=1 if firm decided to adopt a web site, and zero otherwise, **x** is the vector of explanatory variables, **β** the vector of unknown parameters to be estimated, and Φ(.) is the standard normal cumulative distribution. To analyse and compare the influence of each factor on the probability of being a web site adopter, we need to compute the marginal effect of x_j. This effect is obtained, for the continuous variables, using the formula given by:

$$\partial P\left(y=1/\overline{\mathbf{x}}\right)\Big/\partial x_j = \phi\left(\overline{\mathbf{x}}\boldsymbol{\beta}\right)\beta_j \quad (4.2)$$

For the binary explanatory variables it is given by:

$$\Delta P\left(y=1/\overline{\mathbf{x}}\right)\Big/\Delta x_j = \Phi\left(\overline{\mathbf{x}}\boldsymbol{\beta} \mid \overline{\mathbf{x}}, x_j=1\right)-\Phi\left(\overline{\mathbf{x}}\boldsymbol{\beta} \mid \overline{\mathbf{x}}, x_j=0\right) \quad (4.3)$$

where ϕ(.) is the density standard normal distribution.

The vector of explanatory variables (**x**) includes:

A technology readiness (TR) index that was built by aggregating 8 items on technologies used by the firm (on a yes/no scale): computers, e-mail, intranet, extranet, own networks

that are not the Internet (own exclusive networks), wired local area network [Lange et al.], wireless LAN, wide area network (WAN), and one item standing for existence of IT specific skills in the firm (on a yes/no scale) [Zhu et al., 2004]. The first 8 items represent the penetration of traditional information technologies, which formed the technological infrastructure [Kwon and Zmud, 1987]. The last item represents IT human resources [Mata et al., 1995]. To aggregate the items we used multiple correspondence analyses (MCA). The MCA is a method of "multidimensional exploratory statistic" that is used to reduce the dimension when the variables are binary. For more details see [Johnson and Wichern, 1998]. The first dimension explains 50% of inertia. In the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. Cronbach's α, the most widely used measure for assessing reliability (Chau, 1999), is equal to 0.88, indicating adequate reliability. Reliability measures the degree to which items are free from random error, and therefore yield consistent results.

Technology integration (TI) was measured by the number of IT systems for managing orders that are automatically linked with other IT systems of the firm (see Appendix A). The variable ranges from 0 to 5. This variable reflects how well the IT systems are connected on a common platform.

Internal security applications (ISA) was measured by the numbers of the use of internal security applications in the firms (see Appendix A). The variable range from 0 to 6.

Perceived benefits of electronic correspondence (PBEC) was measured by the shift from traditional postal mail to electronic correspondence as the main standard for business communication, in the last 5 years (on a yes/no scale).

IT training programs (ITTP) is also a binary variable (yes/no) related to the existence of professional training in computer/informatics, available to workers in the firm.

Access to the IT system of the firm (AITSF) was measured by the number of places from which workers access the firms information systems (see Appendix A). The variable ranges from 0 to 4.

Internet and e-mail norms (IEN) was measured by whether firms have defined norms about Internet and e-mail (on a yes/no scale).

Web site competitive pressure (WEBP) is computed as the percentage of firms in each of the 9 industries that had already adopted a web site two years before the time of the survey, i.e. in 2004. As in Zhu et al. (2003) the rationality underlying our model is that an observation of the firm on the adoption behaviour of its competitors influences its own adoption decision.

Services (SER) is a binary variable (yes/no) equal one if firm belong to the service sector.

4.4. Estimation results

The web site adoption model is estimated using maximum likelihood. The estimation results for small and large firms are presented in Table 4.1.

Goodness-of-fit is assessed in three ways. First, we used log likelihood ratio test, which reveals that our models are globally statistic significant. Secondly the discrimination power of the model is evaluated using the area under the receiver operating characteristic (ROC) curve, which is equal to 90.9% and 78.0% for small and large firms, respectively. Finally, the R^2 shows that the percentage explained by the model is 41.9% for small firms and 15.7% for large firms. The three statistical procedures reveal a substantive model fit, a satisfactory discriminating power and there is evidence to accept an overall significance of the model.

Hypotheses H1-H8 were tested analysing the sign, the magnitude, the statistical significance of the coefficients and the marginal effects. As can be seen from Table 4.1, for small firms, the estimation results suggested that all the coefficients have the expected signs and the only independent variable that is not statistically significant is the access to the IT system of the firm (AITSF). We can identify seven relevant drivers of web site adoption for small firms: technology readiness (TR), technology integration (TI) and internal security application (ISA) reflecting the technological context; perceived benefits of electronic correspondence (PBEC), IT training programs (ITTP) and Internet and e-mail

norms (IEN), representing the organization context; web site competitive pressure (WEBP), concerning the environmental context. For large firms, we identify four significant factors influencing web site adoption decision: technology readiness (TR), IT training programs (ITTP), access to the IT system of firms (AITSF) and web site competitive pressure (WEBP). In both cases, as expected, the economic sector is a relevant factor (SER).

Table 4.1: Estimated coefficients for web site adoption model

	Small firms	Large firms
Technological context		
- Technology readiness (TR)	1.044***	0.346*
- Technology integration (TI)	0.069***	-0.028
- Internal security applications (ISA)	0.170***	0.038
Organizational context		
- Perceived benefits of electronic correspondence (PBEC)	0.293***	-0.039
- IT training programs (ITTP)	0.235***	0.644***
- Access to the IT system of the firm (AITSF)	0.044	0.278***
- Internet and e-mail norms (IEN)	0.379***	0.165
Environmental context		
- Web site competitive pressure (WEBP)	0.011***	0.017***
Controls		
- Services (SER)	0.185***	0.306**
Constant	-1.742***	-1.041***
Sample size	3,155	637
LL	-1038.5	-223.3
R^2	0.419	0.157
AUC	0.909	0.779

Note: * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

The estimated marginal effects for the determinants of web site adoption model, for small and large firms, are reported in Table 4.2.

Table 4.2: Estimated marginal effects for web site adoption model

	Small firms	Large firms
Technological context		
- Technology readiness (TR)	0.252***	0.064*
- Technology integration (TI)	0.017***	-0.005
- Internal security applications (ISA)	0.041***	0.007
Organizational context		
- Perceived benefits of electronic correspondence (PBEC)	0.079***	-0.007
- IT training programs (ITTP)	0.061***	0.144***
- Access to the IT system of the firm (AITSF)	0.011	0.051***
- Internet and e-mail norms (IEN)	0.100***	0.032
Environmental context		
- Web site competitive pressure (WEBP)	0.003***	0.003***
Controls		
- Services (SER)	0.044***	0.056**

Note: * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

Their comparison reveals that, as expected, most of the marginal effects vary between small and large firms. The exception is the web site competitive pressure impact that is the same for small and large firms. Therefore hypotheses H1-H7 are validated and H8 is not confirmed.

There are three additional aspects to be noted here. Firstly, the technological context is much more relevant for small firms than for large firms. Secondly, within organizational context, perceived benefits and Internet e-mail norms are more important to determine web site adoption for small firms than for their larger counterparts. Finally, the access to the IT system of the firm is relevant only for large firms. As a whole, our results are in accordance with those reported in studies comparing IT adoption in large and small firms [Daniel and Grimshaw, 2002]. However, the limited number of research in this specific domain difficult the generalization of the results.

4.5. Conclusions

Within the context of an increased use of Internet business solutions, such as web sites, this study fills a gap in the literature by comparing the relative importance of the factors influencing the adoption of web sites for small and large firms. The theoretical framework incorporates most of the facilitators and inhibitor factors identified in other studies. The research model evaluates, for small and large firms, the impact of three technological factors, four organizational factors and one environmental factor on the web site adoption decision. Using a representative sample of Portuguese small and large firms, the estimation results for this comparative study reveal that the important determinants of web site adoption decision vary with size of a firm. Other studies in this domain [Daniel and Grimshaw, 2002, Premkumar, 2003] also suggested that the problems, opportunities, and management issues encountered by small business in the IT area are different from those faced by their larger counterparts. However, our study provides a more in depth analysis since it identifies those factors that more or less relevant for large/small firms and quantifies its impact on web site adoption decision. These findings have practical implications for managers and policy makers. Firstly, policy makers should be conscious that the motivations towards the IT adoption are different for small and large firms. Therefore, government initiatives, such as the Technological Plan, for Portugal, must be

different for small and large firms, namely those related to procurement incentives. Secondly, managers should be aware that technology readiness constitutes both physical infrastructure and intangible knowledge such as IT skills. This urges top leaders (mainly in small firms) to foster managerial skills and human resources that possess knowledge of these new information technologies. Therefore, there is a business opportunity for IT firms to establish the service that support the small size firms in the technological context. In our opinion this is particularly important in Portugal given the relative importance of small businesses in the economy (Vicente and Martins, 2008). Finally, our study sought to help firms become more effective in moving from a traditional channel to the Internet by identifying the profile of early web site adopters.

As in most empirical studies, our work is limited in several ways. The cross-sectional nature of this study does not allow knowing how this relationship will change over time. To solve this limitation the future research should involve panel data. Another limitation of our work is that it only investigates web site adoption decision. To provide a more balanced view of firms' IT adoption decision, other Internet business solutions, such as e-commerce should also be examined.

Chapter 5 – Determinants of e-commerce adoption by small firms in Portugal

5.1. Introduction

Small firms play a significant role in Portuguese economy. In 2005 they comprised 99.0% of the enterprises and accounted for 66.8% of the total employment and 37.7% of the added value [INE, 2007]. Nonetheless, the productivity of Portuguese small firms is one of the lowest in the European Union [OECD, 2006]. With regard to information technology use amongst Portuguese small firms, in 2006 computer penetration rate was high for firms with 10 to 49 workers (90%), but relatively low for micro-firms, i.e, those with fewer than 10 workers (55%). The adoption of Internet related technologies by small firms is still relatively low when compared with large firms (i.e, those with more than 250 workers): 60% of the small firms have adopted the Internet compared with 100% for large firms; 25% owned a web site (75%, for large firms) and only 3.8% sell and purchase products and services over the Internet, compared with 48% for their larger counterpart [UMIC, 2007].

The main purposes of this study are the following: (1) to examine the importance of technology-organization-environment (TOE) related factors as fundamental determinants of Internet (first phase), web site (second phase) and e-commerce (third phase) adoption; (2) to analyze the extent to which the pattern of TOE factors varies with the phase of adoption. To achieve these research objectives, we used a rich data set of 3,155 firms that are representative of Portuguese firms with fewer than 50 employees in 2006, (excluding the financial service sector). The understanding of the determinants of Internet, web site and e-commerce adoption, at firm level, may be a useful tool in addressing the right type of policy measures in order to stimulate the use of e-commerce. This is particularly needed in the case of Portugal, which suffers from a serious lack of competitiveness in comparison to other industrialized economies. This article is intended as a contribution to the empirical literature on the determinants of e-commerce adoption by small firms, for two main reasons. First, we study the determinants of the adoption decision at different stages of e-

commerce involvement, a topic that is still quite limited. Second, we take Portugal as a country of application for which there are few published studies on the subject.

5.2. Conceptual framework and hypothesis

We propose a framework in which firms gain experience and knowledge in a sequence of stages (Daniel and Grimshaw, 2002, Dholakia and Kshetri, 2004). In the first stage of a project the firm gains experience, which it can use to move on to the second stage, at which point it will gain further experience. Stage models have been used in only a limited number of studies related to Internet and e-commerce adoption (Daniel and Grimshaw, 2002, Martin and Matlay, 2001). The stage model states that the engagement with e-commerce is sequential and progressive. The sequence begins with the use of e-mail/Internet, and progresses through web site development to the buying, selling and payment mechanism of e-commerce. We suggest a three-phased involvement approach to e-commerce adoption: Internet (has an Internet connection), web site (owns a web site) and e-commerce (sells on the Internet). The analysis of the major determinants of e-commerce adoption decision is based on the TOE model [Tornatzky and Fleischer, 1990]. We identify three features that may influence Internet, web site, and e-commerce adoption: technological context (technology readiness, technology integration, and security applications); organization context (firm size, perceived benefits of electronic correspondence, IT training programmes, access to the IT system of the firm, Internet and e-mail norms, and main perceived obstacle); and environment context (competitive pressure). In accordance with the TOE theory, we develop a conceptual framework for Internet, web site, and e-commerce adoption (see Figure 5.1).

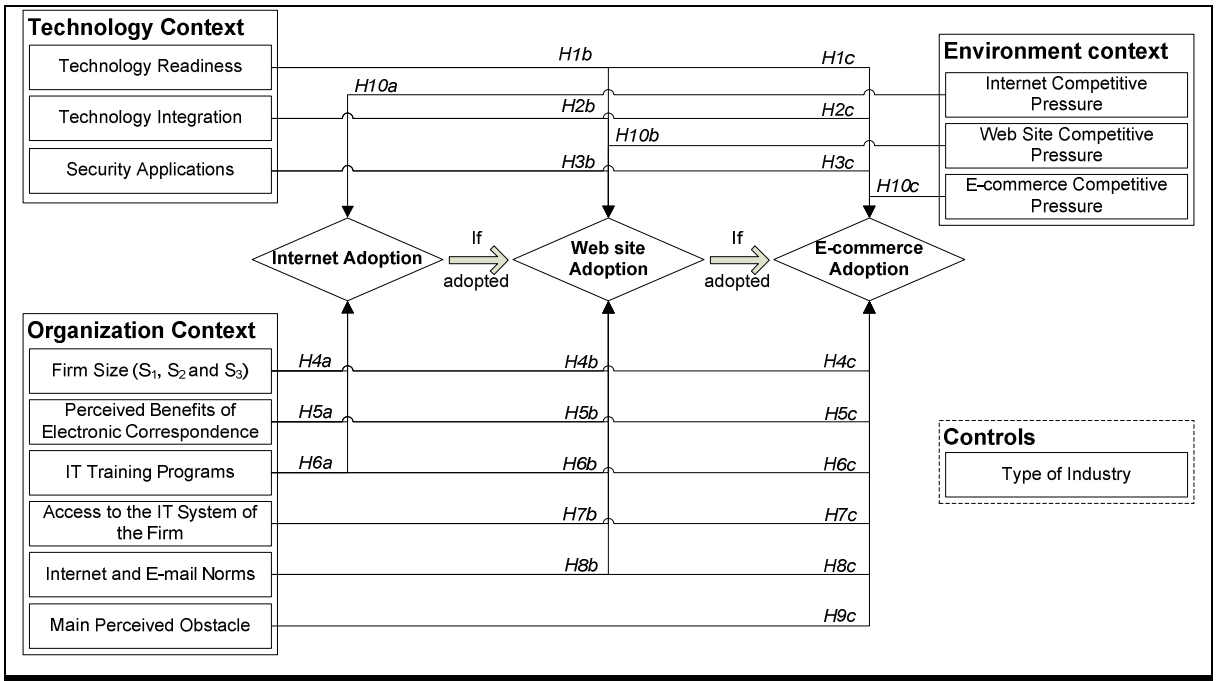

Figure 5.1. Conceptual Framework for Internet, web site, and e-commerce adoption

5.2.1. Technology context

Technology readiness can be defined as technology infrastructure and IT human resources [Mata et al., 1995]. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Theoretical assertions are supported by several empirical studies [Armstrong and Sambamurthy, 1999, Hong and Zhu, 2006, Iacovou et al., 1995, Kwon and Zmud, 1987, Pan and Jang, 2008, Zhu, 2004b, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b].

H1b and H1c. The level of technology readiness is positively associated with web site and e-commerce adoption

Before the Internet became available, firms had been using technologies to support business activities along their value chain, but many were ‘‘islands of automation’’- they lacked integration across applications [Hong and Zhu, 2006]. Evidence from the literature suggests that integrated technologies help improve firm performance through reduced cycle time, improved customer service, and lowered procurement costs [Barua et al., 2004]. As a complex technology, e-business demands close coordination of various

components along the value chain. Correspondingly, a greater integration of existing applications and the Internet platform represent a greater capacity for conducting business over the Internet [Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003, Zhu et al., 2006b].

H2b and H2c. The level of technology integration is positively associated with web site and e-commerce adoption

The lack of security may down technological progress. For example, for Portugal in 2002 this was the greatest barrier to Internet use [Martins and Oliveira, 2005], and in China it is one of the most important barriers to the adoption of e-commerce [Tan and Ouyang, 2004].

H3b and H3c. Security applications are positively associated with web site and e-commerce adoption

5.2.2. Organization context

Firm size is one of the most commonly studied determinants of IT adoption [Lee and Xia, 2006]. Several empirical studies indicate that there is a positive relationship between the variables [Pan and Jang, 2008, Premkumar et al., 1997, Thong, 1999, Zhu et al., 2003].

H4a and H4b. Firm size is positively associated with web site and e-commerce adoption

Empirical studies have consistently found that perceived benefits have a significant impact on IT adoption [Beatty et al., 2001, Gibbs and Kraemer, 2004, Iacovou et al., 1995, Kuan and Chau, 2001, Lin and Lin, 2008].

H5a, H5b and H5c. Perceived benefits of electronic correspondence are positively related with Internet, web site, and e-commerce adoption

The presence of skilled labour in a firm increases its ability to absorb and make use of an IT innovation, and therefore is an important determinant of IT diffusion [Caselli and Coleman, 2001, Hollenstein, 2004, Kiiski and Pohjola, 2002].

H6a, H6b and H6c. IT training programs are positively associated with Internet, web site, and e-commerce adoption

The fact that workers can have access to the IT system from outside of the firm reveals that the organization is prepared to integrate its technologies [Mirchandani and Motwani, 2001].

H7b and H7c. The level of access to the IT system from outside of the firm is positively associated with web site and e-commerce adoption

Regulatory environment has been acknowledged as a critical factor influencing innovation diffusion [Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b, Zhu et al., 2004]. Firms often mention inadequate legal protection for online business activities, unclear business laws, security, and privacy as concerns in using web technologies [Kraemer et al., 2006]. We used Internet and email norms as a proxy for regulatory environment.

H8a, H8b and H8c. The presence of Internet and e-mail norms is positively associated with Internet, web site, and e-commerce adoption

Perceived obstacles are particularly important because the adoption process may be complicated and costly [Hong and Zhu, 2006, Pan and Jang, 2008, Zhu et al., 2006b].

H9c. The main perceived obstacle is negatively associated with e-commerce adoption

5.2.3. Environment context

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Porter and Millar (1985) analysed the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by using a new innovation, firms might be able to alter the rules of competition, affect the industry structure, and leverage new ways to outperform rivals, thus changing the competitive landscape. This analysis can be extended to IT adoption. Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion [Al-Qirim, 2007, Gibbs and Kraemer, 2004, Hollenstein, 2004, Iacovou et al., 1995, Mehrtens et al., 2001, Zhu et al., 2003].

H10a. The level of Internet competitive pressure is positively associated with Internet adoption

H10b. The level of web site competitive pressure is positively associated with web site adoption

H10c. The level of e-commerce competitive pressure is positively associated with e-commerce adoption

5.3. Data and methodology

5.3.1. Data

This study follows a field survey methodology. The sample unit in this questionnaire is the firm. The base of sampling is firm population that operates in Portugal, with fewer than 50 employees and with start-up dates before 2005. Our database was developed by the National Institute of Statistics (INE). The survey was conducted in the 1st semester of 2006 by a department specialized in data collection. The first contact with firms was by mail and/or e-mail. To collect the data, INE used two different methods: paper questionnaire (via mail) and electronic questionnaire (via web). The questionnaire design was made by Eurostat following a discussion with all members. This questionnaire (Appendix B) was adopted for Portugal by professionals involved in the project whose goal was to adapt it to the national reality. Concerning cases of total or partial absence of response to a specific question, no other treatment was applied other than confirmation with the firm. In fact, according to the methodological recommendations of Eurostat, the situation of an operator that “did not answer” or “does not know” the answer to a specific question should never imply its imputation based on the answers of the other operators. For situations of no answer to the questionnaire, we corrected the predicted (initial) sample, assuming that the non -respondent units are non-selected units. In this way, the calculation of the weighting factor is based on the sample obtained which is based on the number of responding firms. We used a sample of 3,155 firms with fewer than 50 employees which is stratified by economic sector (NACE classification), number of employees, and turnover.

Data presented in Figure 5.2 support the three-phased involvement approach. For example, in the real estate and business activities, although 51.9% of firms with fewer than

5 employees have adopted the Internet and 17.7% owned a web site, only about 1% sell products and services over the Internet. However, significant differences exist in the level of e-commerce involvement when firms are analysed by size and economic activities (9 industries are considered).

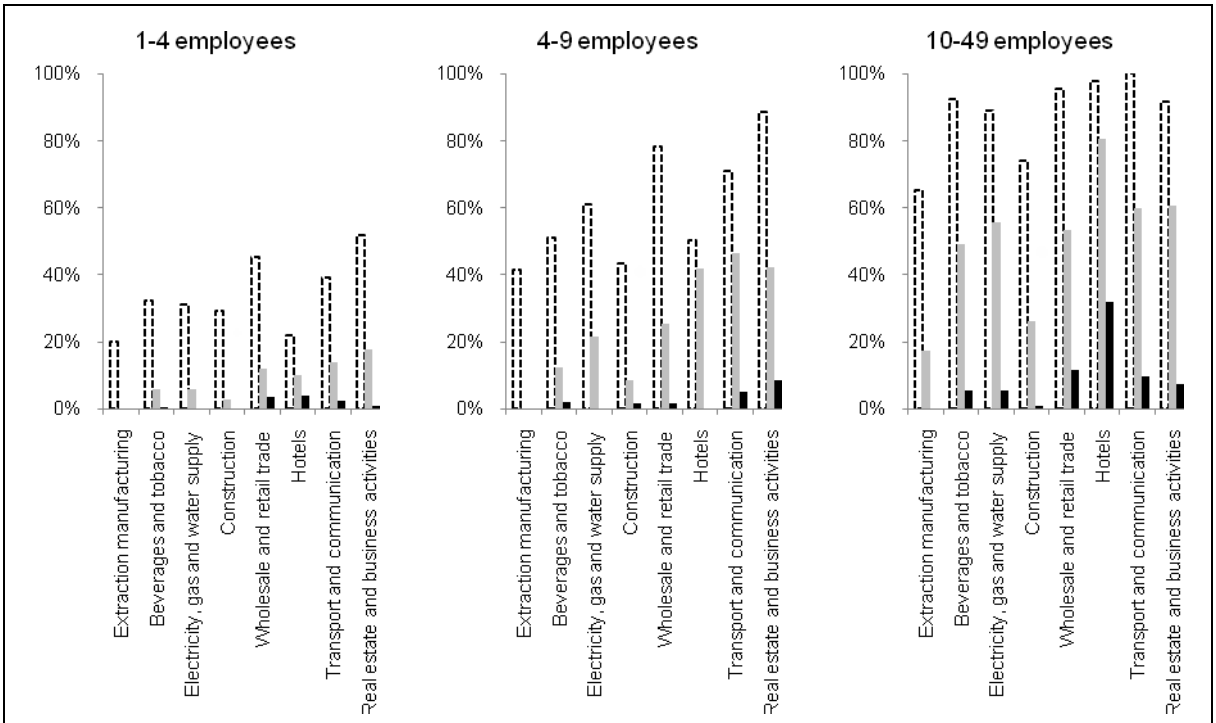

Figure 5.2. e-commerce involvement by size and industry: Internet (dash), web site (grey) and e-commerce (black)

5.3.2. Methodology

In our conceptual framework we examine the influence of several TOE factors on the adoption decision at three adoption stages, as can be seen in see Figure 5.3.

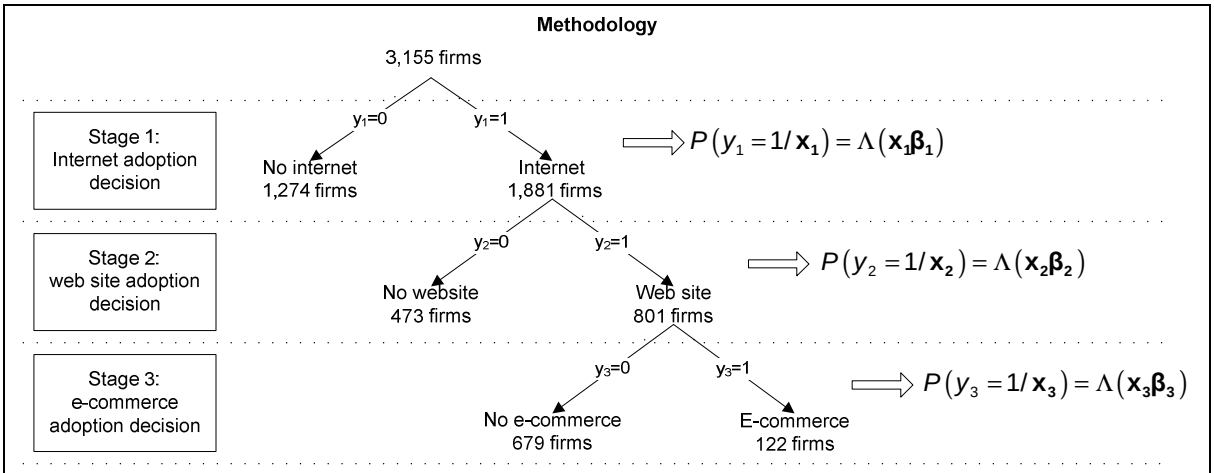

Figure 5.3. The different phases of IT adoption (Internet, web site, and e-commerce adoption)

Since the dependent variable is binary (to adopt or not), a logistic regression model is developed. Similar models have been used in the information systems (IS) literature to study electronic data interchange (EDI) adoption [Kuan and Chau, 2001] , IT outsourcing [Bajwa et al., 2004], and e-business adoption [Pan and Jang, 2008, Zhu et al., 2003]. We estimated the following logistic regression model, for phase adoption *i*, given by:

$$P(y_i=1/\mathbf{x_i})=\Lambda(\mathbf{x_i\beta_i}) \quad \text{for i=1,2,3} \tag{5.1}$$

Where y_1 is Internet adoption, y_2 is web site adoption, y_3 is e-commerce adoption, $\mathbf{x_i}$ is the vector of the explanatory variables, $\boldsymbol{\beta_i}$ the vector of unknown parameters to be estimated, and $\Lambda(.)$ is the logistic cumulative distribution. To analyse and compare the influence of each factor on the probability of being an adopter, we need to compute the marginal effect of each explanatory variable, x_j. For the continuous variables, this effect is obtained using the formula:

$$\partial P(y=1/\bar{\mathbf{x}}) \Big/ \partial x_j = \lambda(\bar{\mathbf{x}}\boldsymbol{\beta})\beta_j \tag{5.2}$$

For the binary explanatory variables it is obtained with:

$$\Delta P(y=1|\bar{\mathbf{x}}) \Big/ \Delta x_j = \Lambda(\bar{\mathbf{x}}\boldsymbol{\beta} \mid \bar{\mathbf{x}},\ x_j=1) - \Lambda(\bar{\mathbf{x}}\boldsymbol{\beta} \mid \bar{\mathbf{x}},\ x_j=1) \tag{5.3}$$

Where λ(.) is the density logistic distribution. In equations (5.2) and (5.3) we dropped the index *i* for simplicity. For more details see [Greene, 2008].

Definition of explanatory variables (see Appendix B for further details).

- A technology readiness index was constructed by aggregating 8 items on technologies used by the firm (on a yes/no scale): computers, e-mail, intranet, extranet, own networks that are not the Internet (own exclusive networks), wired local area network (LAN), wireless LAN, wide area network (WAN), and one item standing for the existence of IT specific skills in the firm (on a yes/no scale). The first 8 items represent the penetration of traditional information technologies, which formed the technological infrastructure [Kwon and Zmud, 1987]. The last item represents IT human resources [Mata et al., 1995]. To aggregate these 9 items measured on a yes/no scale, we used multiple correspondence analyses (MCA). The MCA is a method of "multidimensional exploratory statistic" that is used to reduce the dimension when the variables are binary [Johnson and Wichern, 1998]. The first dimension explains 43% of inertia. In the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. This resulting variable reflects the technology readiness (Appendix C).
- Technology integration was measured by the number of IT systems for managing orders that are automatically linked with other IT systems of the firm. The variable ranges from 0 to 5. This variable reflects how well the IT systems are connected on a common platform.
- Security applications was measured by the number of existing security applications in the firms. The variable ranges from 0 to 6.
- Firm size was measured by three binary variables: (S_1) micro firms (1 to 4 employees); (S_2) very small firms (5 to 9 employees); (S_3) small firms (10 to 49 employees).
- Perceived benefits of electronic correspondence was measured by the shift from traditional postal mail to electronic correspondence as the main standard for business communication, in the last five years (on a yes/no scale).
- IT training programmes is also a binary variable (yes/no) related to the existence of professional training in computer/informatics, available to workers in the firm.

- Access to the IT system of the firm was measured by the number of places from which workers access the firms' information systems. The variable ranges from 0 to 4.
- Internet and e-mail norms was measured by whether firms have defined norms about Internet and e-mail (on a yes/no scale).
- Main perceived obstacles was measured by five dummy variables reflecting the main problems faced in the implementation of e-commerce solution.
- Internet competitive pressure, web site competitive pressure, and e-commerce competitive pressure are computed as the percentage of firms in each of the nine industries that had already adopted Internet/ web site/e-commerce two years before the time of the survey, i.e. in 2004. As in Zhu et al. (2003) the rationale underlying our model is that an observation of the firm on the adoption behaviour of its competitors influences its own adoption decision.

To control for type of industry we used a binary variable (yes/no), representing the service sector.

5.4. Estimation results

For each dependent variable (Internet adoption decision; web site adoption decision; e-commerce adoption decision), a logistic regression model was estimated by maximum likelihood. The postulated hypotheses were tested analysing the sign and the statistical significance of the estimated coefficients. Positive and significant coefficients imply that the corresponding variable is an adopter facilitator. Negative and significant coefficients indicate that the corresponding variables are adopter inhibitors.

For Internet adoption decision we considered only non technological factors in order to avoid perfect colinearity between the dependent and explanatory variables.

As can be seen from Table 5.1, for the three adoption decision models, all the coefficients have the expected signs. We can identify three organizational drivers of Internet adoption: firm size, perceived benefits of electronic correspondence, and IT training programmes, and one environmental driver: Internet competitive pressure. We conclude that hypotheses H4a, H5a, H6a, and H10a are confirmed.

Table 5.1: Estimation results

Dependent variable (1/0)	Internet adoption		Web site adoption		E-commerce adoption	
	Coeff.	p-value	Coef.	p-value	Coef.	p-value
Technology readiness	nc		1.235***	0.000	-0.030	0.917
Technology integration	nc		0.125***	0.001	0.147**	0.011
Security applications	nc		0.163***	0.000	-0.006	0.945
Firm size:						
S_1 (1-4 employees)	reference	reference	reference	reference	reference	reference
S_2 (5-9 employees)	1.043***	0.000	0.388**	0.012	0.449	0.192
S_3 (10-49 employees)	2.243.***	0.000	0.656***	0.000	0.307	0.309
Perceived benefits of electronic correspondence	4.043***	0.000	0.481***	0.001	0.195	0.397
IT training programmes	3.534***	0.000	0.302**	0.027	0.256	0.303
Access to the IT system of the firm	nc		0.167**	0.045	0.218*	0.056
Internet and e-mail norms	nc		0.524***	0.000	-0.102	0.670
Main perceived obstacles:						
- Security problems and uncertainty about the legal framing of Internet sales (PO_1)	nc		nc		reference	reference
- Goods and/or services are not susceptible to being sold through the Internet (PO_2)	nc		nc		-1.889***	0.000
- Customers are not ready to buy through the Internet (PO_3)	nc		nc		-0.622*	0.094
- Costs of the Internet sales system (PO_4)	nc		nc		-0.508	0.262
- None of these (PO_5)	nc		nc		-0.597	0.108
Internet competitive pressure	0.008*	0.084	nc		nc	
Web site competitive pressure	nc		0.022***	0.000	nc	
E-commerce competitive pressure	nc		nc		0.057***	0.007
Service Sector	0.793***	0.000	0.405***	0.001	0.534*	0.073
Constant	-1.778***	0.000	-3.016***	0.000	-2.393***	0.000
Sample size	n = 3,155		n = 1,881		n = 801	
LR	$X^2_6 = 1240.80$	0.000	$X^2_{11} = 605.54$	0.000	$X^2_{15} = 93.70$	0.000
Log likelihood	-1507.72	-	-980.27	-	-294.93	-

Note: nc means that the variable is not considered in the analysis * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

We identify nine relevant drivers of web site adoption: technology readiness, technology integration and security application reflecting the technological context; firm size, perceived benefits of electronic correspondence, IT training programmes, access to the IT system of the firm, and Internet and e-mail norms, representing the organization context;

web site competitive pressure characterizing the environmental context. We conclude that all stipulated hypotheses for web site adoption decision are confirmed.

For e-commerce adoption, there are only three coefficients that are statistically significant at the 5% level, suggesting that technology integration, main perceived obstacles, and e-commerce competitive pressures are the only relevant factors. Moreover, our results indicate that goods and/or services provided by the company that are not susceptible to being sold through the Internet is the most important obstacle of e-commerce adoption. As a whole, the results not support hypotheses H1c, H3c, H4c, H6c, and H8c.

To analyse the extent to which the results vary with the adoption phase (our second research goal), we compared the size of the impact of each significant variable at the three adoption phases. For this purpose, we used the estimated marginal effects computed from equations (2) and (3) that are presented in Table 5.2.

There are two important things to be noted here. Firstly, the importance of the variables varies with the phase of adoption. Secondly, for those factors that affect more than one decision, the magnitude of the impact also varies with the phase of adoption. For example, as can be seen in Table 5.2, technology integration, although being significant for web site and e-commerce adoption decision, its marginal effect is twice as large for web site than for e-commerce adoption decision. Our findings suggest an interesting and somewhat expected result: the relative importance of technological and organizational factors decreases with the adoption phase. Moreover, the environmental factor, although relevant in both phases, has a greater impact in the last adoption phase.

Table 5.2: Marginal effects for the logistic regression model

Variables	Marginal effects		
	Internet	Web site	E-commerce
Technology readiness	nc	0.300	ns
Technology integration	nc	0.030	0.015
Security applications	nc	0.040	ns
Firm size (S_1 is the reference class):			
S_2 (5-9 employees)	0.149	0.095	ns
S_3 (10-49 employees)	0.298	0.159	ns
Perceived benefits of electronic correspondence	0.306	0.119	ns
IT training programs	0.323	0.074	ns
Access to the IT system of the firm	nc	0.041	0.022
Internet and e-mail norms	nc	0.128	ns
Main perceived obstacles (Security problems and uncertainty about the legal framing of Internet sales is the reference class):			
- Goods and/or services are not susceptible of being sold through the Internet (PO_2)	nc	nc	-0.235
- Customers are not ready to buy through the Internet (PO_3)	nc	nc	-0.053
- Costs of the Internet sales system (PO_4)	nc	nc	ns
- None of these (PO_5)	nc	nc	ns
Internet competitive pressure	0.001	nc	nc
Web site competitive pressure	nc	0.005	nc
E-commerce competitive pressure	nc	nc	0.006
Service Sector (Manufacturing is the reference)	0.141	0.097	0.049

Note: nc means that the variable is not considered in the analysis, and ns means that the variable is not statistically significant.

5.5. Discussion and conclusions

In this study we have proposed a conceptual model based on TOE framework to analyse the determinants of three different adoption decisions by small firms. At the basic level, we considered the adoption of a very simple information technology, the Internet; at a medium level, we examine web site adoption and at the more advanced level, a complex technology is contemplated: e-commerce. While e-commerce adoption models have been widely discussed and studied in theory and practice, few empirical studies exist for southern European countries, such as Portugal. The major findings of our study are the

following: (1) the environmental factor significantly influences the three adoption decisions, meaning that competitive pressure is an important innovation-diffusion driver in these three stages of adoption; (2) organizational factors like size, perceived benefits, and access to firms' IT system contribute to both Internet and web site adoption decisions, but had no impact on e-commerce adoption; technology readiness and security applications as components of technological factors, Internet and e-mails norms as organizational factors, had a significant effect on web site adoption decision but had no effect on e-commerce adoption. This indicates that once a firm decides to own a web site, these variables become less important for e-commerce purposes; (3) Portuguese small firms' behaviour regarding e-commerce adoption is not very different from their New England counterparts' [Dholakia and Kshetri, 2004]. Even with an economic environment as different as is the one between Portugal and New England, small firms tend to have commonalities; this conclusion confirms the idea that the problems, opportunities, and management issues encountered by small businesses in the e-commerce area are common and cross borders.
In terms of policy implications, the above findings suggest that a key factor is the improvement of IT skills at the basic and higher levels. This can be achieved by lowering, through different types of policy instruments, the IT training cost, and by promoting a closer relationship between firms, associations, and education institutions. With the cost of infrastructure technology decreasing, the lack of qualified IT human resources is probably one of the major constraints for Portuguese small firms' technology readiness improvement.

The cross-sectional nature of this study does not allow determining how this relationship will change over time. To solve this limitation, future research should involve panel data.

Chapter 6 – Determinant factors of Internet business solutions adoption the case of Portuguese firms

6.1. Introduction

The empirical evidence from both aggregate and microeconomic level studies suggest that information technologies (IT) played a major role in the resurgence in the growth of United States (US) output and productivity after 1995 [Bertschek, 2003, Jorgenson, 2002, Stiroh, 2003]. Other studies show that IT investments contributed to the capital deepening and growth in most OECD countries in the 1990s, though with considerable variation across countries [Pilat, 2004]. Probably of the many technologies that fall under the IT umbrella, Internet is the one that has the biggest impact in terms of costs savings and profitability in business [Litan and Rivlin, 2001]. The use of Internet by businesses create value either through finding ways of reducing costs or, on the demand side, by improving the match between buyer preferences and the goods they purchase [Borenstein and Saloner, 2001]. The net impact study published by Varian et al. [2002] estimated that the adoption of Internet business solutions (IBS) had yield to US organizations from the first year of implementation through 2001, cumulative cost savings of $155.2 billion and increased revenues of $444 billion. Their study also found that the adoption of IBS in the United Kingdom, Germany and France has resulted in a current, cumulative cost savings 9 billion of Euros to organizations deploying them. It is easy, then, to understand why Internet Policy is playing a major role in many governments' agendas. The European Council, recognizing that the contribution of IT to growth in Europe is still too low (namely compared with the US) and that much more could be expected, set in March 2000, the so-called Lisbon Strategy aimed at making the European Union (EU) the most competitive and dynamic knowledge based economy by 2010. But to generate growth, Internet connectivity needs to be translated in economic activities. IBS are defined as the initiatives that combine the Internet with networking, software and computing hardware technologies to enhance or improve existing business processes or to create new business opportunities [Varian et al., 2002, Wade et al., 2004]. The IBS allows firms to increase revenue generation through externally focused initiatives such as expansion into new markets and development of new products and services [Varian et al., 2002, Wade et al., 2004]. In this

study, we are only concerned with customer-facing solutions. The purpose of our study is the following:

1. To develop an integrated model of IBS adoption, taking into account the sample selection issue. We define a model with two adoption stages: firstly, firm decides to adopt or not a web site; at the second stage, those who adopted have to decide on the level of IBS to be used.
2. To identify by means of econometric analysis (ordered probit with selectivity) if sample selection bias is a relevant feature; to determine the major determinants of IBS adoption at the two adoption stages and the extent to which their magnitude differ with the stage of the adoption.

Although the Internet boom has drastically affecting way of doing business in all OECD countries [OECD, 2004], the available empirical evidence for Portugal is scarce in the literature. Even if there are some interesting studies on this subject [Dholakia and Kshetri, 2004, Giunta and Trivieri, 2007, Jeon et al., 2006, Lucchetti and Sterlacchini, 2004], there are few publications for the Portuguese economy. We aim to fill this gap by investigating the determinants of IBS adoption by Portuguese firms. Our empirical study is based on a rich data set of 2,626 firms that are representative of the Portuguese business sector with more than 9 employees in 2006 (excluding the financial service sector).

Our findings are particularly useful within the actual context where the Portuguese Government is encouraging (since 2005) the adoption of IT by firms (the so-called Technological Plan). A crucial prerequisite to launching effective strategies for developing and expanding IBS is to identify the key determinants of its successful adoption. This is particularly relevant for the case of Portugal, a country that, for different reasons, has been suffering for several years a serious lack of competitiveness in comparison with other EU economies.

Our paper is intended as a contribution to the empirical literature on the determinants of IT adoption, for two main reasons. Firstly, we study the determinants of IBS adoption using an integrated model and taking into account for selectivity. This topic is still quite limited in the literature [Battisti et al., 2007]. Secondly, we take Portugal as a country of application, for which there are few published studies on the subject [Parker and Castleman, 2007].

The paper is organised as follows. The next section presents the theoretical framework. Section 3 describes the data. Section 4 presents the econometric specification. In Section 5 we estimated and tested our model using on ordered probit model with selectivity and two sequential models: one probit and one ordered probit. Finally, we present major conclusion and policy implication of our results.

6.2. Factors affecting IBS: a review of literature

In the last few years there is a growing interest in the economic literature about IT use and its determinant factors [Giunta and Trivieri, 2007]. However, as mentioned before, the determination of the extent of use by adopting firms after first adoption has not been subjected to widespread research, even if it is a relevant feature [Varian et al., 2002, Wade et al., 2004]. In this section, we summarize the main determinant factors influencing IBS adoption that we used as explanatory variables in the econometric analyses. According to Dholakia and Kshetri [2004], were classified these determinants into internal and external factors. The internal factors considered are related to technological context (technology readiness, security applications, access to the IT system of the firm) and to organisational context (firm size, human capital and absorptive capacity, perceived benefits of electronic correspondence and Internet and e-mail norms). The external factors are those related to web site and e-commerce competitive pressure [Jeon et al., 2006].

Technology readiness

IT human resources [Arvanitis and Hollenstein, 2001, Battisti et al., 2007, Caselli and Coleman, 2001, Giunta and Trivieri, 2007, Hollenstein, 2004, Kiiski and Pohjola, 2002] and technology infrastructure are important to explain IT adoption. Combining both we construct a new variable labelled technology readiness. Technology readiness “is reflected not only by physical assets, but also by human resources that are complementary to physical assets” [Mata et al., 1995]. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Theoretical assertions are supported by several empirical studies, for example, Zhu et al. [2006b]. Therefore, firms with greater technology readiness are in a better position to adopt IBS.

Security applications

Technological progress may be hindered by the lack of security. For example, for Portugal in 2002 this was the greatest barrier to Internet use [Martins and Oliveira, 2005] and in China it is one of the most important barriers to the adoption of e-commerce [Tan and Ouyang, 2004]. We expect firms with a higher level of security applications to be more probable IBS adopters.

Access to the IT system of the firm

The fact that workers can have access to the IT system from outside of the firm reveals that the organisation is prepared to integrate its technologies [Mirchandani and Motwani, 2001]. Hence, firms that are able to provide more access to the IT system to workers are more probable to be IBS adopters.

Firm size

Firm size is one of the most commonly studied determinants of IBS adoption [Battisti et al., 2007, Dholakia and Kshetri, 2004, Giunta and Trivieri, 2007, Hollenstein, 2004, Honjo, 2004, Lee and Xia, 2006, Lucchetti and Sterlacchini, 2004]. Large firms are more likely to undertake innovation both because appropriability (the benefits of the new IT) is higher for larger firms and because the availability of funds for these firms is greater. However, larger firms have multiple levels of bureaucracy and this can impede decision-making processes about new ideas and projects. In addition, IT adoption often requires close collaboration and coordination, mainly for the extent of IT adoption, that can be easily achieved in small firms [Martins and Oliveira, 2008].

Human capital and absorptive capacity

To measure human capital and absorptive capacity we used IT training programs and the number of IT workers with a university degree. The presence of skilled labour in a firm increases its ability to absorb and make use of an IT innovation, and therefore is an important determinant of IBS [Arvanitis and Hollenstein, 2001, Battisti et al., 2007, Caselli and Coleman, 2001, Giunta and Trivieri, 2007, Hollenstein, 2004, Kiiski and Pohjola, 2002]. Since the successful implementation of IBS usually requires complex skills, we expect firms with IT training programs and having more IT workers with a university to be more likely to adopt IBS.

Perceived benefits of electronic correspondence

Empirical studies consistently found that perceived benefits have a significant impact in IT and IBS adoption [Beatty et al., 2001, Gibbs and Kraemer, 2004, Hollenstein, 2004, Iacovou et al., 1995, Kuan and Chau, 2001]. We anticipate that firms who adopt IBS are those who further recognize the perceived benefits of electronic correspondence.

Internet and e-mail norms

Regulatory environment has been acknowledged as a critical factor influencing innovation diffusion [Borenstein and Saloner, 2001, Zhu et al., 2003, Zhu et al., 2006b, Zhu et al., 2004]. Firms often refer inadequate legal protection for online business activities, unclear business laws, and security and privacy as concerns in using web technologies [Kraemer et al., 2006]. In our context we believe that firms that have implemented Internet and e-mail norms are more confident on how to use this type of IT.

External factors

Empirical evidence suggests that industry competitive pressure is a powerful driver of IT adoption and diffusion [Battisti et al., 2007, Gibbs and Kraemer, 2004, Hollenstein, 2004, Iacovou et al., 1995, Zhu et al., 2003]. We expect the probability of adopting IBS to be positively influenced by the proportion of adopters in the industry or sector to which the specific firm is affiliated.

6.3. Data

We used a sample of 2,626 firms with more than 9 employees that is statistically representative of the whole private business sector in Portugal at January 2006, excluding the financial sector. The sample is stratified by economic sector (NACE classification), number of employees and turnover. Based on a special agreement between our Institution (ISEGI) and the National Institute of Statistics, we had the right to use the data from the National survey on the Use of IT by Firms. This is a very rich questionnaire that provided all of the information we need to attain our research objectives.

6.4. Econometric specification

In our theoretical framework, we classified firms into five categories based on their IBS intensity, according to Varian *et al.* [2002] terminology, and using Rogers' [2003] adopter categories, that are: firms that don't have web site - laggards; firms that have web site – late majority; firms that have web site and customer development/e-marketing – early majority; firms that have web site, customer development/e-marketing and customer service & support – early adopters; firms that have web site, customer development/e-marketing, customer service & support and digital e-commerce – pioneers. In Figure 6.1 we compare theoretical Rogers adopter curve with the adopter curve of our study [Beatty et al., 2001, Rogers, 2003]. As can be seen, our curve is in accordance with the adoption curve proposed by Rogers [2003].

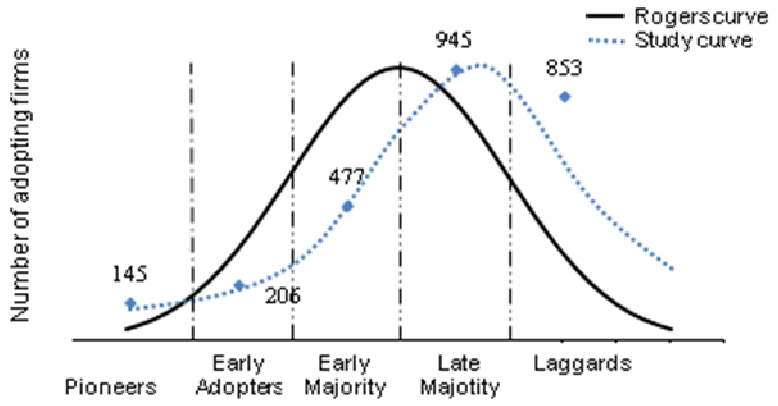

Figure 6.1. Comparison of Rogers adopter curve with adopter curve from this study
Source: [Rogers, 2003]

As suggested by the literature [Daniel and Grimshaw, 2002, Dholakia and Kshetri, 2004, Martin and Matlay, 2001, Reid and Smith, 2000] the adoption process has stages and the influence patterns of internal and external factors vary with the stage of adoption. In our model we define two adoption stages: first stage: web site adoption decision and second stage: level of IBS adoption decision (see Figure 6.2).

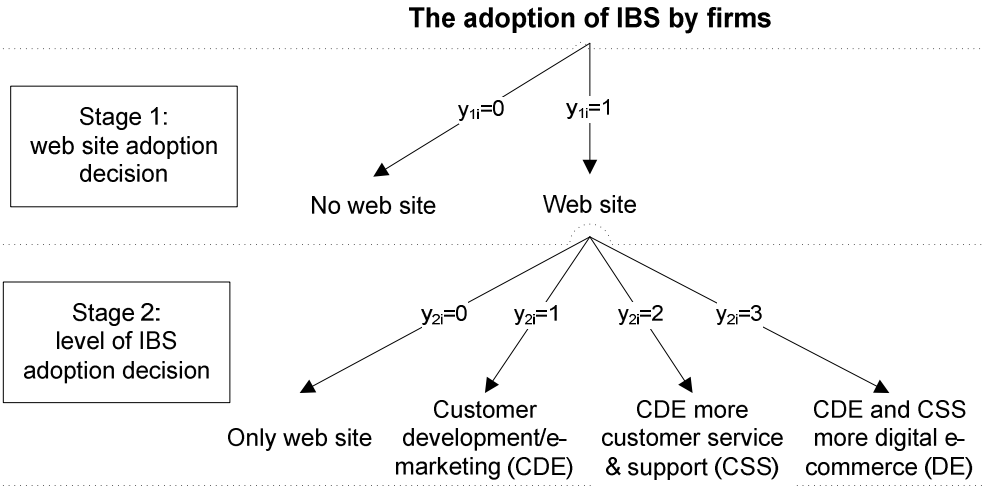

Figure 6.2. The adoption of IBS by firms

The level of IBS adoption decision should be modelled jointly with the decision on web site adoption because the level of IBS is censored when no web site adoption is observed. It is obvious that if we restrict our analysis only to those firms who adopted web site, probably sample selection bias will be introduced [Greene, 2008, Heckman, 1979]. For this reason, we employ techniques that control sample selection bias and, in addition, as the data employed in the present study report the level of IBS as an ordinal variable, the standard sample selection model [Heckman, 1979] has been extended to accommodate ordinality [Dubin and Rivers, 1990, Greene, 2008].

To account for the ordinal character of the level of IBS, we use an ordered probit model along the lines suggested by McKelvey and Zavoina [1975], which is based on the following specification:

$$y_{2i}^{*} = \mathbf{x_{2i}}\boldsymbol{\beta}_{2i} + \varepsilon_{2i} \tag{6.1}$$

Where, y_2* is a latent variable represented by y_{2i} with the following structure:

$$y_{2i} = \begin{cases} 0 & \text{if } y_{2i}^{*} \le \mu_0 = 0 \\ 1 & \text{if } \mu_0 \le y_{2i}^{*} \le \mu_1 \\ \ldots & \\ J & \text{if } y_{2i}^{*} > \mu_{j-1} \text{ and } 0 < \mu_1 < \mu_2 < .... < \mu_{j-1} \end{cases} \tag{6.2}$$

The variable of theoretical interest y_{2i}^{*} is a continuous unobserved index of the level of IBS. The observed rating categories, y_{2i}, are assumed to represent an ordered partitioning of

this continuous scale where, y_{2i} is the observed rating category for the *i*th firm, $\boldsymbol{\beta_2}$ is a vector of coefficients, $\boldsymbol{x_{2i}}$ is a vector of explanatory variables for the *i*th individual, e_{2i} is a standard normal random error and the μ_j are threshold parameters. Higher $\boldsymbol{\beta_2}$ values indicate greater probability of higher level of IBS adoption. For four response levels (i.e. rating categories, $J + 1 = 4$), the probabilities are given by:

$$\begin{aligned} P(y_{2i} = 0) &= \Phi(-\mathbf{x}_{2i}\boldsymbol{\beta}_2) \\ P(y_{2i} = 1) &= \Phi(\mu_1 - \mathbf{x}_{2i}\boldsymbol{\beta}_2) - \Phi(-\mathbf{x}_{2i}\boldsymbol{\beta}_2) \\ P(y_{2i} = 2) &= \Phi(\mu_2 - \mathbf{x}_{2i}\boldsymbol{\beta}_2) - \Phi(\mu_1 - \mathbf{x}_{2i}\boldsymbol{\beta}_2) \\ P(y_{2i} = 3) &= 1 - \Phi(\mu_2 - \mathbf{x}_{2i}\boldsymbol{\beta}_2) \end{aligned} \tag{6.3}$$

where, $\Phi(\cdot)$ is the cumulative normal distribution function. In the ordered probit model with selection, the correlation (denoted by ρ) between the error terms of the decision to adopt web site and the level of IBS equations can be obtained. A test for the existence of selectivity bias can then be performed by testing whether ρ differs from zero [Dubin and Rivers, 1990].

Thus, the ordered probit model with selectivity is specified as:

$$y_{1\mathrm{i}}^{*} = \mathbf{x_{1i}}\boldsymbol{\beta_1} + \varepsilon_{1i} \tag{6.4}$$

Where, y_{1i}* is a latent variable represented by y_{1i} with the following structure:

$$y_{1\mathrm{i}} = \begin{cases} 0 & \text{if } y_{1i}^{*} \le \mu = 0 \\ 1 & \text{if } y_{1i}^{*} > \mu = 0 \end{cases} \tag{6.5}$$

Further, y_{2i} satisfies the ordered probit specification of Equation (6.2) and [y_{2i}] is observed if and only if $y_{1i} = 1$. The variable y_{1i}^{*} is a continuous unobserved variable measuring the propensity to obtain a rating, i.e. web site adopted. Also, $\mathbf{x_{1i}}$ is a vector of explanatory variables and $\boldsymbol{\beta_1}$ is the associated vector of coefficients. Lastly, we assume that the random errors ε_1 and ε_2 follow a bivariate standard normal distribution with correlation, ρ. If the hypothesis of uncorrelated errors (ρ=0) is not rejected then we can proceed as usual by specifying two sequential models. This means that we can compute, without existence

of selectivity bias, one probit model for web site adoption with all firms and one ordered probit model for the level of IBS only with firms that had adopted web site.

Definition of the explanatory variables

A technology readiness index was built by aggregating 8 items on technologies used by the firm (dummy variables) and one item standing for existence of IT specific skills in the firm (dummy variable). To aggregate the items measured in yes/no scale, we used multiple correspondence analyses (MCA). For further details see Appendix D. Security applications was measured by the number of existing security applications and ranges from 0 to 6. Access to the IT system of the firm was measured by the number of places from which workers access the firm information systems. Firm size was measured by three dummies: small firms (10 up to 49 employees); medium-size firms (50 up to 249 employees); large firms (more than 249 employees). The base group is represented by small firms. Human capital and absorptive capacity was measured by two variables: IT training programs is related to the existence of professional training in computer/informatics available to workers in the firm (dummy variable); the number of IT workers with a university degree divided by ten. Perceived benefits of electronic correspondence was measured by the shift from traditional postal mail to electronic correspondence as the main standard for business communication, in the last 5 years (dummy variable). Internet and e-mail norms was measured by whether firms have defined norms about Internet and e-mail (dummy variable). Web site competitive pressure and e-commerce competitive pressure are computed as the percentage of firms in each of the 9 industries that had already adopted a web site/e-commerce two years before the time of the survey, i.e. in 2004. The rationality underlying our model is that an observation of the firm on the adoption behaviour of its competitors influences its own adoption decision [Battisti et al., 2007, Hollenstein, 2004, Zhu et al., 2003]. To control for economic specific behaviour, we used a dummy variable that is equal to one if the firm belongs to the service sector (real estate, renting and business activities and other services) and zero otherwise. For a complete description of the variables used in the econometric analysis and for a summary statistics see Tables 6.1 and 6.2, respectively.

Table 6.1: Description of variables

	Description
Explained variables	
WEB	Dummy =1 if firms have web site and zero otherwise
LIBS	Level of IBS (0- if firm only have web site; 1 – if firms have web site with customer development/e-marketing; 2 - if firms have web site with customer development/e-marketing and customer service & support; 3 - if firms have web site with customer development/e-marketing, customer service & support and digital e-commerce).
Explanatory variables	
TR	MCA index of technology readiness
SA	Number of security applications
ITSF	Number of access to the IT system of the firm
Firm Size:	
- S_1	Dummy =1 if firms have 10-49 employees and zero otherwise
- S_2	Dummy =1 if firms have 50-249 and zero otherwise
- S_3	Dummy =1 if firms have more than 249 and zero otherwise
Human capital and absorptive capacity:	
- ITTP	Dummy =1 if firms have IT training programs and zero otherwise
- ITWD/10	Number of IT workers with a university degree divided by 10
PBEC	Dummy =1 if firms have perceived benefits of electronic correspondence and zero otherwise
IEN	Dummy =1 if firms have Internet and e-mail norms and zero otherwise
Competitive Pressure:	
- WEBP	Percentage of firms in each of the 9 industries that had already adopted a web site in 2004
- EP	Percentage of firms in each of the 9 industries that had already adopted a e-commerce in 2004
Industry type	
- SER	Dummy =1 if firms belong to the service sector and zero otherwise
- MAN	Dummy =1 if firms belong to the manufacturing sector and zero otherwise

Table 6.2: Summary statistics

Variable	All firms (n=2,626)				Firms with web site (n=1,773)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Web site (WEB)	0.675	0.468	0.000	1.000	1.000	0.000	1.000	1.000
Level of IBS (LIBS)	0.504	0.859	0.000	3.000	0.747	0.955	0.000	3.000
- Level 0	0.675	0.468	0.000	1.000	1.000	0.000	1.000	1.000
- Level 1	0.315	0.465	0.000	1.000	0.467	0.499	0.000	1.000
- Level 2	0.134	0.340	0.000	1.000	0.198	0.399	0.000	1.000
- Level 3	0.055	0.228	0.000	1.000	0.082	0.274	0.000	1.000
Technology Readiness (TR)	0.000	0.613	-1.838	0.862	0.212	0.488	-1.282	0.862
Security applications (SA)	3.811	1.687	0.000	6.000	4.288	1.411	0.000	6.000
Access to the IT system of the firm (ITSF)	1.535	0.904	0.000	4.000	1.720	0.970	0.000	4.000
Firm Size:								
- Small size firms (S_1)	0.350	0.477	0.000	1.000	0.265	0.442	0.000	1.000
- Medium size firms (S_2)	0.408	0.492	0.000	1.000	0.428	0.495	0.000	1.000
- Large firms(S_3)	0.243	0.429	0.000	1.000	0.307	0.461	0.000	1.000
Human capital and absorptive:								
- IT training programs (ITTP)	0.579	0.494	0.000	1.000	0.695	0.460	0.000	1.000
- IT workers with a degree (ITWD/10)	0.268	2.092	0.000	66.9	0.375	2.492	0.000	69.9
Perceived benefits of electronic correspondence (PBEC)	0.311	0.463	0.000	1.000	0.382	0.486	0.000	1.000
Internet and e-mail norms (IEN)	0.652	0.477	0.000	1.000	0.758	0.428	0.000	1.000
Competitive Pressure								
- Web site competitive pressure (WEBP)	49.398	12.928	23.810	85.000	51.414	12.446	23.810	85.000
- E-commerce competitive pressure (EP)	9.036	5.189	0.032	1.231	0.134	0.229	0.000	27.500
Industry type								
- Service (SER)	0.576	0.494	0.000	1.000	0.605	0.489	0.000	1.000
- Manufacturing or other non service(MAN)	0.424	0.494	0.000	1.000	0.395	0.489	0.000	27.500

6.5. Estimation results

The ordered probit model with and without selectivity was estimated, as usual, using maximum likelihood methods. The estimation results are presented in Table 6.3.

Table 6.3: Internet business solution estimation model

	Ordered probit with selectivity		Sequential equations	
			Probit	Ordered probit
	Web site	**Level of IBS**	**Web site**	**Level of IBS**
Technology Readiness (TR)	0.710***	0.230*	0.709***	0.279***
Security applications (SA)	0.088***	0.081***	0.088***	0.088***
Access to the IT system of the firm (ITSF)	0.170***	0.032	0.171***	0.040
Firm Size:				
- Medium size firms (S_2)	0.068	-0.116	0.068	-0.111
- Large firms(S_3)	0.264***	-0.234***	0.267***	-0.220***
Human capital and absorptive capacity:				
- IT training programs (ITTP)	0.277***	0.059	0.276***	0.080
- IT workers witha degree (ITWD/10)	-0.005	0.022**	-0.004	0.021**
Perceived benefits of electronic correspondence (PBEC)	0.172**	-0.060	0.168**	-0.050
Internet and e-mail norms (IEN)	0.154**	0.176**	0.155**	0.191***
Industry type				
- Service (SER)	-0.128*	0.106	-0.125*	0.101
Competitive Pressure				
- Web site competitive pressure (WEBP)	0.021***	-	0.021***	-
- E-commerce competitive pressure (EP)		0.039***	-	0.041***
Constant	-1.360***	-	-1.361***	-
_cut1	-	0.955**	-	1.124***
_cut2	-	1.780***	-	1.952***
_cut3	-	2.360***	-	2.535***
Likelihood ratio test of independent equations (ρ=0)	-0.154		-	
Sample size	2,626		2,626	1,173
Log- likelihood	-3,144.82		-1,215.56	-1,929.40
Chi-squared	$X^2_{22} = 744.20$***		$X^2_{11} = 880.04$***	$X^2_{11} = 195.91$***

Note: We used STATA software to estimate the ordered probit with selectivity [Miranda and Rabe-Hesketh, 2006], probit and ordered probit; * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

The columns two and three of Table 6.3 report the estimation results for ordered probit with selectivity. We used a likelihood ratio test which tests the null hypothesis of uncorrelated errors (H_0: ρ=0). No support was found to reject this hypothesis, at the usual 5% significance level (p-value=0.52). This result suggests that the web site and the level of IBS adoption decisions can be estimated sequentially, without the existence of selectivity bias. This means that the probability of being a web site adopter does not necessarily mean being a more advanced adopter. As many firms with web presence do not actually adopt IBS extent we expect that the first stage adoption is less likely to bring fundamental changes to the firm. This point has rarely been tested in practice and was also emphasized by Hong and Zhu [2006].

The last two columns of Table 6.3 report the estimation results for the sequential probit model: one single probit (with all firms) and one ordered probit (with only firms that use web site). It is on these sets of results that we concentrate the remaining part of the paper. The variables in these models are not highly correlated with other regressors. As can be seen from Table 6.3, for the web site adoption decision all the coefficients have the expected signs and the only explanatory variable that is not statistically significant is IT workers with an university degree (ITWD/10). We can identify eight relevant drivers of web site adoption: technology readiness (TR), Security application (SA), firm size, perceived benefits of electronic correspondence (PBEC), IT training programs (ITTP), access to the IT system of the firm (AITSF) and Internet and e-mail norms (IEN) reflecting the internal factors; web site competitive pressure (WEBP) characterizing the external pressure factors. For the level of IBS adoption, the estimated coefficients that are statistically significant are: technology readiness (TR), security applications (SA), firm size (S_3), IT workers with a university degree (ITWD/10), Internet and e-mail norms (IEN) and e-commerce competitive pressure (EP). As a whole, the results are in accordance with the theory and with those found in the literature that is illustrated in Section 6.2.

To policy purposes, it is useful to compute the so-called marginal effects (for more details of marginal effects see Greene [2008]). The estimated marginal effects, at the mean of the explanatory variables, for the significant determinants of IBS model are reported in Table 6.4.

Table 6.4. Marginal effects for Internet business solutions

	Probit	Ordered probit			
	WEB	LIBS=0	LIBS=1	LIBS=2	LIBS=3
Technology Readiness (TR)	0.2376	-0.1110	0.0378	0.0370	0.0362
Security applications (SA)	0.0296	-0.0349	0.0119	0.0116	0.0114
Access to the IT system of the firm (ITSF)	0.0574	ns	ns	ns	ns
- Medium size firms (S_2)	ns	ns	ns	ns	ns
- Large firms(S_3)	0.0855	0.0869	-0.0315	-0.0286	-0.0268
- IT training programs (ITTP)	0.0935	ns	ns	ns	ns
- IT workers with a degree (ITWD/10)	ns	-0.0084	0.0029	0.0028	0.0027
Perceived benefits of electronic correspondence (PBEC)	0.0552	ns	ns	ns	ns
Internet and e-mail norms (IEN)	0.0527	-0.0754	0.0276	0.0248	0.0230
- Service (SER)	-0.0417	ns	ns	ns	ns
- Web site competitive pressure (WEBP)	0.0069	-	-	-	-
- E-commerce competitive pressure (EP)	-	-0.0163	0.0056	0.0054	0.0053

Note: ns mean that the variable is not significant.

There are several differences between the first and second stages of adoption results, confirming the idea that the impact of the explanatory variables is not the same for web site adoption and the level of IBS adoption. Firstly, the variable large firms (S_3) have the opposite effect, meaning that large firms (S_3) are more likely to adopt a web site, but small firms that adopted a web site are the ones that adopted more levels of IBS. For example, a large firm displays an 8.6% greater predicted probability of having a web site than a small firm. The level of IBS adoption reveals that a large firm has a 2.7% less predicted probability of being a pioneer (WEBF=3). This means that small firms use higher levels of IBS as a strategy to achieve customers. This result is consistent with Martins and Oliveira [2008] who suggested that small firm adopters may possess certain advantages that allow them to use the Internet more intensively and with Lee and Xia [2006], who stated that while large organizations tend to have advantage in the early stages, they face critical challenges in the latter ones. Secondly, the variables used to measured human capital and absorptive capacity have significant different impacts at the two adoption stages. The coefficients related to IT training programs (ITTP) are statistical significant only in web site adoption, while the variable IT workers with an university degree (ITWD/10) is only statistically significant for the level of IBS adoption decision. This reveals that for more advanced level of adoption a solid human capital background is necessary. Another difference is in the marginal effects of the variable technology readiness (TR); it has a stronger effect in web site adoption than in the level of IBS adoption decision. For example, the marginal effect for technology readiness (TR) in web site adoption is 23.8%, meaning that when the index of technology readiness (TR) increases 1 unit, the probability of being web site adopter increases 23.8%. The same effect for the level of IBS adoption shows that for early adopters (WEBF=2) and pioneers (WEBF=3) the predicted probability is about 3.7%. This means that technology readiness is more important for firms that adopted web site than for those who have adopted higher levels of IBS.

The security applications (SA), Internet and e-mail norms (IEN) and respectively competitive pressure are the unique variables that are statistically significant and have identical impacts in both models. This reveals that the impact of security, legacy system and competitive pressure is the same at both adoption stage levels.

6.6. Conclusions

In this study we proposed a conceptual model to analyse the determinants of IBS adoption decisions by firms, that is estimated using a ordered Probit model with sample selection. IBS adoption is of major importance because it enables firms to increase revenue generation through externally focused initiatives such as expansion into new markets and development of new products and services [Varian et al., 2002, Wade et al., 2004].

The idea behind our paper was to offer a contribution to the empirical literature on a topic, namely IT adoption by firms, which for integrated IBS models yet seem limited. Moreover, only few empirical publications exist for southern European countries as Portugal. In contrast with most studies on IT adoption, which are based on small samples of firms mostly located a specific area, our study examined 2,626 firms representative of the Portuguese private economic sectors (except the financial one).

The adopter curve in our study is identical to the one proposed in the innovation theory [Beatty et al., 2001, Rogers, 2003]. Based on the ordered probit model with selectivity, no support was found for sample selection. Hence, for this sample of Portuguese firms, the web site and the level of IBS can be estimated separately and sequentially. In line with other findings about the adoption of basic and more advance IT [Battisti et al., 2007, Battisti and Stoneman, 2003, Battisti and Stoneman, 2005, Hollenstein, 2004, Martins and Oliveira, 2008, Oliveira et al., 2008], we conclude that to be an IT adopter (web site) does not mean being an extensive IT user (the level of IBS). Our empirical results also validate the internal and external factors framework for identifying the facilitators and inhibitors of IBS adoption. Moreover, our results demonstrated that, as suggested by other authors [Daniel and Grimshaw, 2002, Dholakia and Kshetri, 2004, Martin and Matlay, 2001, Reid and Smith, 2000] the influence patterns of factors vary with the stage of adoption. The major findings are the following. Firstly, our results suggest that the unique factors that are important and have identical effects in both models are security applications (SA), Internet and e-mail norms (IEN) and competitive pressure. This reveals that security, legacy system and competitive pressure are transversal to both adoption decision processes. Secondly, other variables have limited influence: perceived benefits of electronic correspondence (PBEC), IT training programs (ITTP) and access to the IT system of the firm (AITSF), had a significant effect on web site adoption decision but had no effect on the

level of IBS adoption. This indicates that once a firm decides to own a web site, these variables become less important to determine the level of IBS adoption. On the other hand, IT workers with a university degree (ITWD/10) have a relevant impact on the level of IBS adoption decision but are not important within the web site adoption model. This reveals that for more advanced levels of IBS adoption solid background of human capital of firms in IT is necessary. In addition, large firms (S_3) are more likely to use a web site and less likely to use higher levels of IBS, that is, large firms are the first to adopt web site; however, small firms (S_1) that adopted web site have higher level of IBS adoption (pioneers). This means that small firms use more advanced levels of IBS as a strategy to achieve customers. This is in accordance with the idea that large organizations tend to have advantage in the early stages, but they face critical challenges in the latter ones [Lee and Xia, 2006].

Our findings have practical implications for managers and policy makers at the national and European Union (EU) level. In terms of policy implications, the above findings suggest that European and national actions aimed at increasing IT use by firms (e-Europe action plan[1]; i2010 initiative; technological plan), should be based on a well-aimed policy mix. A key factor, at the national level, is the improvement of IT skills at the basic and higher levels. This can be achieved by lowering, through different types of policy instruments, the IT training cost, and by promoting a closer relationship between firms, associations and education institutions. In our opinion, the improvement of the legal and regulatory environment is a task that pertains to the European Commission. With the cost of infrastructure technology decreasing, the lack of qualified IT human resources is probably one of the major constraints for Portuguese firm's technology readiness improvement.

Our study also has important implications for managers who are involved in processes of introducing IT innovations into their organizations. Managers should be aware that technology readiness constitutes both physical infrastructure and intangible knowledge such as IT skills. This urges top leaders to foster managerial skills and human resources that possess knowledge of these new information technologies.

[1] For further details on this plans see for example: http://ec.europa.eu/information_society/eeurope/2005/index_en.htm, http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm and http://www.planotecnologico.pt/.

As in most empirical studies, our work is limited in some ways. The cross-sectional nature of this study does not allow us to know how this relationship will change over time. Neither it permits to analyse unobserved random effects. To solve this limitation the future research should involve panel data.

Chapter 7 – Firms patterns of e-business adoption: evidence for the European Union-27

7.1. Introduction

The development of e-business capability is crucial since it is swiftly chaining the way that companies buy, sell, and deal with customers, becoming a more integral part of its business strategies [Abu-Musa, 2004]. E-business adoption becomes a significant research topic because it enables the firm to execute electronic transactions along value chain activities [Straub and Watson, 2001, Zhu and Kraemer, 2002]. It represents a new way to integrate Internet-based technologies with core business potentially affecting the whole business [Zhu, 2004a].

The European Commission [2005] claims that more efforts are needed to improve e-business in European firms if the Lisbon targets of competitiveness are to be accomplished. European firms, under the pressure of their main international competitors, need to find new opportunities to reduce costs and improve performance. For this reason, it is fundamental to identify the patterns of e-business adoption among firms in European Union (EU) members.

To the best of our knowledge, very limited empirical research has been performed to identify the patterns of e-business adoption among firms in EU27 using the technology, organization and environment (TOE) contexts. This study fills this gap. The main objectives of this study are the following:

- To identify distinct clusters of e-business adoption;
- To characterize the pattern of e-business adoption by firms across these clusters;
- To understand the extent to which industry e-business adoption characteristics are more or less relevant than country specific characteristics.

The paper is organized as follows. The next section presents the literature review of the factors affecting e-business adoption. After we describe the data used. Then, we define

the methodology used and present the results obtained. Finally, we present conclusions and future research.

7.2. e-Business adoption by firms: literature review

Several authors [Hong and Zhu, 2006, Kuan and Chau, 2001, Lin, 2008, Oliveira and Martins, 2008, Pan and Jang, 2008, Thong, 1999, Zhu et al., 2003, Zhu et al., 2006b] used the TOE framework, developed by Tornatzky and Fleisher [1990], to analyse information technology (IT) adoption by firms. Based on the TOE framework, we stipulate that three aspects may possibly influence e-business adoption: technological context (technology readiness and technology integration); organizational context (firm size, expected benefits and obstacles of e-business and improved products or services or internal processes); and environmental context (Internet penetration and competitive pressure).

Technology context

Technology readiness can be defined as technology infrastructure and IT human resources. Technology readiness "is reflected not only by physical assets, but also by human resources that are complementary to physical assets" [Mata et al., 1995]. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Theoretical assertions are supported by several empirical studies [Armstrong and Sambamurthy, 1999, Hong and Zhu, 2006, Iacovou et al., 1995, Kwon and Zmud, 1987, Pan and Jang, 2008, Zhu, 2004b, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b].

Evidence from the literature suggests that technology integration helps improve firm performance by reduced cycle time, improved customer service, and lowered procurement costs [Barua et al., 2004]. E-business demands close coordination of various components along the value chain. Correspondingly, a greater integration of existing applications and the Internet platform represent a greater capacity of conducting business over the Internet [Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003, Zhu et al., 2006b].

Organization context

Firm size is one of the most commonly studied determinants of IT adoption [Lee and Xia, 2006]. Large firms are more likely to undertake innovation. Three major arguments support the positive role of firm size in determining IT adoption: appropriability (the benefits of the new IT), the greater availability of funds and the quicker capture of economies of scale. However, larger firms have multiple levels of bureaucracy and this can impede decision-making processes about new ideas and projects. Moreover, IT adoption often requires close collaboration and coordination that can be easily achieved in small firms.

Empirical studies consistently found that perceived benefits have a significant impact in IT adoption [Beatty et al., 2001, Gibbs and Kraemer, 2004, Iacovou et al., 1995, Kuan and Chau, 2001, Lin and Lin, 2008]. Perceived obstacles are particularly relevant because the adoption process may be complicated and costly [Pan and Jang, 2008, Zhu et al., 2006b]. Improved products or services or internal process that are enabled by or related to a subset of IT, namely e-business technologies [Koellinger, 2008].

Environment context

Internet penetration measures the adoption and diffusion of computer and Internet of individual and household in the population of each country. It is a important factor for decision makers of e-business adoption because it reflects the potential market [Zhu et al., 2003].

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Porter and Millar [1985] analyzed the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by using a new innovation, firms might be able to alter the rules of competition, affect the industry structure, and leverage new ways to outperform rivals, thus changing the competitive landscape. This analysis can be extended to IT adoption. Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion [Al-Qirim, 2007,

Battisti et al., 2007, Dholakia and Kshetri, 2004, Gibbs and Kraemer, 2004, Grandon and Pearson, 2004, Hollenstein, 2004, Iacovou et al., 1995, Mehrtens et al., 2001, Zhu et al., 2003].

7.3. Data

Our data source is the e-Business W@tch [w@tch, 2006a, w@tch, 2006b], which collects data concerning the use of information communication technology (ICT) and e-business in European enterprises. The data, collected by means of representative surveys of firms that used computers, are related to EU27 members and had a scope of 12,439 telephone interviews with decision-makers in enterprises. Interviews were carried out in March and April 2006, using computer-aided telephone interview (CATI) technology. The sample drawn was a random sample of companies from the respective sector population in each of the countries.

According to the methodological recommendations of Eurostat, the situation of an operator that “did not answer” or “does not know” the answer to a specific question should not imply its imputation, in any case, based on the answer of the other operators. Consequently, we obtained a smaller sample that we compared, by a proportion test, with the original one. The proportion test for the variable e-business adoption reveals that the only country where statistically significant differences exist is Bulgaria. For this reason we excluded it from our analysis.

We also used, as additional information, the Eurostat data (Survey on ICT Usage in Households and by Individuals 2006) to compute the Internet penetration index by country. We excluded Malta because no data were available. The final sample includes 6,694 firms belonging to the EU27 members excluding Malta and Bulgaria. About 80 percent (79.0%) of the data was collected from owners, managing directors, heads of IT and other senior members of IT, suggesting the high quality of the data source.

7.4. Methodology and results

As a first step, we group the items to reduce the number of variables of the survey; for that we applied a factor analysis (FA). Then, to determine homogenous groups of firms in terms of e-business adoption, we applied cluster analysis (CA).

7.4.1. Factor analysis results

We performed a FA of multi-item indicators to reduce the number of variables of the survey and to evaluate the validity. We used the principal component technique with varimax rotation (see Table 7.1) to extract four eigen-value, which were all greater than one. The first 4 factors explain 72.4% of variance contained in the data. The Kaiser-Meyer-Olkin (KMO) measures the adequacy of sample; KMO general is 0.91, which reveals that the matrix of correlation is appropriate for the FA. The KMO for individual variables is also adequate. All the factors have a loading greater than 0.50 (except TI4). This indicates that our analysis is based on a well-explained factor structure. The four factors found are: expected benefits and obstacles of e-business, Internet penetration, technology readiness and technology integration. These factors are in accordance with the literature review.

Table 7.1: Factor and validity analysis

Items measured	F1	F2	F3	F4
Expected benefits and obstacles of e-business (EBOEB)				
Why did your company decided to engage in e-business activities? (0-not at all; 1-not important; 2-important)				
EB1 - Because your customers expected it from you	**0.91**	0.01	0.11	0.06
EB2 - Because your company believes that e-business will help to get an edge over your competitors	**0.90**	-0.04	0.13	0.05
EB3 - Because your competitors also engage in e-business	**0.88**	-0.02	0.08	0.04
EB4 - Because your suppliers expected it from you	**0.87**	-0.03	0.10	0.05
Important obstacles for not practising e-business in your company? (0-not at all; 1-not important; 2-important)				
EO1 - My company is too small to benefit from any e-business activities	**-0.93**	-0.02	-0.11	-0.04
EO2 - E-business technologies are too expensive to implement	**-0.94**	-0.03	-0.08	-0.02
EO3 - Our systems are not compatible with those of suppliers or customers	**-0.94**	-0.03	-0.06	-0.01
EO4 - We are concerned about potential security risks and privacy issues	**-0.94**	-0.03	-0.05	-0.01
EO5 - We think that there are important unsolved legal issues involved	**-0.95**	-0.04	-0.05	-0.01
EO6 - It is difficult to find reliable IT suppliers	**-0.95**	-0.03	-0.06	-0.01
Internet penetration (IP)				
IP1 - Individuals using computer in the European Union	0.02	**0.98**	0.05	-0.05
IP2 - Individuals using Internet in the European Union	0.01	**0.98**	0.05	-0.05
IP3 - Households with Internet access at home	0.03	**0.97**	0.03	-0.03
IP4 - Households with computer (International Benchmarking)	0.02	**0.97**	0.01	-0.01
IP5 - Households using a broadband connection to the Internet (International Benchmarking)	0.05	**0.92**	0.01	0.00
IP6 - Individuals using Internet commerce in the European Union	-0.04	**0.92**	0.06	0.00
Technology readiness (TR)				
TR1 - Sum of the following network applications: a Local Area Network (LAN); Wireless LAN; Voice-over-IP; Fixed line connections; Wireless-Local-Area-Networks or W-LANs, Mobile communication networks; Virtual Private Network (VPN)	0.18	0.08	**0.75**	0.16
TR2 - Sum of the following technologies: Internet; intranet; web site;	0.24	0.08	**0.68**	0.08
TR3 - Sum of the following questions ICT skills: your company currently employ ICT practitioners; your company regularly send employees to ICT training programmes	0.14	0.01	**0.66**	0.18
TR4 - Sum of the following security applications: secure server technology, for example SSL, TLS or a comparable technical standard; digital signature or public key infrastructure; a firewall	0.22	0.11	**0.66**	0.08
TR5 - Sum of the following online applications other than e-mail: to share documents between colleagues or to perform collaborative work in an online environment; to track working hours or production time; to collaborate with business partners to forecast product or service demand; to collaborate with business partners in the design of new products or services; to manage capacity or inventories; to send e-invoices to customers in the public sector; to send e-invoices to customers in the private sector; to receive e-invoices from suppliers.	0.23	0.05	**0.55**	0.32
TR6 - Percentage of employees that have access to the Internet	0.12	0.17	**0.55**	-0.25
Technology Integration (TI)				
Does your company use any of the following systems or applications for managing information in the company (0- do not know what this is; 1-no; 2-yes)?				
TI1 - a SCM system, that is a Supply Chain Management System	0.08	-0.07	0.06	**0.68**
TI2 - an EDM system, that is an Enterprise Document Management System	0.08	-0.15	0.11	**0.65**
TI3 - an ERP system, that is Enterprise Resource Planning System	0.06	-0.06	0.27	**0.65**
TI4 - Knowledge Management software	0.06	0.03	0.21	**0.49**
Eigen value	**8.72**	**5.57**	**2.73**	**1.80**
Percentage of variance explained	**33.55**	**21.43**	**10.50**	**6.94**

Note: variables are marked according to factor loading

7.4.2. Cluster analysis results

To perform the CA we used the variables presented in Table 7.2 obtained from the FA (TR, TI, EBOEB and IP) and also some variables computed directly (SIZE, IPSIP and CP) from the e-Business W@tch survey.

Table 7.2: Description of variables used in CA

Variables	Description
Technological context	
Technology readiness (TR)	FA index of technology readiness
Technology integration (TI)	FA index of technology integration
Organizational context	
Firm size (SIZE)	The logarithm number of employees
Expected benefits and obstacles of e-business (EBOEB)	FA index of expected benefits and obstacles of e-business
Improved products or services or internal processes (IPSIP)	Binary =1 if firms improved products or services or internal processes
Environmental context	
Internet penetration (IP)	FA index of Internet penetration
Competitive pressure (CP)	Binary =1 if firms think that ICT has an influence on competition in their industry

The objective of the CA is to classify firms in homogenous groups, so that firms from the same group are as similar as possible in what concerns the pattern of e-business adoption, and as different as possible from firms belonging to other groups. The variables used to perform the CA have measurement scales that are both quantitative and qualitative, and so, it was necessary to use the dissimilarity matrix calculated through the method proposed by Gower [Gower, 1971]. For that, we used the statistical analysis system (SAS) software and the distance macros [SAS, 2003]. Once the dissimilarity matrix was computed, we performed, as usual, a hierarchical CA, through the most known methods: Ward, median, centroid, complete linkage and single linkage. From the results obtained from these five methods, it was possible to determine the optimal number of groups (four), as well as the method that best fits these data (Ward), (see Appendix E). The centroids of the clusters obtained through Ward's method were used as initial seeds for the non hierarchical model (*k-means*), which allowed us to refine the previous solution. According to Sharma [1996], this is the best solution to obtain clusters.

To characterise the groups we used as auxiliary variables the firm size (by classes), industries and countries (Table 7.3).

Table 7.3: Description of adoptions and auxiliary variables

Variables	Description
Adoption	
E-business (EB)	Binary =1 if firm adopts e-purchasing or e-selling
e-purchasing adoption (e1)	Binary =1 if firm adopts e-purchasing
e-selling adoption (f4)	Binary =1 if firm adopts e-selling
Auxiliary	
Size by classes (micro, small, medium and large)	Four binary variable for each size
Industry (manufacture, construction, tourism and telecommunications)	Four binary variables for each industry
EU27 members (excluding Malta and Bulgaria)	Twenty-five binary variables for each country

Summary statistics for variables in each cluster are provided in Table 7.4. Clusters patterns were compared using chi-squared tests for binary variables and Kruskal-Wallis test for quantitative variables. All variables, except auxiliary variables related to countries, present statistically significant differences across clusters, suggesting that our cluster analysis generated groups of firms that are statistically distinct according to the variables characterising e-business adoption.

Table 7.4: Summary statistics for CA

	All	Cluster				Statistic Test (p-value)
		1	2	3	4	
Number of firms	**6,964**	**1,699**	**1,150**	**1,509**	**2,606**	
Percentage of firms	**100.0%**	**24.4%**	**16.5%**	**21.7%**	**37.4%**	
TOE Variables						
Technology readiness (TR)	**0.000**	-0.482	-0.041	-0.215	0.457	991.69 (<0.001)
Technology integration (TI)	**0.000**	-0.140	0.090	-0.155	0.141	83.76 (<0.001)
Firm size (SIZE)	**2.733**	2.406	2.948	2.473	3.003	183.69 (<0.001)
Expected benefits and obstacles of e-business (EBOEB)	**0.000**	-0.480	-0.205	0.141	0.322	710.83 (<0.001)
Improved products or services or internal processes (IPSIP)	**0.539**	0.000	1.000	0.000	1.000	3207.97 (<0.001)
Internet penetration (IP)	**0.000**	0.071	0.017	0.002	-0.055	52.43 (<0.001)
Competitive pressure (CP)	**0.591**	0.000	0.000	1.000	1.000	2,848.98 (<0.001)
Adoption variables						
e-purchasing adoption	**0.619**	0.448	0.602	0.606	0.746	149.59 (<0.001)
e-selling adoption	**0.310**	0.169	0.250	0.307	0.430	242.62 (<0.001)
E-business	**0.693**	0.516	0.666	0.693	0.820	139.10 (<0.001)
Auxiliary variables						
Micro	**0.423**	0.489	0.357	0.493	0.368	64.84 (<0.001)
Small	**0.306**	0.312	0.339	0.279	0.302	8.04 (0.045)
Medium	**0.211**	0.167	0.241	0.180	0.245	42.24 (<0.001)
Large	**0.060**	0.033	0.063	0.048	0.084	49.06 (<0.001)
Manufacture	**0.512**	0.504	**0.647**	0.427	0.507	62.33 (<0.001)
Construction	**0.169**	**0.265**	0.127	0.192	0.112	159.74 (<0.001)
Tourism	**0.181**	0.166	0.149	**0.233**	0.175	31.48 (<0.001)
Telecommunications	**0.138**	0.065	0.077	0.148	**0.206**	185.11 (<0.001)

Note: We also analyze summary statistics by cluster for each country but we do not identify any pattern. In addition, several countries (Netherlands, Sweden, Germany, Ireland, Luxembourg, Italy, Slovakia, Cyprus and Latvia) did not have statistically differences by clusters.

A description of each of the clusters, drawn from Table 7.4 is given below:

Cluster 1 (lowest e-business adoption). These firms had the lowest level of technology readiness compared to the other three clusters; their expected benefits of e-business are the lowest, but they had the highest level of Internet penetration index. They are therefore referred to here as lowest e-business adoption group, that is, firms who are at the very start of their e-business adoption but are currently operating in countries with a high Internet penetration. The competitive pressure they faced is low. Most of the firms within this group are micro and small firms without improved products or services and the most common activity sector is the construction. This cluster contains 24.4% of the whole sample firms.

Cluster 2 (medium e-business adoption with technology integration). The firms in this cluster were making some use of integrated technologies and most of them are improving their products or internal processes. They were presenting a medium level of technology readiness but a low competitive pressure. Firms in cluster 2 are small and medium size firms coming from manufacturing industry and having a medium level of e-business adoption. This cluster includes 16.5% of the firms.

Cluster 3 (medium e-business adoption with high competitive pressure). Firms in this cluster had the lowest index of technology integration and a low level of technology readiness. Contrarily to firms in cluster 2, most of them do not improve their services or internal processes, but all of them are facing competitive pressure. In this group the most common firms are micro firms coming from the tourism industry. This cluster contains 21.7% of firms.

Cluster 4 (highest e-business adoption). Firms in cluster 4 were found to have high levels of all variables, except for the Internet penetration. Cluster 4 incorporates firms that operate in the telecommunications industry and had medium or large size. This is the biggest cluster with 37.4% of firms.

The findings suggest that the four clusters identified represent a set of e-business patterns (Figure 7.1) that are much more related to industry sector and firm size than to countries. Micro and small firms from the construction sector can be viewed as laggards and big

firms from telecommunications as the pioneers. Moreover, our results also suggested a positive relationship between e-purchase and e-selling adoption.

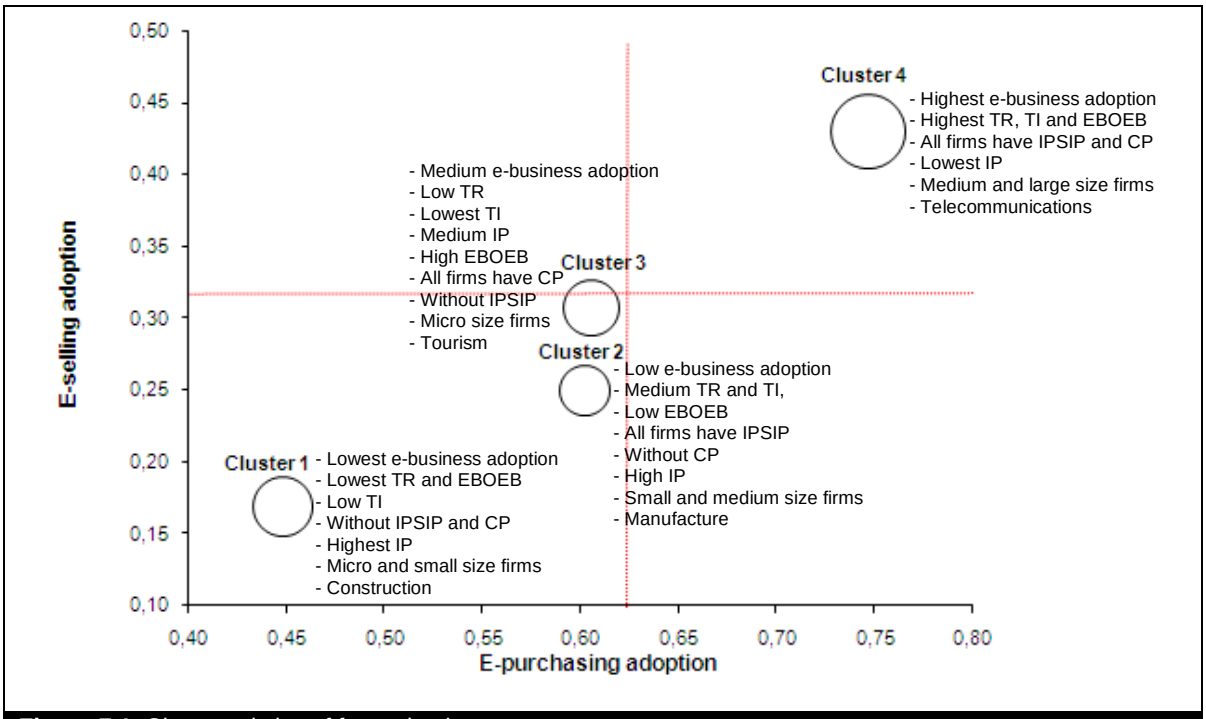

Figure 7.1. Characteristics of four e-business groups

7.5. Conclusions and future research

This study sought to explore the patterns of e-business adoption by European firms. Four distinct clusters of e-business adoption were found. The major conclusions are the following. Firstly, in general, firms with high levels of TOE factors have also enhanced levels of e-business (Figure 7.2, 7.3, 7.4 and 7.5). Secondly, the two clusters (cluster 3 and 4) that have the highest level of e-business adoption incorporate firms all of them with the higher level of competitive pressure (CP). This reveals the importance of environmental factors to improve e-business adoption. Thirdly, the comparison of e-business patterns, between cluster 3 and cluster 2 (figures 7.1, 7.2 and 7.3), suggest that the technology context is more important for the manufacture industry than for the tourism industry. Finally, the Internet penetration index, which is the specific variable for each country, has a different behaviour from e-business adoption. This index does not follow the trends of e-business adoption as can be seen in Figure 7.6. Additionally, the variables

related to countries do not have statistically significant differences across clusters. These reveal that in the European context the most important to characterise e-business adoption is the industry and their specific characteristics and not the country to which the firms belong.

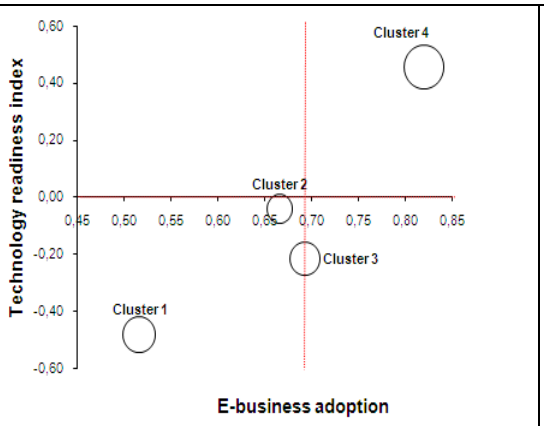

Figure 7.2. Technology readiness index versus e-business adoption

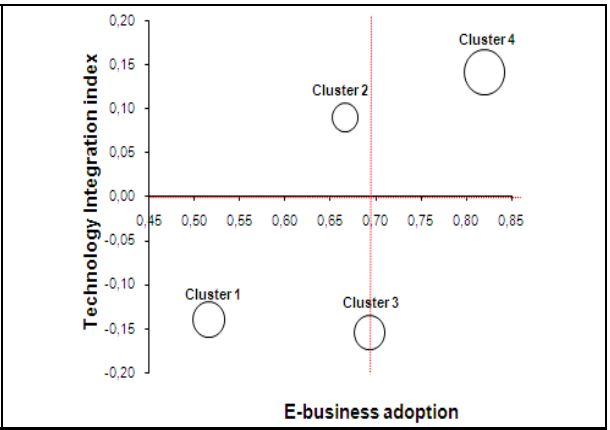

Figure 7.3. Technology integration index versus e-business adoption

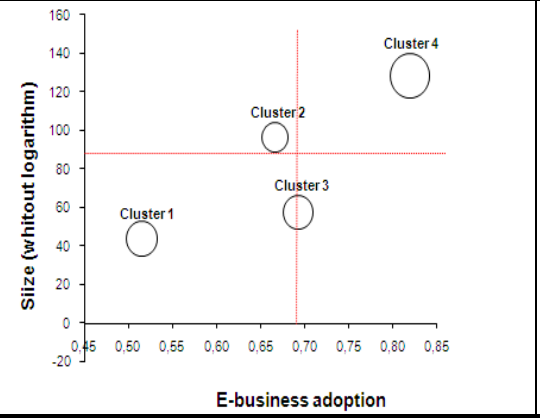

Figure 7.4. Size versus e-business adoption

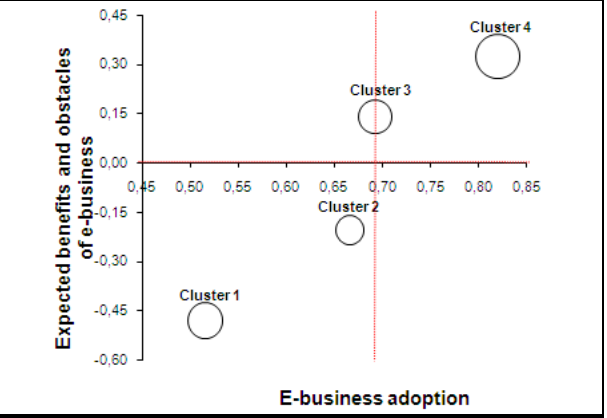

Figure 7.5. Expected benefits and obstacles of e-business versus e-business adoption

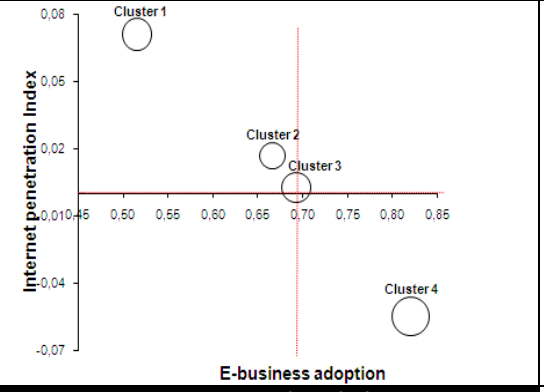

Figure 7.6. Internet penetration index versus e-business adoption

In terms of future research, it would be interesting to study one model that determines e-business adoption for each industry in the European context. It would be also important to compare the impacts of TOE variables in different industries (manufacture, construction, tourism and telecommunications).

Chapter 8 – Understanding e-business adoption across industries in European countries

8.1. Introduction

Electronic business (e-business), or the use of Internet-based technologies to conduct business, is recognized as a significant area for information technology (IT) innovation and investment [Willcocks et al., 2000]. As defined in Zhu et al. [2006a, page 601], "e-business refers to conducting transactions along the value chain (including purchasing from upstream suppliers and selling products and services to downstream customers) by using the Internet platform (e.g. TCP/IP, HTTP, XML) in conjunction with the existing IT infrastructure". In this study we used the same definition of e-business. Firms using e-business obtain substantial returns through efficiency improvements, inventory reduction, sales increase, customer relationship enhancement, new market penetration, and financial returns [Amit and Zott, 2001, Barua et al., 2004, Lederer et al., 2001, Raymond and Bergeron, 2008, Zhu and Kraemer, 2002]. The development of e-business capability is crucial because it is not only rapidly changing the way that companies buy, sell, and deal with customers, but also becoming a more central part of their business strategies [Abu-Musa, 2004]. E-business adoption becomes a noteworthy research topic because it enables the firm to perform electronic transactions along value chain activities [Straub and Watson, 2001, Zhu and Kraemer, 2002] and it represents a new way to incorporate Internet-based technologies with core business, thereby potentially affecting the whole business [Zhu, 2004a].

The European commission [2005] claims that more efforts are needed to improve e-business in European firms if the Lisbon targets of competitiveness are to be achieved. Under the pressure of their main international competitors, European firms need to find new opportunities to reduce costs, improve performance and the extent to which there are common behaviours across them. For these reasons, it is important to understand why firms adopt e-business or do not. Some studies analyse e-business adoption [Lin and Lin,

2008, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b] but do not compare the different drivers' importance for e-business adoption across industries.

Recent findings reveal that in the European context the most important aspect to characterize e-business adoption is the industry and its specific characteristics rather than the country the firms belong to [Oliveira and Martins, 2010a]. For this reason, it is important to understand e-business adoption by industry within the 27 European Union countries (EU 27) context. The telecommunications (telco) industry is the most advanced sector in e-business adoption. This might serve as input for promoting e-business technologies to less e-business-intensive industries. Tourism as a whole is one of the fastest growing industries worldwide. In recent years, growth rates in tourism have been higher than those of the overall world economy. From a global perspective, the European Union (EU) is still the most tourism-intensive region worldwide [W@tch, 2007]. For these reasons, we focus on these two industries. In the EU context, e-business adoption differs across these industries. In 2006, for the telco industry, e-business adoption was 82%; and for the tourism industry, it was 53% [W@tch, 2006c].

The purpose of this paper is to identify the factors that explain e-business adoption in two different industries (telco and tourism). Specifically, we want to understand what factors are important to explain e-business adoption in each industry, and to understand if the magnitude of these factors varies across these industries in the EU27 context. To the best of our knowledge, very limited empirical research has been undertaken to evaluate the determinants of e-business adoption across different industries; this study fills this gap. To achieve our purpose we developed a research model that is a combination of the Tornatzky and Fleischer [1990] model and the Iacovou et al. [1995] model. The paper is organized as follows: first, we present the theories and literature review; then we describe the research model and hypotheses; finally, we estimate and test our model, discuss our results, and offer the main conclusions and implications.

8.2. Theories and literature review

A review of the literature suggests that the technology, organization and environment (TOE) framework [Tornatzky and Fleischer, 1990] may provide a useful starting point for

studying e-business adoption [Lin and Lin, 2008, Zhu and Kraemer, 2005]. The TOE framework identifies three features of a firm's context that may influence adoption of technological innovation: (1) the technological context describes both the existing technologies in use and new technologies relevant to the firm; (2) the organizational context refers to characteristics of the organization such as scope and size; (3) the environmental context is the arena in which a firm conducts its business, referring to its industry, competitors, and dealings with the government. The TOE framework explains adoption of innovation, as can be seen in the left side of Figure 8.1. The TOE framework has been examined in a number of empirical studies on various information systems (IS) domains. It was used to explain electronic data interchange (EDI) adoption [Kuan and Chau, 2001]. Thong [1999] explained IS adoption and use. Pan and Jang [2008] explained enterprise resource planning (ERP) adoption. This framework was also used to explain e-business adoption [Zhu et al., 2003, Zhu and Kraemer, 2005] and use [Lin and Lin, 2008, Zhu and Kraemer, 2005, Zhu et al., 2006b]. Empirical findings from these studies confirmed that the TOE methodology is a valuable framework in which to understand the adoption of IT innovation.

Over time, innovations become more complex and cross the limits of individual firms. More and more interorganizational systems (IOSs) become significant in the business world. For instance, electronic data interchange (EDI) and B2B e-commerce are innovations that entail integration between multiple businesses. Five years after TOE, Iacovou et al. [1995] analysed IOSs characteristics that influence firms to adopt IT innovations. They studied EDI adoption. Their framework is well suited to explain the adoption of an IOS. It is based on three factors: perceived benefits; organizational readiness, and external pressure (see right-hand side of Figure 8.1). Perceived benefits is a different factor from the TOE framework that will be added into our research model, whereas organization readiness is a combination of the technology and organization context of the TOE model. Hence, IT resources is similar to technology context and financial resources is similar to organizational context. The external pressure in the Iacovou et al. [1995] model adds the trading partners to the external task environmental context of the TOE as a critical role of IOSs adoptions.

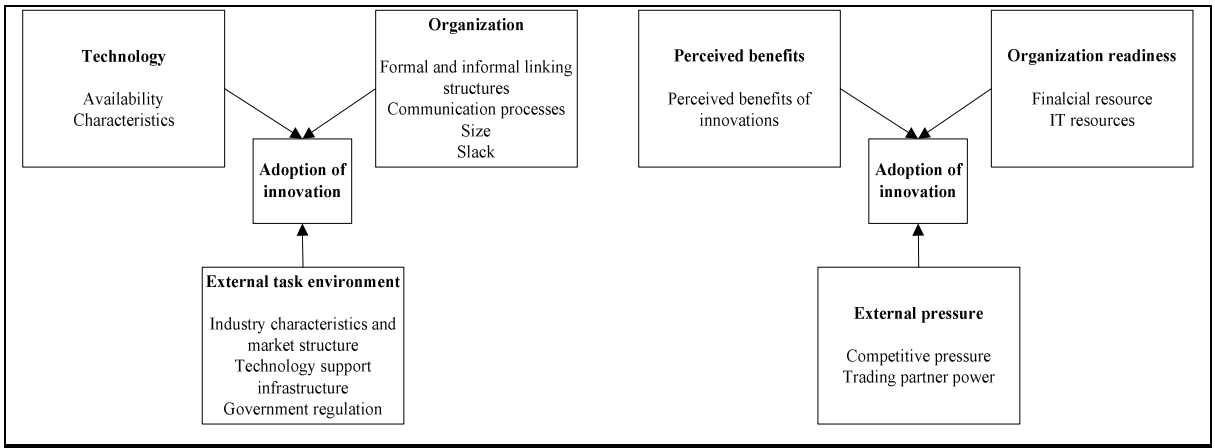

Figure 8.1. Tornatzky and Fleischer [1990] model and Iacovou et al. [1995] model

The present research combines features of the two earlier models, resulting in an integrated framework for e-business adoption. The research model proposed here comprises three dimensions, which are:

- perceived benefits;
- technology and organizational readiness;
- environmental and external pressure.

The perceived benefits dimension comes from the Iacovou et al. [1995] model. The technology and organizational readiness is a combination of technology and organizational context from the Tornatzky and Fleischer [1990] framework and organizational readiness from the Iacovou et al. [1995] model. The environmental and external pressure is also a combination from both earlier studies.

8.2.1. Research model and hypotheses

We developed a conceptual framework for e-business adoption (see Figure 8.2) in which the dependent variable is the e-business adoption and we stipulated six hypotheses.

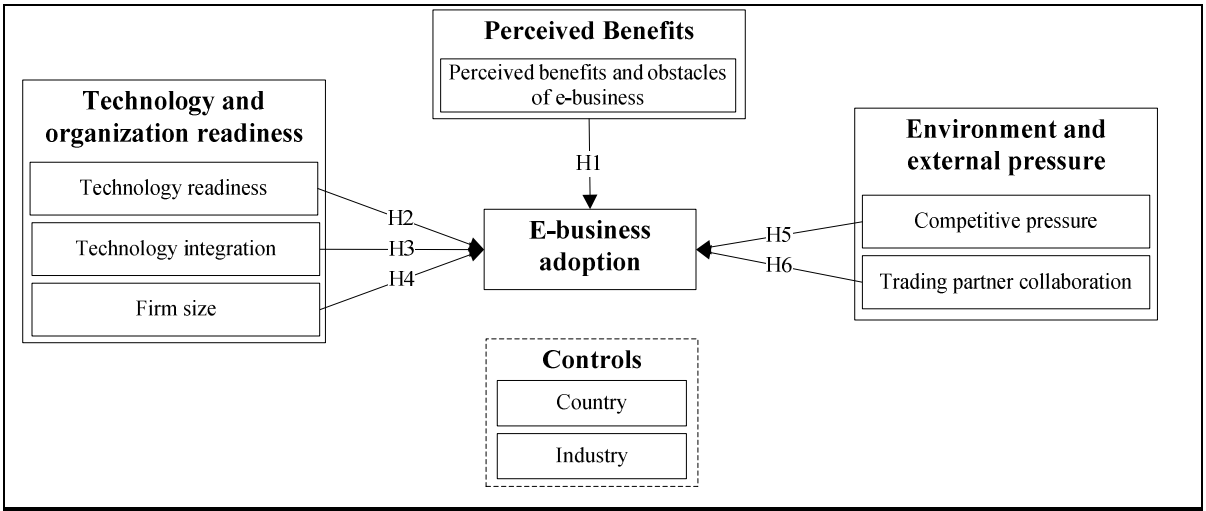

Figure 8.2. Research model

8.2.1.1 Perceived benefits

Perceived benefits and obstacles of e-business. Perceived benefits refers to the anticipated advantages that e-business adoption can provide to the organization. Better managerial understanding of the relative advantage of an innovation increases the likelihood of the allocation of the managerial, financial, and technological resources necessary to use that innovation [Iacovou et al., 1995, Rogers, 2003]. Earlier studies argue that firms using e-business may obtain benefits such as sales increase, new market penetration, and cost reduction [Zhu and Kraemer, 2002, Zhu et al., 2004]. Other empirical studies also validate that positive perception of the benefits of an innovation provides an incentive for its use [Beatty et al., 2001, Gibbs and Kraemer, 2004, Grover and Teng, 1994, Hsu et al., 2006, Iacovou et al., 1995, Kuan and Chau, 2001, Lin and Lin, 2008, Premkumar et al., 1994, Son et al., 2005]. It is necessary to understand perceived benefits, as well as perceived obstacles, because the adoption process may be complicated and costly [Hong and Zhu, 2006, Pan and Jang, 2008, Zhu et al., 2006b]. The adoption of e-business requires a substantial degree of technical and organizational competence for smooth transition [Hong and Zhu, 2006]; these barriers can result in resistance from users. As a consequence, it is essential to reduce the perceived barriers. Cho [2006] concluded that firms that perceive fewer obstacles to the adoption of a technology will be more likely to adopt the IT. Other empirical studies have found that obstacles are a significant barrier: to e-business adoption and use [Zhu et al., 2006b]; to e-

commerce migration [Hong and Zhu, 2006]; to ERP adoption [Pan and Jang, 2008]; and to e-markets adoption [Johnson, 2010]. We postulate the following:

H1: Higher benefits combined with lower obstacles is a positive predictor of e-business adoption.

8.2.1.2. Technology and organizational readiness

Technology readiness can be defined as technology infrastructure and IT human resources [Zhu et al., 2006b]. Technology infrastructure establishes a platform on which Internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. E-business can become an integral part of the value chain only if firms have infrastructures and technical skills. These factors may enable the technological capacity of the firm to adopt e-business. However, firms that do not have robust technology infrastructure and wide IT expertise may not wish to risk the adoption of e-business, implying that firms with greater technology readiness are in a better position to adopt e-business. Several empirical studies have identified technological readiness as an important determinant of IT adoption [Armstrong and Sambamurthy, 1999, Hong and Zhu, 2006, Iacovou et al., 1995, Kwon and Zmud, 1987, Pan and Jang, 2008, Zhu, 2004a, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b]. Therefore, we postulate the following:

H2. The level of technology readiness is a positive predictor of e-business adoption.

Technology integration. Before the Internet, firms had been using technologies to support business activities along their value chain, but many were ‘‘islands of automation’’ – they lacked integration across applications [Hong and Zhu, 2006]. Evidence from the literature suggests that integrated technologies help improve firm performance through reduced cycle time, improved customer service, and lowered procurement costs [Barua et al., 2004]. As a complex technology, e-business demands close coordination of various components along the value chain. Correspondingly, a greater integration of existing applications and the Internet platform represent a greater capacity for conducting business over the Internet [Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003, Zhu et al., 2006b]. We therefore postulate the following:

H3. The level of technology integration is a positive predictor of e-business adoption.

Firm size is one of the most commonly studied determinants of IT adoption [Lee and Xia, 2006]. Some empirical studies indicate that there is a positive relationship between the two variables [Grover, 1993, Hsu et al., 2006, Pan and Jang, 2008, Premkumar et al., 1997, Soares-Aguiar and Palma-Dos-Reis, 2008, Thong, 1999, Zhu et al., 2003]. However, larger firms have multiple levels of bureaucracy and this can impede decision-making processes regarding new ideas and projects [Hitt et al., 1990, Whetten, 1987]. Moreover, e-business adoption often requires close collaboration and coordination that can be easily achieved in small firms. There is also empirical evidence against this positive relationship [Dewett and Jones, 2001, Harris and Katz, 1991, Martins and Oliveira, 2008, Oliveira, 2008, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b]. The actual adoption of e-business may entail radical change in firms' business processes and organization structures, which might be hindered by the structural inertia of large firms [Damanpour, 1992]. In the opinion of Zhu and Kraemer [2005], size is often associated with inertia; that is, large firms tend to be less agile and less flexible than small firms. The possible structural inertia associated with large firms may slow down e-business adoption. Hence, we postulate the following:

H4. Firm size is a negative predictor of e-business adoption.

8.2.1.3. Environmental and external pressure

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Porter & Millar [1985] analysed the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by using a new innovation, firms might be able to alter the rules of competition, affect the industry structure, and leverage new ways to outperform rivals, thus changing the competitive landscape. This analysis can be extended to IT adoption. Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion [Al-Qirim, 2007, Battisti et al., 2007, Dholakia and Kshetri, 2004, Gibbs and Kraemer, 2004, Grandon and Pearson, 2004, Hollenstein, 2004, Iacovou et al., 1995, Lai et al., 2007, Mehrtens et al., 2001, Zhu et al., 2003]. Therefore, we assume that:

H5: Competitive pressure is a positive predictor of e-business adoption.

Trading partner collaboration is an important factor because the value of e-business can be maximized only when many trading partners are using it [Iacovou et al., 1995]. As suggested by empirical evidence, the success of e-business depends on the trading partners' readiness to jointly use the Internet to perform value chain activities [Barua et al., 2004]. In a trading community with greater partner readiness, individual adopters reveal higher levels of e-business usage due to network effects [Shapiro and Varian, 1999]. Some empirical researches suggest that trading partner is an important determinant for EDI, e-procurement and e-business adoption and use [Iacovou et al., 1995, Lai et al., 2007, Lin and Lin, 2008, Soares-Aguiar and Palma-Dos-Reis, 2008, Zhu et al., 2006a, Zhu et al., 2003]. Thus, we expect that:

H6: Trading partner collaboration is a positive predictor of e-business adoption.

8.2.1.4. Controls

In this study, we need to control for type of industry and country effects. It is usual in IS literature to use dummy variables to control these effects [Bresnahan et al., 2002, Soares-Aguiar and Palma-Dos-Reis, 2008, Zhu et al., 2006a, Zhu et al., 2003]. We used dummy variables to control for data variation that would not be captured by the explanatory variables mentioned above.

8.4. Methods

8.4.1. Sample

Our data source is e-Business W@tch [2006a, w@tch, 2006b], which collects data on the use of information communication technology (ICT) and e-business in European firms. Pilot interviews were conducted with 23 companies in Germany in February 2006, in order to test the questionnaire (structure, comprehensibility of questions). The sample drawn was a random sample of firms from the respective industry population in each of the countries, with the objective of fulfilling minimum strata with respect to company size class

per country-industry cell. Strata were to include a 10% share of large companies (250+ employees), 30% of medium sized enterprises (50-249 employees), 25% of small enterprises (10-49 employees) and up to 35% of micro enterprises with fewer than 10 employees. We studied 27 EU members in two industries (telco and tourism) which had a scope of 3,708 telephone interviews with decision-makers in firms, carried out in March and April 2006, using computer-aided telephone interview (CATI) technology. Globally, the response rate was 13.1%, which was comparable to other studies of similar scale [Zhu and Kraemer, 2005]. In particular, the response rates varied from country to country, ranging from 7.1% to 32.0%. We used data from the 2006 year because this was the last year with all countries of EU27 and these industries available. These data were collected by means of representative surveys of firms that used computers. According to the methodological recommendations of Eurostat, the situation of an operator that "did not answer" or "does not know" the answer to a specific question should not imply its imputation, in any case, based on the answer of the other operators. Consequently, we obtained a smaller sample that we compared, by a proportion test, with the original one. The proportion test for the variable e-business adoption reveals that there is no statistically significant difference by industry and country. The final sample includes 2,459 firms belonging to the EU27. About 80 percent (78.1% full sample, 83.1% telco industry, and 74.5% tourism industry) of the data were collected from owners, managing directors, heads of IT, and other senior members of IT, suggesting the high quality of the data source (Table 8.1).

Table 8.1: Respondent's position

Respondent's position	Full sample		Telco		Tourism	
	Obs.	(%)	Obs.	(%)	Obs.	(%)
Owner/Proprietor	683	27.8%	335	32.9%	348	24.2%
Managing Director/Board Member	553	22.5%	204	20.0%	349	24.2%
Head of IT/DP	465	18.9%	211	20.7%	254	17.6%
Other senior member of IT/DP Department	219	8.9%	97	9.5%	122	8.5%
Strategy development/organization	415	16.9%	39	3.8%	85	5.9%
Other	124	5.0%	133	13.1%	282	19.6%
Total	2,459	100.0%	1,019	100.0%	1440	100.0%

8.4.2. Factor analysis and reliability test

As a first step, we performed a factor analysis (FA) of multi-item indicators to reduce the number of variables of the survey and to evaluate the validity, which is a very common analysis in innovation studies [Eid and Trueman, 2004, Oliveira and Martins, 2010a, Premkumar et al., 1994, Tan et al., 2009, Thong, 1999, To and Ngai, 2006, Wei et al., 2009]. We used the principal component technique with varimax rotation (see Table 8.2) to extract four eigen-values, which were all greater than one. The first four factors explain 71.3% of the variance contained in the data. The Kaiser-Meyer-Olkin (KMO) measures the adequacy of the sample; general KMO is 0.96 (KMO ≥ 0.90 is excellent [Sharma, 1996]), which reveals that the matrix of correlation is adequate for the FA. The KMO for individual variables is also adequate. All of the factors have a loading greater than 0.50 (except indicator TI4). This indicates that our analysis employs a well-explained factor structure. The four factors found are: perceived benefits and obstacles of e-business, technology readiness, trading partner collaboration, and technology integration. The factors obtained are in accordance with the literature review.

Reliability measures the stability of the scale based on an assessment of the internal consistency of the items measuring the construct. It is assessed by calculating the composite reliability for each composite independent variable. Most of the constructs have a composite reliability over the cut off of 0.70, as suggested by Nunnally [1978]. Perceived benefits and obstacles of e-business, technology readiness and trading partner collaboration have a Cronbach's alpha value respectively of 0.98, 0.77 and 0.82. The last dimension, technology integration, comprises four items and has a Cronbach's alpha value of 0.61 which may be adequate for exploratory research. We decided to retain this dimension as it relates to the important issue of technology integration in e-business adoption. Thus, constructs developed by this measurement model could be used to test the conceptual model and the associated hypotheses.

Table 8.2: Factor analysis

Items measured	Factor 1	Factor 2	Factor 3	Factor 4
Perceived benefits and obstacles of e-business				
Why did your company decide to engage in e-business activities? (0-not at all; 1-not important; 2-important)				
EB1 - Because your customers expected it from you	**0.90**	0.12	0.08	0.06
EB2 - Because your company believes that e-business will help to get an edge over your competitors	**0.90**	0.11	0.09	0.06
EB3 - Because your competitors also engage in e-business	**0.86**	0.07	0.05	0.05
EB4 - Because your suppliers expected it from you	**0.83**	0.10	0.10	0.07
Important obstacles for not practicing e-business in your company? (0-not at all; 1-not important; 2-important)				
EO1 - My company is too small to benefit from any e-business activities	**-0.93**	-0.10	-0.08	-0.03
EO2 - E-business technologies are too expensive to implement	**-0.94**	-0.08	-0.06	-0.02
EO3 – The technology is too complicated	**-0.94**	-0.08	-0.07	-0.02
EO4 - Our systems are not compatible with those of suppliers or customers	**-0.94**	-0.06	-0.05	-0.01
EO5 - We are concerned about potential security risks and privacy issues	**-0.95**	-0.05	-0.05	-0.02
EO6 - We think that there are important unsolved legal issues involved	**-0.95**	-0.06	-0.06	-0.01
EO7 - It is difficult to find reliable IT suppliers	**-0.95**	-0.07	-0.06	-0.01
Technology readiness				
TR1 - Sum of the following network applications: a Local Area Network (LAN); Wireless LAN; Voice-over-IP; Fixed line connections; Wireless-Local-Area-Networks or W-LANs, Mobile communication networks; Virtual Private Network (VPN)	0.15	**0.76**	0.18	0.11
TR2 - Sum of the following questions ICT skills: your company currently employ ICT practitioners; your company regularly send employees to ICT training programmes	0.12	**0.72**	0.06	0.19
TR3 - Sum of the following security applications: secure server technology, for example SSL, TLS or a comparable technical standard; digital signature or public key infrastructure; a firewall	0.20	**0.67**	0.21	0.08
TR4 - Sum of the following technologies: Internet; intranet; web site;	0.26	**0.62**	0.31	0.04
TR5 - Percentage of employees that have access to the Internet	0.06	**0.55**	0.25	-0.18
Trading partner collaboration				
Does your company use online applications other than e-mail, to support any of the following business functions (0-no, and not use Internet; 1-no; 2-yes)?				
TP1 - To collaborate with business partners in the design of new products or services	0.13	0.17	**0.89**	0.04
TP2 - To collaborate with business partners to forecast product or service demand	0.13	0.15	**0.88**	0.11
Technology Integration				
Does your company use any of the following systems or applications for managing information in the company (0- do not know what this is; 1-no; 2-yes)?				
TI1 - an EDM system, that is an Enterprise Document Management System	0.05	0.07	0.13	**0.71**
TI2 - an ERP system, that is Enterprise Resource Planning System	0.06	0.19	0.09	**0.71**
TI3 - a SCM system, that is a Supply Chain Management System	0.07	0.00	0.08	**0.69**
TI4 - Knowledge Management software	0.05	0.30	0.01	**0.48**

8.4.3. Data analysis and results

The independent variables are in accordance with our research model, which is a combination of the Tornatzky and Fleischer [1990] model and the Iacovou et al. [1995] model. Perceived benefits and obstacles of e-business, technology readiness, trading partner collaboration, and technology integration were obtained by factor analysis. All the other variables were obtained directly by the questionnaire. The dependent variable is e-business adoption, a binary variable which has value equal to one if firms adopt e-business and zero otherwise (Table 8.3).

Table 8.3: Description of independent variables

Variables	Description
Perceived benefits	
Perceived benefits and obstacles of e-business	FA index of perceived benefits and barriers of e-business
Technology and organization readiness	
Technology readiness	FA index of technology readiness
Technology integration	FA index of technology integration
Firm size	The logarithm number of employees
Environment and external pressure	
Competitive pressure	Dummy equal to one if firms think that ICT has an influence on competition in your industry
Trading partner collaboration	FA index of Trading partner
Controls	
Country	Twenty seven country dummies for 27 countries
Industry	Two dummies for 2 industries

We began our analysis by checking the multi-collinearity, for which we calculated the variance inflation factor (VIF) for the regression coefficients. The VIF ranged from a low of 1.06 to a high of 2.51. The values are below the threshold of 10, indicating that there is no problem of multi-collinearity amongst the variables [Hair et al., 1998].

Since the dependent variable is binary (to adopt or not), we applied logistic regression to test the research model, and used the significance of the regression coefficients to support the hypotheses. We also computed marginal effects of independent variables. We

estimated three different regressions: one for the full sample, and one for each industry (Table 8.4).

Table 8.4: Logistic regression for e-business adoption in all industries

Independent variables	Full sample		Telco		Tourism	
	Coef.	P-value	Coef.	P-value	Coef.	P-value
Perceived benefits and obstacles of e-business	0.737***	0.000	0.704***	0.000	0.788***	0.000
Technology readiness	0.788***	0.000	0.727***	0.000	0.857***	0.000
Technology integration	0.141**	0.032	0.257**	0.026	0.087	0.288
Firm size	0.004	0.931	-0.066	0.371	0.025	0.651
Competitive pressure	0.527***	0.000	0.482**	0.029	0.590***	0.000
Trading partner collaboration	0.638***	0.000	0.547***	0.000	0.677***	0.000
Sample size	2,459		1,019		1,440	
Area under the curve (AUC)	0.834		0.820		0.847	

Note: we also include dummies for the 27 countries in all regressions and industries dummies for regressions of all industries; ; * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

The goodness-of-fit for all regressions was assessed in three ways. First, to analyse the joint statistical significance of the independent variables we computed the likelihood ratio (LR) test, which is statistically significant (p-value<0.001 for each regression). This implies a strong relationship between the dependent variable and the independent variables for each regression. Secondly, we used the Hosmer-Lemeshow test [Hosmer and Lemeshow, 1980, Lemeshow and Hosmer, 1982], which reveals that there are no differences between fitted values of the model and the actual values, for any of the three regressions (p-values are respectively 0.38, 0.15, and 0.56). Finally, the discrimination power of the model is evaluated in two ways. We use the area under the curve (AUC), which is equal to 83%, 82%, and 85% respectively for e-business adoption in full sample, telco, and tourism industries. This reveals an excellent discrimination for all regressions [Hosmer and Lemeshow, 2000]. We also computed the prediction accuracy: 81.2%, 84.5%, and 80.1% respectively. The adoption by random choices ([adopters/(adopters + non-adopters)]^2+ [non-adopters/(adopters + non-adopters)]^2) would result in 64.0%, 71.8%, and 59.6% respectively for each regression, which are much less than in the case of our regressions. Thus we conclude that the logistic regressions have much higher discriminating power than the random choice model. The three statistical procedures reveal a substantive model fit, a satisfactory discriminating power, and there is evidence to accept an overall significance of the models.

For the full sample regression, perceived benefits and obstacles of e-business, technology readiness, technology integration, trading partner collaboration, and competitive pressure are positively associated with e-business. All hypotheses (H1-H6) are confirmed except H4 (firm size). The same result is obtained for telco. For the tourism industry, the H1, H2, H5 and H6 are confirmed.

In deep analysis we computed the statistically significant marginal effects to test the differences between telco and tourism industries (Table 8.5). Results reveal that marginal effects for perceived benefits and obstacles of e-business, technology readiness, and trading partner collaboration are significantly different between these two industries. In other words, competitive pressure is the unique driver that has the same marginal effect in both industries for e-business adoption.

Table 8.5: Marginal effects of logistic regression for e-business in all industries

Independent variables	Marginal effects			Telco vs. Tourism	
	Full	Telco	Tourism	Two tailed test	p-value
Perceived benefits and obstacles of e-business	0.099***	0.067***	0.127***	-3.900	0.000
Technology readiness	0.106***	0.069***	0.139***	-3.253	0.001
Technology integration	0.019**	0.024**	ns	-	-
Firm size	ns	ns	ns	-	-
Competitive pressure†	0.076***	0.051*	0.100***	-1.281	0.200
Trading partner	0.086***	0.052***	0.109***	-3.208	0.001

Note: we also include dummies for the 27 countries in all regressions and industry dummies for regressions of all industries , ns – not significant; * p-value<0.10; ** p-value<0.05; *** p-value<0.01; variables with "†" are binary.

8.5. Discussion and implications

The purpose of this paper was to identify the factors that explain e-business adoption and to understand the extent to which the magnitude of these factors varies across the two industries (telco and tourism industry) in the EU27 context. Our empirical results generally support the model. In the perceived benefits dimension, the perceived benefits and obstacles of e-business (H1) is a statistically significant facilitator for e-business adoption in both industries (Table 8.4). Therefore, for managers who think that e-business

technologies are too expensive to implement, with the cost of technology decreasing, this obstacle is transposed. Also, policy makers should regulate the Internet to make it a reliable commerce platform (e.g., dealing with fraud and credit card misuse), and promote the diffusion of the Internet amongst end-users. This measure solves two more obstacles of e-business, which are: potential security risks and privacy issues, and legal issues involved. Moreover, the marginal effects are different between telco and tourism industries (Table 8.5). The tourism industry is the one where this variable is more important, perhaps because in the telco industry the firms are more informed of the perceived benefits and obstacles of e-business.

In the technology and organization readiness dimension, the technology readiness (H2) is also a statistically significant facilitator for e-business adoption for all regressions. This means that managers and policy makers should be aware that technology readiness is constituted both by physical infrastructures and intangible knowledge, such as IT skills. For managers, investments in physical infrastructure and the hiring of employees with IT skills should be made; for current employees training programmes should be promoted. Policy makers should promote the construction of infrastructures and reduce tax laws to stimulate firms to provide IT training programmes to employees. This is in accordance with the European Commission [2008] that claims that the importance of ICT skills – i.e. professional skills, user skills, and e-business skills – for the competitiveness and growth of the European economy has been confirmed in several high-level documents and initiatives of the European Commission. The tourism industry reveals a statistically significant higher relative importance (marginal effects) of technology readiness for e-business adoption when compared with the telco industry. One possible explanation is that tourism workers have less ICT skill and the tourism firms have fewer ICT infrastructures; consequently, due to the lack of technology readiness, this variable is more important for the tourism industry. Technology integration (H3) is a statistically significant facilitator only in the telco industry (Table 8.4). One possible explanation is that as telco firms have higher levels of IT knowhow, only these firms can take advantage of technology integration, i.e., improving firm performance, improving customer service, and lowering procurement costs [Barua et al., 2004]. In particular, managers in the tourism industry need to improve knowhow in IT workers, to take advantage of technology integration, which can provide more flexible dynamic packaging (bundling products with flexibility). Dynamic package depicts what is probably the most sophisticated and challenging e-business format in

tourism in terms of technology requirements [W@tch, 2007]. Firm size (H4) is not statistically significant for e-business adoption in both industries. This result is in accordance with literature where firm size is a “controversial” predictor for IT adoption. This means that in the telco and tourism industries the advantage of the availability of funds being greater for large firms [Iacovou et al., 1995, Rogers, 2003] does not prevail, nor does the disadvantage of larger firms having multiple levels of bureaucracy, which can impede decision-making processes regarding new ideas and projects [Hitt et al., 1990, Whetten, 1987]. This reveals that e-business is not a phenomenon dominated by large firms, this is special important for managers that think their firm is too small to benefit from any e-business activities.

In the environment and external pressure dimension, the competitive pressure (H5) is a statistically significant facilitator for e-business adoption in both industries (Table 8.4), and there is no statistically significant difference in terms of magnitude of importance (Table 8.5). Hence, gaining competitive advantage is still one of the most important drivers of e-business adoption; furthermore, managers should be aware that competitive pressure (H6) has the same importance for e-business adoption across the industries, which reveals the same level of competition in the online market. Trading partner collaboration is a statistically significant facilitator for both industries (Table 8.4). Consequently, managers and policy makers should encourage the formation of networks with other players and the sharing of resources in order to satisfy the needs of diverse and ever faster changing customer requirements. This, in turn, could increase the competiveness of the whole network [W@tch, 2007]. Our analysis indicates a statistically significant higher magnitude of trading partner collaboration for e-business adoption in the tourism industry when compared to telco (Table 8.5). One possible explanation is that the trading partners are less collaborative in the tourism industry than in the telco industry [W@tch, 2007].

There is at least one variable from each dimension that is statistically significant in e-business adoption for the two industries; in the other words the main drivers of e-business adoption across industries are perceived benefits and obstacles of e-business adoption, technology readiness, competitive pressure, and trading partner; moreover, all three dimensions proposed are relevant for e-business adoption across different industries in the EU context. As the telco industry is the most intensive adopter and user of e-business [W@tch, 2007], it can serve as an example for other industries, and there is a business

opportunity for this industry to provide e-business solutions for firms belonging to other industries.

8.5.1. Theoretical implications

Whilst there are many theoretical studies of e-business adoption, comparisons across industries are lacking. To promote e-business adoption and their comparison across industries, it is critical to clarify the factors that explain e-business adoption, and to conduct a deep analysis to understand if different industries have the same drivers for e-business adoption. Based on the Tornatzky and Fleischer [1990] model and the Iacovou et al. [1995] model, we define our research model to investigate the factors affecting the e-business adoption across the telco and tourism industries. To the best of our knowledge, this study is one of the first that examines adoption of e-business with a multi-industries comparison of EU27 countries using a research model that combines these two models. Using empirical data from 2,459 firms belonging to the EU27, from two different industries, we found strong support for our research model, the three dimensions proposed are important for both industries. Moreover, we also found differences in the relative importance of drivers for e-business adoption for the different industries. Our results reveal that to better understand e-business adoption it is not sufficient to use industry as a control variable. It is more adequate to estimate a model for each industry. This is one of the first research efforts to provide concrete empirical support for the theories of e-business adoption in the EU27 context comparing two different industries. As the sample was not limited to data from a single country, this helps to strengthen the generalization of the model and findings.

8.6. Conclusions

E-business adoption enables the firm to perform electronic transactions along value chain activities [Straub and Watson, 2001, Zhu and Kraemer, 2002]. To promote e-business adoption, it is critical to clarify the factors that explain this adoption, and make a deep analysis to understand if different industries have the same drivers for e-business

adoption. These have special importance, since recent findings reveal that in Europe the most relevant factor to characterize e-business adoption is the industry and its specific characteristics, and not the country that the firms belong to [Oliveira and Martins, 2010a]. In this paper, we have established and empirically tested the prediction model of the six determinants of e-business. In general, our hypotheses are confirmed, our research model seems appropriate. The perceived benefits and obstacles of e-business, technology readiness, competitive pressure, and trading partner collaboration are the drivers that are important for all industries. Through the comparison of the industries, we can verify that there are statistically significant differences between the telco and tourism industries. The relative importance of all drivers for e-business adoption in the telco differs from the tourism. The only exception is competitive pressure, where there is no difference between these industries.

8.7. Limitations and future studies

As in most empirical studies, our work is limited in some ways. Firstly, the cross-sectional nature of this study does not allow knowing how this relationship will change over time. To solve this limitation, future research should involve panel data. Secondly, our study investigates only adoption decisions. To provide a more balanced view of firms' adoption and assimilation of e-business into the core business activities, the extent of e-business migration from traditional platform to the Internet should also be examined, as suggested by Hong & Zhu [2006]. Thirdly, we did not include the government regulation variables in our model because these variables are not available in this questionnaire. A new questionnaire should therefore be constructed for in further research. Fourthly, in the tourism industry the rate of adoption between business-to-business (B2B) and business-to-consumer (B2C) is different. Further research is needed to understand the different drivers of B2B and B2C, and across industries. Finally, we fully encourage confirmatory studies of our research model; and urge future researchers to test it in different contexts. It should be applied to other IT adoptions in order to be refined. Others studies with new samples should be used for the validation of our model. Samples of specific context or industry, such as manufacturing or service, should be gathered to further examine the applicability of this model.

Chapter 9 – Understanding B2B e-commerce adoption and usage in Europe: findings from 27 European countries

9.1. Introduction

The European Commission [2005] claims that more efforts are needed to improve the business process in European firms if the Lisbon treaty targets of competitiveness are to be achieved. Under the pressure of their main international competitors, European firms need to find new opportunities to reduce costs, improve performance and identify the extent to which there are common behaviours across them. Currently the European Union (EU) has 27 members with different patterns of e-business readiness [Castaings and Tarantola, 2008]. To the best of our knowledge, very limited empirical research has been undertaken to evaluate the determinants of business-to-business (B2B) e-commerce usage within this context. This study aims to fill this gap, particularly since B2B e-commerce has been identified as an emerging trend [Claycomb et al., 2005] that is expected to grow ten times, totalling $12.4 trillion worldwide by 2012 [IDC, 2008].

In order to study B2B usage amongst 27 European countries (hereafter referred to as EU27), we use Pettigrew and Whipp's [1991] contextualist theory of organizational change as a meta theorizing framework. Our research suggests a fresh understanding of B2B e-commerce usage amongst countries, besides providing guidelines to policymakers and practitioners. The paper is organized as follows. First we present the theories and literature review. Then, we describe the research model and hypothesis. Finally, we evaluate and test our model, discuss the key findings and present the main conclusions.

9.2. Informing literature and research model

B2B e-commerce adoption can be analyzed along three dimensions – the *context*, *content* and *process* of change (based on Pettigrew and Whipp [1991]). This is largely because

variables in the context affect the content of B2B adoption, which in turn affect the processes in place, that allow for adequate adoption. B2B e-commerce usage therefore ought to be studied by including an analysis of the internal and external *context*, the *process* and the *content* [Magnusson, 2004]. The *context* explains why and where B2B e-commerce adoption and usage is initiated [Pettigrew, 1985], and that there are internal and external factors that affect B2B e-commerce adoption and usage in the firms [Serafeimidis and Smithson, 2000]. The *content* is a crucial factor in any information technology (IT) adoption study and is an understanding of what is being adopted. In our case, it explains the benefits and obstacles in using B2B e-commerce [Stockdale and Standing, 2006]. The *process* is how the change is implemented [Pettigrew, 1985]. In our case, it explains how B2B e-commerce is implemented by firms, why the firms need technology readiness/resource and the extent of the integration of technology across different processes.

9.2.1. Context dimension

In the context dimension includes internal factors like firm size and education level of employees and managers and external factors such as competitive pressure and trading partner collaboration.

Internal context

Firm size is one of the most commonly studied determinants of IT adoption [Lee and Xia, 2006]. Different firm sizes have different characteristics with regard to B2B e-commerce adoption and usage. Large firms have financial advantages although they have multiple levels of bureaucracy, which can impede decision making processes concerning new ideas and projects [Hitt et al., 1990, Whetten, 1987]. Smaller firms have ‘behavioral advantage’ whereby it is easier to get the close collaboration and coordination that is required for B2B e-commerce adoption and usage. The education level of workers in a firm is also an important factor. As the presence of skilled labor in a firm increases, its ability to absorb and make use of an IT innovation also increases [Martins and Oliveira, 2007]. Therefore, education level is an important determinant of B2B e-commerce adoption and

usage, since usually the successful implementation of B2B e-commerce requires complex skills.

In information systems (IS) and organizational research literatures, the importance of size as a predictor of IT adoption and the direction and nature of the causal influence of size has been persistently controversial [Ettlie and Rubenstein, 1987]. Some empirical studies indicate that there is a positive relationship between the two variables [Grover, 1993, Hsu et al., 2006, Pan and Jang, 2008, Premkumar et al., 1997, Soares-Aguiar and Palma-Dos-Reis, 2008, Thong, 1999, Zhu et al., 2003]. However, there is also empirical evidence suggesting otherwise [Dewett and Jones, 2001, Harris and Katz, 1991, Martins and Oliveira, 2008, Oliveira, 2008, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b]. The actual adoption of B2B e-commerce may entail bringing about a radical change in firms' business processes and organization structures, which might be hindered by the structural inertia of large firms [Damanpour, 1992]. In our study, firm size is defined by the logarithm number of employees in the organization. Because our model has other exploratory variables such as process dimension (technology readiness and technology integration) that large firms may possess, the notion of structural inertia leads us to expect that large firm size may deter B2B adoption and usage. Hence, we postulate the following:

H1a: Firm size is a negative predictor for B2B e-commerce *adoption*

H1b: Firm size is a negative predictor for B2B e-commerce *usage*

The overall capacity of the organization to evaluate technological opportunities (for example B2B) in the areas of its activity depends primarily on human capital and knowledge of the organization [Cohen and Levinthal, 1989]. The profound changes that IT requires, needs workers with higher level education. In this study, education level is measured by the percentage share of employees having a college or university degree in the firm. It is expected to exert a positive impact on the adoption and usage of IT [Battisti et al., 2007, Bresnahan et al., 2002, Brynjolfsson and Hitt, 2000, Giunta and Trivieri, 2007, Hollenstein, 2004, Martins and Oliveira, 2007]. We hypothesize the following:

H2a: Workers' educational level is a positive predictor for B2B e-commerce *adoption*

H2b: Workers' educational level is a positive predictor for B2B e-commerce *usage*

External context

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Pressure from competitors has been identified as an important driving force in the external context [Premkumar et al., 1997]. Porter & Millar [1985] identified the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by incorporating an innovation, firms might be able to alter the rules of competition, affect the industry structure, and leverage new ways to outperform rivals- thus changing the competitive landscape. This analysis can be extended to B2B e-commerce adoption and usage. Trading partner collaboration is an important factor because the value of B2B e-commerce can be maximized only when many trading partners are using B2B e-commerce [Iacovou et al., 1995].

Competitive pressure is a recognizable driving force for new technology usage; it tends to stimulate companies to seek competitive edge by using innovations [Gatignon and Robertson, 1989]. This study defines competitive pressure as the notion of firms that information communication technology (ICT) has an influence on competition in their sector. Several studies have identified competitive pressure as a powerful determinant of degree of computerization [Dasgupta et al., 1999]; adoption and usage of interorganizational systems [Grover, 1993]; electronic data interchange (EDI) adoption [Iacovou et al., 1995] or EDI usage [Ramamurthy et al., 1999]; e-commerce adoption [Dholakia and Kshetri, 2004] or e-commerce usage [Gibbs and Kraemer, 2004]; e-procurement systems [Soares-Aguiar and Palma-Dos-Reis, 2008]; and e-business adoption [Zhu et al., 2003] or e-business usage [Lin and Lin, 2008, Zhu et al., 2006a, Zhu and Kraemer, 2005]. Furthermore, B2B facilitates inter-firm collaboration to improve transactional efficiencies, expand existing channels, and maximize advantages from new opportunities. Firms that are first-movers in deploying B2B have tended to derive the greatest advantages. Hence, highly competitive pressure promotes the implementation and operation of most successful B2B adoption and usage. Therefore, we hypothesize that:

H3a: Competitive pressure is a positive predictor for B2B e-commerce *adoption*

H3b: Competitive pressure is a positive predictor for B2B e-commerce *usage*

In this study, trading partner collaboration is defined as cooperation between business partners to design and forecast products or service. As suggested by empirical evidence, the success of B2B e-commerce depends on the trading partners' readiness to jointly use the Internet to perform value chain activities [Barua et al., 2004]. In a trading community with greater partner readiness, individual adopters reveal higher levels of e-business usage due to network effects [Shapiro and Varian, 1999]. Some empirical researches suggest that trading partner is an important determinant for EDI, e-procurement and e-business adoption and usage [Iacovou et al., 1995, Lin and Lin, 2008, Soares-Aguiar and Palma-Dos-Reis, 2008, Zhu et al., 2006a, Zhu et al., 2003]. Thus, we expect that:

H4a: Trading partner collaboration is a positive predictor for B2B e-commerce *adoption*

H4b: Trading partner collaboration is a positive predictor for B2B e-commerce *usage*

9.2.2. Content dimension

The content of change aims to answer the question – what are the benefits and obstacles to usage of B2B e-commerce? Perceived benefits refer to the anticipated advantages that B2B e-commerce adoption and usage can provide to an organization. Better managerial understanding of the relative advantage of an innovation increases the likelihood of the allocation of the managerial, financial and technological resources necessary to use that innovation [Iacovou et al., 1995, Rogers, 1995]. Perceived obstacles are particularly important because these can be critical in making the adoption and usage process seem more complicated and costly [Hong and Zhu, 2006, Pan and Jang, 2008, Zhu et al., 2006b].

Previous studies argue that firms using B2B e-commerce may obtain such benefits as sales increase, new market penetration and cost reduction [Zhu and Kraemer, 2002, Zhu et al., 2004]. Consequently, the success of B2B e-commerce adoption and usage depends of the perceived benefits by management. Other empirical studies also validate the fact that positive perceptions of benefits of an innovation provide an incentive for use of an innovation [Beatty et al., 2001, Gibbs and Kraemer, 2004, Grover and Teng, 1994, Hsu et al., 2006, Iacovou et al., 1995, Kuan and Chau, 2001, Lin and Lin, 2008, Premkumar et al., 1994, Son et al., 2005]. Therefore, the following hypotheses are generated:

H5a: Perceived benefit is a positive predictor for B2B e-commerce *adoption*

H5b: Perceived benefit is a positive predictor for B2B e-commerce *usage*

In our study, perceived obstacles refer to the anticipated impediments to adoption of e-business in an organization. The adoption of B2B e-commerce requires a substantial degree of technical and organizational competence for smooth transition [Hong and Zhu, 2006]; and these perceived barriers can result in resistance from users. As a consequence, it is essential to reduce the perceived barriers. The greater the top management's support, the easier it is for the organization to overcome difficulty and complexity of IT adoption [Bajwa et al., 2004, Cho, 2006, Hwang et al., 2004, Nah and Delgado, 2006, Premkumar and Ramamurthy, 1995, Umble et al., 2003]. Cho [2006] concluded that firms that perceive fewer obstacles to the adoption of a technology will be more likely to adopt the IT. Other empirical studies found that obstacles are a significant barrier to e-business adoption and usage [Zhu et al., 2006b], e-commerce migration [Hong and Zhu, 2006], and to ERP adoption [Pan and Jang, 2008]. So we hypothesize the following:

H6a: Perceived obstacles *is a positive predictor for B2B* e-commerce *adoption*

H6b: Perceived obstacles *is a positive predictor for B2B* e-commerce *usage*

9.2.3. Process dimension

The process dimension refers to technology readiness of firms and the extent to which a technology is integrated in the firm across different processes. Technology readiness can be defined as technology infrastructure and IT human resources [Mata et al., 1995]. Technology infrastructure establishes a platform on which Internet technologies can be applied to institute a web presence for the business. IT human resources provide the knowledge and skills to develop web applications [Zhu and Kraemer, 2005]. Before the Internet, firms had been using technologies to support business activities along their value chain, but many were ‘‘islands of automation’’ – as in they lacked integration across applications [Weill and Broadbent, 1998]. Evidence from literature suggests that integrated technologies help improve firm performance through reduced cycle time, improved customer service and lowered procurement costs [Barua et al., 2004]. As a complex technology, B2B e-commerce demands close coordination of various components along

the value chain. Correspondingly, a greater integration of existing applications and the Internet platform represent a greater capacity for conducting business over the Internet [Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003, Zhu et al., 2006b].

B2B e-commerce can become an integral part of the value chain only if firms have the requisite infrastructure and technical skills. These factors can facilitate and enable the technological capacity of the firm to adopt and use B2B e-commerce. However, firms that do not have robust technology infrastructure and wide IT expertise, may not want to risk the adoption of B2B e-commerce. This means that firms with greater technology readiness are in better position to adopt and use B2B e-commerce. Several empirical studies have identified technological readiness as an important determinant of IT adoption [Armstrong and Sambamurthy, 1999, Hong and Zhu, 2006, Iacovou et al., 1995, Kwon and Zmud, 1987, Pan and Jang, 2008, Zhu, 2004b, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006b]. Therefore, we postulate the following:

H7a: Higher level of technology readiness is a positive predictor for B2B e-commerce *adoption*

H7b: Higher level of technology readiness is a positive predictor for B2B e-commerce *usage*

Like Hong and Zhu (2006), we also define technology integration as the extent to which various technologies and applications are represented on the web platform. Technology integration enables firms to continuously improve and innovate by identifying and sharing information across products/services/business units to enhance organizational knowledge and readiness [Barua et al., 2004]. Therefore, the success of B2B e-commerce adoption and usage depends of the level of technology integration. Some empirical studies have found that technology integration is positively related to e-business adoption and usage [Zhu et al., 2006b] and also to e-commerce adoption [Hong and Zhu, 2006]. Hence, we postulate the following:

H8a: Higher level of technology integration is a positive predictor for B2B e-commerce *adoption*

H8b: Higher level of technology integration is a positive predictor for B2B e-commerce *usage*

9.2.4. Controls

In cross-sectional studies, control variables need to be incorporated to better explain variation in adoption and usage. In this study we need to control the type of industry and country effects. It is usual in IS literature to use dummy variables to control these effects [Bresnahan et al., 2002, Soares-Aguiar and Palma-Dos-Reis, 2008, Zhu et al., 2006a, Zhu et al., 2003]. We used dummy variables to control data variation that could not be captured by the explanatory variables mentioned above.

9.2.5. Research model

We developed a conceptual model based on an adaptation of the theory of contextualist by Pettigrew and Whipp [1991] and IT adoption literature for explaining B2B e-commerce adoption and usage (see Figure 9.1).

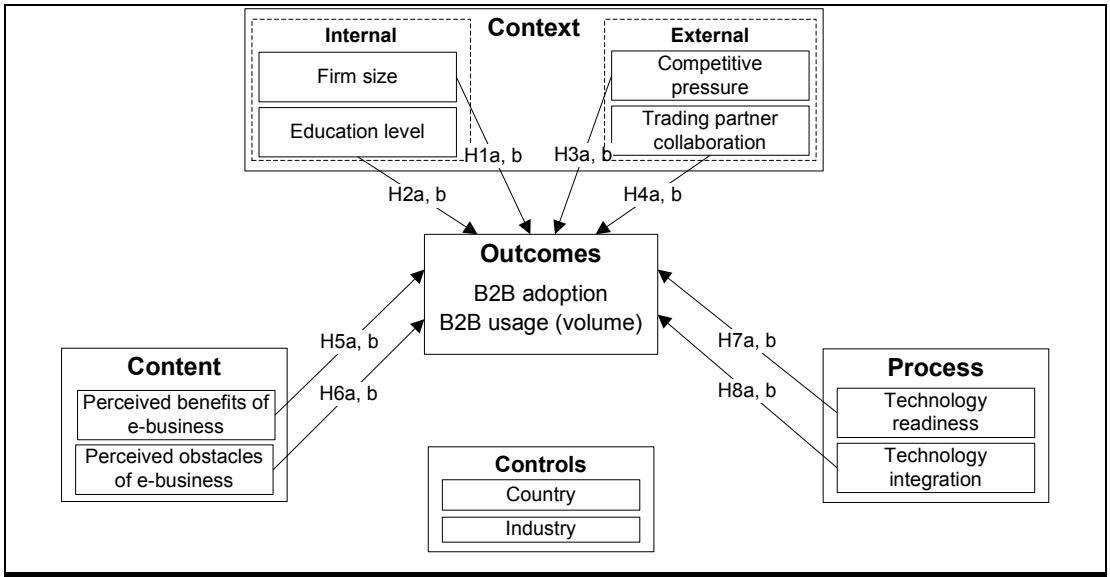

Figure 9.1. Research model based on three essential dimensions of strategic change of Pettigrew and Whipp [1991]

The dependent variables are the B2B e-commerce adoption and usage (volume). We stipulate eight hypotheses, that emerge from the literature review for each (i.e., H1a-H8a for B2B e-commerce adoption and H1b-H8b for B2B e-commerce usage, i.e. volume): four for *context* dimension (firm size, education level, competitive pressure and trading partner

collaboration); two for the *content* dimension (perceived benefits of e-business and perceived obstacles of e-business); and two more for *process* dimension (technology readiness and technology integration).

9.3. Methods and data analysis

Our data source is e-Business W@tch [2006a, w@tch, 2006b], which collects data on the use of ICT and e-business in European firms. Pilot interviews were conducted with 23 companies in Germany in February 2006, in order to test the questionnaire (structure, comprehensibility of questions). A random sample of firms was drawn from the respective sector populations in each of the countries. The objective was to fulfill minimum strata with respect to company size class per country sector cell. Strata were to include a 10% share of large companies (250+ employees), 30% of medium sized enterprises (50-249 employees), 25% of small enterprises (10-49 employees), and up to 35% of micro enterprises with less than 10 employees. We studied EU27 members in eight sectors (food and beverages, footwear, pulp and paper, ICT manufacturing, consumer electronics, construction, tourism and telecommunications) which had a scope of 12,343 telephone interviews which were conducted with decision-makers in firms using computer-aided telephone interview (CATI) technology. The response rates varied from country to country, ranging from 7.1% to 32.0%. We used data from 2006 because it was the last year with EU27 data available. This data was collected by means of representative surveys of firms that used computers. According to the methodological recommendations of Eurostat, the situation of an operator that “did not answer” or “does not know” the answer to a specific question should not imply its imputation based on the answer of the other operators. Consequently, we obtained a smaller sample that we compared through a proportion test, with the original one. The proportion test for the variable B2B e-commerce adoption by industry reveals that Bulgaria is the only country with statistically significant differences. For this reason we excluded it from our analysis. We also excluded Malta for the reasons that we will see in the cluster of countries section. The final sample includes 6,973 firms belonging to the EU27 members excluding Bulgaria and Malta. About 80 percent (79.0%) of the data was collected from owners, managing directors, heads of IT, and other senior members of IT, confirming the high quality of the data source (Appendix F).

9.3.1. Validity and reliability

As a first step, we performed a factor analysis (FA) of multi-item indicators to reduce the number of variables of the survey and to evaluate the validity. We used the principal component technique with varimax rotation (see Table 9.1) to extract four eigenvalues, which were all greater than one. The first four factors explain 70.1% of variance contained in the data. Kaiser-Meyer-Olkin (KMO) measures the adequacy of sample; general KMO is 0.96 (KMO ≥ 0.90 is excellent [Sharma, 1996]), which reveals that the matrix of correlation is adequate for FA. The KMO for individual variables is also adequate. All the factors have a loading greater than 0.50 (except item TI4). This indicates that our analysis employs a well-explained factor structure. The four factors found are: perceived benefits and obstacles of e-business, Internet penetration, technology readiness and technology integration. The factors obtained are in accordance with the literature review. However, there are two variables (perceived benefits and perceived obstacles) that were aggregated during the factor analysis. This reveals that content dimension does not have two different variables – perceived benefits and perceived obstacles, but only one that aggregates these two variables. The perceived obstacles of e-business constitute the negative aspect, while perceived benefits of e-business relate to the positive.

Reliability measures the stability of the scale based on an assessment of the internal consistency of the items measuring the construct. It is assessed by calculating the composite reliability for each composite independent variable. Most of the constructs have a composite reliability over the cut off of 0.70, as suggested by Nunnally [1978]. Perceived benefits and obstacles of e-business, technology readiness and trading partner collaboration have a Cronbach's alpha value of 0.98, 0.77 and 0.81 respectively. The last dimension - technology integration, comprises four items and has a Cronbach's alpha value of 0.59, which may be adequate for exploratory research, which is in the early stages of basic research. Nunnally [1978] suggests that reliabilities of 0.50 to 0.60 to suffice. We decided to retain this dimension as it relates to the important issue of technology integration in B2B e-commerce adoption and usage. Thus, constructs developed by this measurement model could be used to test the conceptual model and the associated hypotheses.

Table 9.1: Factor and validity analysis and description of multi-item indicators used in FA

Items measure	F1	F2	F3	F4
Perceived benefits and obstacles of e-business				
Why did your company decide to engage in e-business activities? (0-not at all; 1-not important; 2-important)				
EB1 - Because your customers expected it from you	**0.90**	0.10	0.09	0.07
EB2 - Because your company believes that e-business will help to get an edge over your competitors	**0.89**	0.11	0.10	0.06
EB3 - Because your competitors also engage in e-business	**0.87**	0.07	0.08	0.05
EB4 - Because your suppliers expected it from you	**0.86**	0.08	0.10	0.06
Important obstacles for not practising e-business in your company? (0-not at all; 1-not important; 2-important)				
EO1 - My company is too small to benefit from any e-business activities	**-0.92**	-0.11	-0.09	-0.04
EO2 - E-business technologies are too expensive to implement	**-0.94**	-0.09	-0.07	-0.02
EO3 – The technology is too complicated	**-0.94**	-0.09	-0.06	-0.02
EO4 - Our systems are not compatible with those of suppliers or customers	**-0.94**	-0.07	-0.06	-0.01
EO5 - We are concerned about potential security risks and privacy issues	**-0.94**	-0.06	-0.05	-0.01
EO6 - We think that there are important unsolved legal issues involved	**-0.95**	-0.07	-0.06	-0.01
EO7 - It is difficult to find reliable IT suppliers	**-0.95**	-0.07	-0.05	-0.01
Technology readiness				
TR1 - Sum of the following network applications: a Local Area Network (LAN); Wireless LAN; Voice-over-IP; Fixed line connections; Wireless-Local-Area-Networks or W-LANs, Mobile communication networks; Virtual Private Network (VPN)	0.17	**0.75**	0.16	0.15
TR2 - Sum of the following questions ICT skills: your company currently employs ICT practitioners; your company regularly sends employees to ICT training programmes	0.13	**0.70**	0.05	0.20
TR3 - Sum of the following security applications: secure server technology, for example SSL, TLS or a comparable technical standard; digital signature or public key infrastructure; a firewall	0.21	**0.65**	0.20	0.06
TR4 - Sum of the following technologies: Internet; intranet; web site;	0.23	**0.62**	0.33	0.07
TR6 - Percentage of employees that have access to the Internet	0.10	**0.53**	0.22	-0.28
Trading partner collaboration				
Does your company use online applications other than e-mail, to support any of the following business functions (0- no, and not use Internet; 1-no; 2-yes)?				
TPC1 To collaborate with business partners to forecast product or service demand	0.15	0.15	**0.88**	0.05
TPC2 To collaborate with business partners in the design of new products or services	0.15	0.14	**0.88**	0.08
Technology integration				
Does your company use any of the following systems or applications for managing information in the company (0-do not know what this is; 1-no; 2-yes)?				
TI1 - an EDM system, that is an Enterprise Document Management System	0.07	0.06	0.12	**0.68**
TI2 - a SCM system, that is a Supply Chain Management System	0.08	0.02	0.11	**0.68**
TI3 - an ERP system, that is Enterprise Resource Planning System	0.05	0.28	0.06	**0.66**
TI4 - Knowledge Management software	0.05	0.25	0.04	**0.47**
Eigen value	9.50	2.40	1.88	1.75
Percentage of variance explained	43.18	10.93	8.53	7.06

Note: variables are marked according to factor loading

9.3.2. B2B e-commerce adoption and usage

The dependent variables are B2B e-commerce adoption and usage (Figure 9.2). B2B e-commerce adoption is a binary variable, which is equal to one if firms adopt B2B e-commerce, otherwise it is zero. Since the dependent variable is binary (to adopt or not), a logistic regression is developed. Similar regressions have been used in the IS literature to study open system adoption [Chau and Tam, 1997], EDI adoption [Kuan and Chau, 2001] , IT outsourcing [Bajwa et al., 2004] and e-business adoption [Pan and Jang, 2008, Zhu et al., 2003]. For firms that adopt B2B e-commerce (4,347 firms), we analyzed B2B e-commerce usage, which is an ordered variable that ranges between 0 to 4 according to the online orders volume percentage (Figure 9.2). An ordered logistic regression is developed (we have 108 missing observations for B2B e-commerce usage). This is because the dependent variable is also ordered. The ordered logistic regression is not common in IS areas, but it is adequate for an ordered dependent variable.

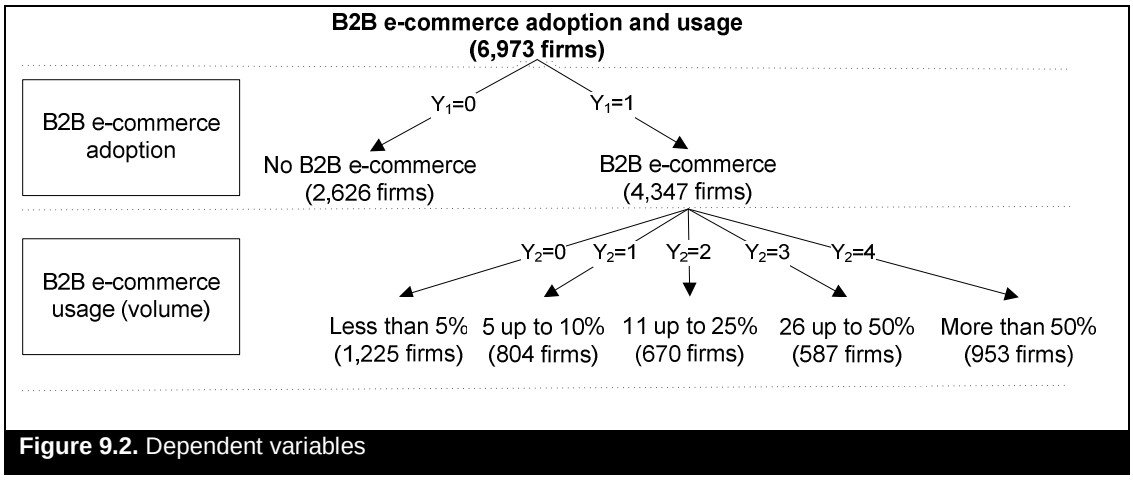

Figure 9.2. Dependent variables

The independent variables are in accordance with our research model. As we have seen, the perceived benefits and obstacles of e-business, technology readiness, trading partner collaboration and technology integration were obtained by factor analysis. All the others variables were obtained directly by the questionnaire. The description of independent variables is in Table 9.2.

Table 9.2: Description of independent variables

Variables	Description
Context	
Firm size	The logarithm number of employees
Education level	The percentage share of employees with a college or university degree in the firm
Competitive pressure	Dummy =1 if firms think that ICT has an influence on competition in their sector
Trading partner collaboration	FA index of trading partner collaboration
Content	
Perceived benefits and obstacles of e-business	FA index of perceived benefits and obstacles of e-business
Process	
Technology readiness	FA index of technology readiness
Technology integration	FA index of technology integration
Controls	
Country	Twenty five dummies for 25 countries
Industry	Eight dummies for 8 industries

In this section we analyze determinants of B2B e-commerce adoption and usage across EU27 (excluding Bulgaria and Malta). For doing this, we use logistic regression and ordered logistic regression respectively. Goodness-of-fit for both regressions is analyzed, and B2B e-commerce adoption is assessed in three ways. First, to analyse the joint statistical significance of the independent variables, we computed the likelihood ratio (LR) test, which is statistically significant (p-value<0.001). This implies a strong relationship between the dependent variable and the independent variables for each model. Secondly, we used the Hosmer-Lemeshow [1980] test, which reveals that there are no differences between fitted values of the model and the actual values (p-values is 0.224). Finally, the discrimination power of the model has been evaluated in two ways. We use the area under curve (AUC), which is equal to 0.798. This reveals an excellent discrimination power for B2B e-commerce adoption [Hosmer and Lemeshow, 2000]. We also computed the prediction accuracy, which is 73.0%. The adoption by random choices ([adopters/(adopters + non-adopters)]^2 + [non-adopters/(adopters + non-adopters)]^2) would result in 53.1% for B2B e-commerce adoption, which is much less than in the case of our regressions. Thus we conclude that the logistic regression has much higher discriminating power than the random choice. We also analysed goodness-of-fit for B2B e-commerce usage by computing the joint statistical significance of the independent variables - the LR test, which is statistically significant (p-value<0.001). The statistical procedures reveal a

substantive model fit and a satisfactory discriminating power, and there is evidence to encourage the acceptance of an overall significance of the regressions.

As can be seen in Table 9.3, for B2B e-commerce adoption and usage, the education level, competitive pressure, trading partner collaboration, perceived benefits and obstacles of e-business, technology readiness and technology integration confirm their roles as significant adoption and usage facilitators; whereas the significantly negative coefficients show that firm size inhibits B2B adoption and usage. All of the stipulated hypotheses are supported, which reveals that the research model proposed with three dimensions (*context, content and process*) is adequate.

Table 9.3: Results of logistic regression for B2B e-commerce adoption and ordered logistic regression for B2B e-commerce usage

Independent variables	**B2B e-commerce adoption** (logistic regression)		**B2B e-commerce usage** (ordered logistic regression)	
	Coef.	**P-value**	**Coef.**	**P-value**
Firm size	-0.044**	0.043	-0.200***	0.000
Education level	0.002**	0.039	0.003***	0.008
Competitive pressure	0.199***	0.002	0.265***	0.000
Trading partner collaboration	0.541***	0.000	0.277***	0.000
Perceived benefits and obstacles of e-business	0.649***	0.000	0.458***	0.000
Technology readiness	0.521***	0.000	0.450***	0.000
Technology integration	0.087**	0.010	0.100***	0.001
Country dummies	Included		Included	
Industry dummies	Included		Included	
Sample size	6,973		4,239	

Note: * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

9.3.3. Cluster analysis of countries

To understand the pattern of ICT adoption across the EU27 members, we used data from the 2006 EU information society statistics (ISS) firm survey, provided by Eurostat. We measured the ICT readiness index using two score variables related to ICT adoption and usage [Castaings and Tarantola, 2008] for each country. Since some data was missing in the case of Malta, we excluded Malta. We considered only 25 members in our final data set, because we also excluded Bulgaria as explained in the research methods section.

Cluster analysis was used to identify how many groups of countries exist with similar ICT patterns. We began by performing a hierarchical cluster analysis that suggests an optimal number of clusters equal to three (see Appendix G). The results were validated by a non-hierarchical method (k-means). According to Sharma [1996], this is the best solution to obtain clusters. The three clusters of countries are depicted in Figure 9.3. The first group can be identified as the 'high ICT readiness group'. It contains eleven countries coming from the EU15: Denmark, Netherlands, Ireland, Germany, Finland, Sweden, Austria, France, Belgium, United Kingdom (UK) and Luxemburg. It excludes the southern European countries. The second, labeled 'medium ICT readiness group', contains eleven countries: Greece, Italy, Estonia, Czech Republic (CZ), Spain, Slovakia, Slovenia, Lithuania, Cyprus, Portugal and Poland. It includes Southern European countries and some of the recent EU27 members. Finally, the 'low ICT readiness group' includes Latvia, Hungary, and Romania, all of them recent EU27 members. The classification obtained by the first two groups is similar to that obtained by Cuervo and Menendez [2006] for digital divide in EU15, with the difference of France and Belgium, which do not belong to the higher level group defined by Cuervo and Menendez.

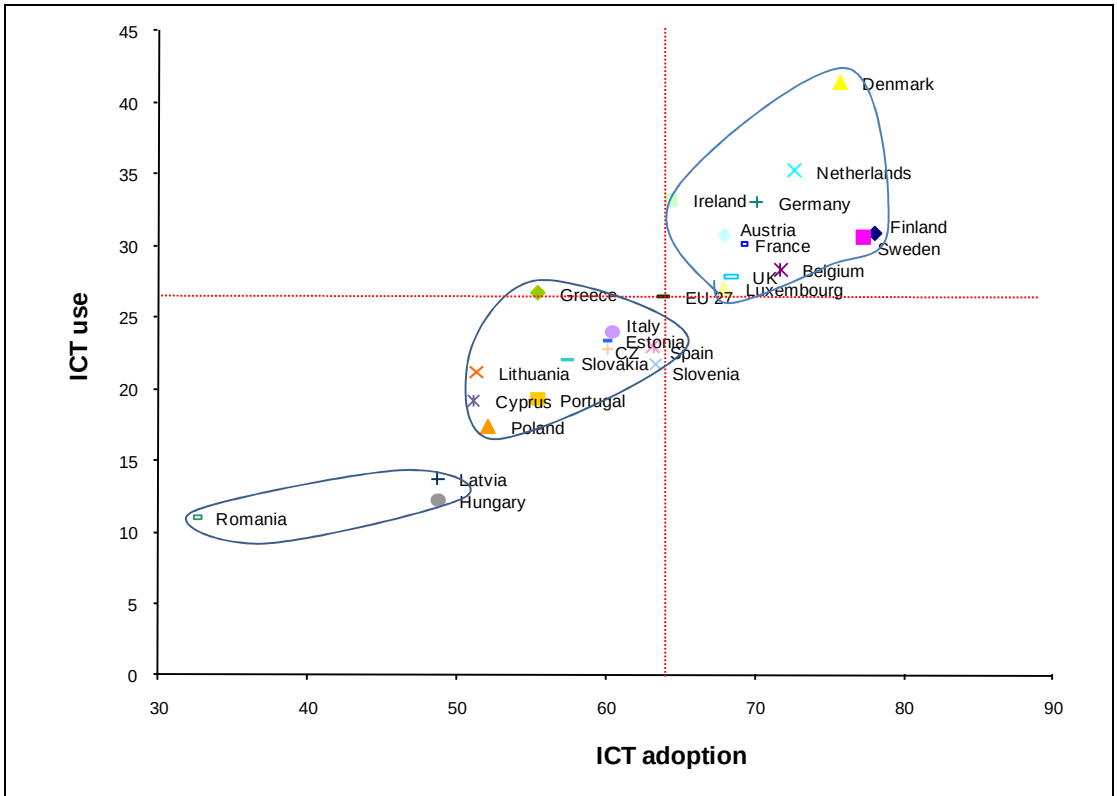

Figure 9.3. Pattern of ICT adoption and usage by EU-27 countries (excluding Bulgaria and Malta)

9.3.4. B2B e-commerce adoption and usage by group of countries

In this section we will analyse the determinants of B2B e-commerce adoption and usage for each group of countries obtained in the previous section. Goodness-of-fit for both regressions were analysed. For B2B e-commerce adoption we computed LR test, which is statistically significant (p-value<0.001 for each group of countries); Hosmer-Lemeshow [1980] test, which is not rejected (p-values are 0.251, 0.198 and 0.334, respectively for high, medium and low ICT readiness group); AUC which is equal to 0.770, 0.793 and 0.785 respectively for B2B e-commerce adoption in high, medium, and low ICT readiness groups of countries. The prediction accuracy, which is 76.0%, 70.3% and 70.3% respectively; and the adoption by random choices ([adopters/(adopters + non-adopters)]^2 + [non-adopters/(adopters + non-adopters)]^2) would result in 60.9%, 50.1% and 50.2% respectively for B2B e-commerce in each group, which are much less than in the case of our regressions. Thus we were able to conclude that the logistic regression has much higher discriminating power than the random choice. We also analysed goodness-of-fit for B2B e-commerce usage. The LR test is statistically significant (p-value<0.001 for each group of countries). The statistical procedures reveal a substantive model fit, a satisfactory discriminating power and there is evidence to accept an overall significance of the models.

As we can see in Table 9.4, for B2B e-commerce adoption within the internal context, firm size is the only significant inhibitor in the high ICT readiness group (p-value<0.01), education level is only significant in the medium ICT readiness group (p-value<0.1); within the external context, competitive pressure is significant for the high and medium ICT readiness groups (p-value<0.05 in both), trading partner collaboration is significant for the three groups (p-value<0.01 in all). For the content dimension, perceived benefits and obstacles of e-business is significant for all groups (p-value<0.01 in all). Within the process dimension, technology readiness is significant for all groups (p-value<0.01 in all), and technology integration is only significant for the high ICT readiness group (p-value<0.05).

To summarize, in the high ICT readiness group, only H2a (education level) is not supported; in the medium ICT readiness group H1a (firm size) and H8a (technology integration) are not supported; and in the low ICT readiness group H1a (firm size), H2a

(education level), H3a (competitive pressure) and H8a (technology integration) are not supported.

Table 9.4: Results of the logistic regression for B2B e-commerce adoption and ordered logistic regression for B2B usage in each group of countries

Independent variables	B2B e-commerce adoption by group of ICT readiness (logistic regression)			B2B e-commerce usage by group of ICT readiness (ordered logistic regression)		
	High	**Medium**	**Low**	**High**	**Medium**	**Low**
Firm size	-0.090***	-0.004	-0.035	-0.211***	-0.177***	-0.212***
Education level	0.002	0.003*	0.005	0.002	0.005**	0.009**
Competitive pressure	0.186**	0.218**	0.129	0.292***	0.309***	-0.324
Trading partner collaboration	0.521***	0.521***	0.633***	0.269***	0.278***	0.335***
Perceived benefits and obstacles of e-business	0.685***	0.616***	0.688***	0.516***	0.372***	0.528***
Technology readiness	0.571***	0.477***	0.500***	0.462***	0.431***	0.468***
Technology integration	0.132**	0.054	0.109	0.056	0.121**	0.296***
Country dummies	Included	Included	Included	Included	Included	Included
Industry dummies	Included	Included	Included	Included	Included	Included
Sample size	3,346	2,916	711	2,293	1,478	368

Note: * p-value<0.10; ** p-value<0.05; *** p-value<0.01.

For B2B e-commerce usage, we found different relationships (as can be seen in Table 9.4). Within the internal context, firm size is a significant inhibitor for all groups (p-value <0.01 in all); this variable is a greater inhibitor for B2B e-commerce usage than for B2B e-commerce adoption. Education level is significant in the medium and low ICT readiness groups (p-value<0.05 in both). Within the external context, competitive pressure is significant for high and medium ICT readiness groups (p-value<0.01 in both), trading partner collaboration is significant for the three groups (p-value<0.01 in all). For the content dimension, perceived benefits and obstacles of e-business is significant for all groups (p-value<0.01 in all). Within the process dimension, technology readiness is significant for all groups (p-value<0.01 in all), and technology integration is significant for medium and low ICT readiness group (p-value<0.05 and p-value<0.01 respectively). In summary, we found that only H2b (education level) and H8b (technology integration) is not supported in the high ICT readiness group; all hypothesis are supported in medium ICT readiness group; and only H3b (competitive pressure) is not supported in the low ICT readiness group.

There are variables that hold diverse significance depending on B2B e-commerce adoption or usage. On one hand, larger firm size is inhibitor for B2B e-commerce usage, while on the other hand, higher education level is facilitator for B2B e-commerce usage. This reveals that when firms are in more advance level of B2B, the firms with higher education level of employees and low size are facilitators. There is one variable from each dimension that is statistically significant in B2B e-commerce adoption and usage for all groups of countries. This is the trading partner collaboration in the context dimension, perceived benefits and obstacles of e-business in the content dimension, and technology readiness in the process dimension. This reveals that: the main drivers of B2B e-commerce adoption and usage are trading partner collaboration, perceived benefits and obstacles of e-business and technology readiness. Moreover, all three dimensions proposed are relevant for B2B e-commerce adoption and usage in different contexts.

9.4. Discussion

9.4.1. Implications for B2B strategic choices in Europe

To increase B2B e-commerce adoption and usage in Europe, our study reveals that it is important to enhance the following variables: education level, competitive pressure, trading partner collaboration, perceived benefits and obstacles of e-business, technology readiness and technology integration. Our study also reveals that a small firm has advantage in B2B e-commerce adoption and usage when compared to a large firm, provided the other variables analyzed in our model are on the same level. This reveals a business opportunity for small firms in the EU27 context for adoption and usage of B2B e-commerce. This is extremely important since there are 20 million small and medium enterprises (SMEs) in the EU27, representing 99% of businesses [Audretsch et al., 2009]. This fact makes them a key driver for economic growth, innovation, employment and social integration [Comission, 2010].

9.4.2. Defining strategic option within and amongst clusters

Based on the cluster analysis in the EU27, there are three distinct groups that present specific patterns of ICT readiness. The 'high ICT readiness group' includes the EU15 members, except the southern European countries. The 'medium ICT readiness group' includes Southern European countries and recent EU27 members (excluding Latvia, Hungary, and Romania); this classification is similar to that obtained by Cuervo and Menendez [2006] for the digital divide in the EU15. The 'low ICT readiness group' includes only recent EU27 members (Latvia, Hungary, and Romania). This result implies that the twelve recent EU27 members (excluding Malta and Bulgaria, which are missing in the data used) are not in the same level of ICT readiness. For this reason, different policies should be developed for each ICT readiness group.

In the context dimension, education level of employees is only important for the medium ICT readiness group to explain B2B e-commerce adoption and is not important for B2B e-commerce usage in the high ICT readiness group. This means that the higher education level of employees is needed for firms that want to use B2B e-commerce intensively; this is particularly relevant in the medium and low ICT readiness groups where the population has a lower education level when compared to the high ICT readiness group (especially with Nordic countries), where the level of education of the population is the highest [Eurostat, 2009]. Also in the context dimension, competitive pressure is not important for B2B e-commerce adoption and usage in the low ICT readiness group. In our opinion, when the level of B2B e-commerce increases in this group, perhaps the competitive pressure will become more important for this group.

In the process dimension, technology integration is important only for B2B e-commerce usage in low and medium ICT readiness groups. This means that in these contexts when firms want to achieve a higher level of B2B e-commerce (usage), the use of technology integration is necessary. In Figure 9.4, we present the main drivers of B2B e-commerce, independently of the context and the variables that need to be enhanced to help it move to a higher level of B2B e-commerce.

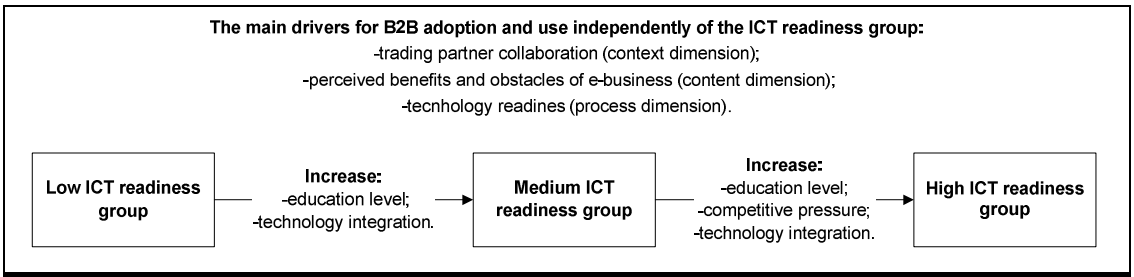

Figure 9.4. Factors that help to move for a higher ICT readiness group

For B2B e-commerce adoption, firm size (context dimension) is a statistically significant inhibitor only for the full sample and high ICT readiness group. Firm size is a strong inhibitor in all ICT readiness groups for e-business usage. This means that B2B e-commerce is not a phenomenon dominated by large firms, especially in the high ICT readiness group and for B2B e-commerce usage. Small firms have the advantage of close collaboration, coordination and less bureaucracy. In addition, in the high ICT readiness group, there commonly exist more available technology and services providers, which help to lower the adoption risk. This is the reason why small firms probably have advantages in adopting B2B e-commerce. On the contrary, for eight European countries Zhu et al. [2003] found that in 1999, larger firm size was a facilitator of e-business adoption. This difference can be due to the decreasing costs of IT over time. Moreover, when firms adopt B2B e-commerce, small firm size is a facilitator for B2B e-commerce usage in all ICT readiness groups.

9.4.3. Social responsibility with respect to B2B variations

The international digital divide is largely the consequence of the social and economic inequities between countries. Countries with lower income and lower educational attainment tend to reveal lower rates of ICT access and usage when compared with higher income and better education attainment countries [Cuervo and Menendez, 2006, Kiiski and Pohjola, 2002, Pohjola, 2003]. Special attention must be paid to countries in the low ICT readiness group to avoid a more pronounced digital divide across EU27 members. Our study suggests that is necessary to increase the education level of the population and consequently the employees' readiness for IT adoption. It is also essential to promote the increased level of technology integration used by firms. For the medium ICT readiness group, it is also important to increase the level of competitive pressure.

9.4.4. Contributions

B2B e-commerce has become an increasingly important topic for both researchers and practitioners [Teo and Ranganathan, 2004]. To promote B2B adoption and usage it is critical to clarify the factors that explain these and conduct a deep analysis to understand if different levels of adoption and usage have the same drivers for B2B e-commerce. We developed a new approach based of the contextualist of Pettigrew and Whipp [1991] to study the factors that explain B2B e-commerce adoption and usage. Based on a large sample of EU27 members, we tested our conceptual model and developed a measurement model satisfying various reliability and validity conditions. In general, our hypotheses are confirmed. Our research model is seemingly appropriate. As the sample was not limited to data from a single country, this helps to strengthen the generalization of the model and findings. The major contributions of this study are the following:

- Firstly, we demonstrated and showed that our model is useful for identifying facilitators and inhibitors of B2B adoption and usage.
- Secondly, we identified seven drivers of B2B e-commerce adoption and usage, six facilitators and one inhibitor (firm size).
- Thirdly, based on Eurostat country-wise data, we found three different groups of ICT readiness.
- Finally, trading partner collaboration in the context dimension, perceived benefits and obstacles of e-business in the content dimension and technology readiness in the process dimension are important drivers for B2B e-commerce adoption and usage in all ICT readiness groups.

Our findings reveal that all three proposed dimensions are fundamental and intricate, such as in the contextualist theory of Pettigrew and Whipp [1991].

9.4.5. Limitations and further research

As in most empirical studies, our work has some limitations. Firstly, the cross-sectional nature of this study does not allow us to predict how this relationship will change over time.

To overcome this limitation, future research should involve panel data. Secondly, we did not include the government regulation variables in our model because data were not available for these variables. Any further research should include these variables.

While explicitly not explored in this research there is a tendency in IS research [Gibbs and Kraemer, 2004, Hsu et al., 2006, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b] to aggregate B2B and B2C e-commerce together. Clearly further research is needed to understand the different drivers between B2B and B2C e-commerce. Future research can also seek additional information to evaluate the impact of B2B adoption and usage on a firm's turnover, market share and productivity. Finally, confirmatory studies of our research model, in different contexts, need to be undertaken. Other studies and samples should be used for the validation of our model.

9.5. Conclusions

In this paper we have analyzed B2B e-commerce adoption and usage at firm level in EU27. We concluded that different countries belonging to EU27 do not have the same level of ICT adoption and diffusion. In fact there are three different levels or clusters, all with their own set of challenges with respect to B2B e-commerce adoption and usage. Identification and appreciation of the different clusters helps in fine tuning policy initiatives, both at the macro and micro level. While such a call may seem obvious, it has not been adequately addressed in the literature. More often than not, the focus has been on defining grand strategic choices for countries, without understanding particular nuances or differences. This is particularly true of policy initiatives that get formulated at a federal level (such as the European Union) with regions having to implement or adopt them. Typically a lack of such appreciation can lead to regional imbalances in technology adoption, which risk failure or complete abandonment of the initiative.

Chapter 10 – Conclusions

10. 1. Summary of findings

There is consensus today that information technology (IT) has significant effects on the productivity of firms [Black and Lynch, 2001, Brynjolfsson and Hitt, 2000]. These effects will only be realized if, and when, IT come into widespread use [Pohjola, 2003]. It is essential to understand the determinants of adoption of IT. For both the Portuguese ("Technology Shock") and the European context ("i2010") IT adoption is a key theme. With the general aim of better understanding IT adoption at firm level, studies in the Portuguese and the European context were developed. For the Portuguese context, we compared simple *versus* complex technologies (Chapter 3); small *versus* large firms (Chapter 4); stages of adoption in small firms (Chapter 5); and we analysed Internet business solutions (IBS) (Chapter 6). For the European context, we analysed the main characteristics of e-business adoption (Chapter 7). We also made an e-business adoption model that combined two theoretical models (Tornatzky and Fleischer [1990] model and the Iacovou et al. [1995] model), and we compared e-business adoption by industries (telecommunications (telco) *versus* tourism) (Chapter 8). In the end, we developed a model for Business-to-business (B2B) e-commerce adoption and usage based on the contextualist theory of Pettigrew and Whipp [1991]. We also found three distinct groups of European countries that present specific patterns of ICT readiness ("low, medium, and high ICT readiness group"), and we also tested the developed model in these different contexts (Chapter 9).

First, we made a literature review about IT adoption models at firm level (Chapter 2). We concluded that the TOE framework is a solid theoretical basis, with consistent empirical support, and the potential of application to information systems (IS) adoption. This model is a good theoretical starting point for our work.

One important result (based on Chapters 3 and 5) is that Internet, web site and e-commerce adoption are taken at different stages. Moreover, the factors have distinct effects on the different stages. In addition, this conclusion was validated for all size firms in

the Portuguese context. To complement the idea of different stages of adoption, Chapter 6 reveals that web site and the level of IBS are also taken at different stages, this means that to be an IT adopter (web site) does not mean being an extensive IT user (the level of IBS).

For the Portuguese and the European context, technology readiness is an important driver of IT adoption. Technology readiness is constituted “not only by physical assets, but also by human resources that are complementary to physical assets” [Mata et al., 1995]. This urges top leaders to promote ICT infrastructures, managerial skills, and human resources that possess knowledge of these new information technologies.

The size of the firms is a variable that has a controversial impact on the IT adoption decision, because some empirical studies indicate that there is a positive relationship [Grover, 1993, Hsu et al., 2006, Pan and Jang, 2008, Premkumar et al., 1997, Soares-Aguiar and Palma-Dos-Reis, 2008, Thong, 1999, Zhu et al., 2003], while other studies report evidence against this positive relationship [Dewett and Jones, 2001, Harris and Katz, 1991, Martins and Oliveira, 2007, Oliveira, 2008, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b]. In our context, it is an important factor. Moreover, comparing “directly” large and small firms, we conclude that small firms behave differently from their counterparts (Chapter 4). We also conclude that for more advanced levels of adoption, such as: level of IBS (Chapter 6) or B2B e-commerce usage (Chapter 9), small-size firms have an advantage when compared to a large firm, providing the other variables analysed are at the same level. On the other hand, large firms in the initial stage of adoption, such as: Internet adoption (Chapter 5) and web site adoption (Chapters 3, 5, and 6) have advantages. This is in accordance with the idea that large firms tend to have advantages in early stages, but they face critical challenges in the latter ones [Lee and Xia, 2006].

Perceived benefits is in general an important facilitator of IT adoption for all contexts and levels of adoption (Chapters 3, 4, 5, 6, 8, and 9, except in Chapter 5 for e-commerce adoption), which reveals the importance of understanding the benefits of the new technology.

Based on the European data, the industry context seems to be more important than the country context (Chapter 7). Furthermore, the relative importance of all drivers for e-business adoption in the telco industry differs from that in the tourism industry (Chapter 8). The only exception is competitive pressure, where there is no difference between these two industries, which reveals the same level of competition in the online market across these industries. Competitive pressure is also important in the Portuguese and the European contexts, and the stage of IT adoption (Chapters 3, 5, 6, and 9). It is also important for small and large firms (Chapter 4).

Trading partner collaborations is an important driver for e-business adoption in the telco and tourism industries (Chapter 8), and for B2B e-commerce adoption and usage (Chapter 9) in the European context. Consequently, managers and policy makers should support the creation of networks with other players and the sharing of resources in order to satisfy the needs of diverse and ever faster changing customer requirements. This, in turn, could increase the competiveness of the whole network [W@tch, 2007].

Education level, in the Portuguese context, is important on the level of IBS adoption decision but was not important in the web site adoption model (Chapter 6). In the EU27, education level is only important for the medium ICT readiness group to explain B2B e-commerce adoption and in the medium and low ICT readiness group to explain B2B e-commerce usage (Chapter 9). This means that the higher education level of employees is needed for firms that wish to adopt IT intensively. This is particularly pertinent in the medium and low ICT readiness groups where the population has a lower education level when compared to the high ICT readiness group (especially with Nordic countries), where the level of education of the population is the highest [Eurostat, 2009].

10.2. Contributions

Chapters 3, 4, 5, and 6 used Portuguese data and they are important contributions to the literature, since there are few published studies on the subject [Parker and Castleman, 2007]. In Chapters 3 and 6 we used an integrated model, and we took selectivity into account, a topic that is still quite limited in the literature [Battisti et al., 2007]. Chapter 4 is related to the scarcity of studies on comparing the determinants of web site adoption in

small and large firms. The contribution of Chapter 5 is also related to the very limited research on comparing the determinants of Internet, web site, and e-commerce adoption in small firms.

To the best of our knowledge, there are few studies that identify the patterns of e-business adoption amongst firms in the EU27 using the TOE framework. Chapter 7 contributed to fill this gap.

In Chapter 8, the purpose is to identify the factors that explain the variation in e-business adoption by two different industries (telco and tourism) in the EU27 context. To our knowledge, there has been no research in this area; this chapter addresses this gap. Another contribution is that we develop a research model that is a combination of the Tornatzky and Fleischer [1990] model and the Iacovou et al. [1995] model to achieve our purpose.

The purpose of Chapter 9 is to understand B2B e-commerce adoption and usage in European countries, and for this we use an adaptation of the theory of contextualist by Pettigrew and Whipp [1991] to organize our initial theoretical/conceptual model; this new approach is our main contribution. All of the stipulated hypotheses are supported, which reveals that the research model proposed with three dimensions (*context*, *content,* and *process*) is adequate.

10.3. Limitations and further research

As in most empirical studies, our work is limited in some ways. Firstly, the cross-sectional nature of this study does not allow knowing how this relationship will change over time. To solve this limitation, future research should involve panel data. Also, we did not include the government regulation variables in our model because these variables are not available in this questionnaire. A new questionnaire should be made in further research.

In terms of future research, it would be interesting to study one model that determines e-business adoption for each industry in the European context. It would also be important to compare the impacts of TOE variables in different industries (manufacture, construction,

tourism, and telecommunications). In the tourism industry the rate of adoption between business-to-business (B2B) and business-to-consumer (B2C) is very different, and further research is needed to understand the different drivers between B2B and B2C, and across industries. As we saw, several studies [Gibbs and Kraemer, 2004, Hsu et al., 2006, Zhu et al., 2006a, Zhu and Kraemer, 2005, Zhu et al., 2006b] tend to aggregate B2B and B2C e-commerce, considering that both have the same drivers. Further research is needed to understand the different drivers between B2B and B2C e-commerce. Another direction for future research is to provide additional information to evaluate the impact of B2B adoption and usage on a firm's turnover, market share, and productivity. Finally, we encourage confirmatory studies of our research model developed in Chapters 8 and 9. It should be tested in other contexts and applied to other IT adoptions to be refined. Other studies and samples should be used for the validation of our models. Samples of specific context or industry, such as manufacturing or service, should be gathered to further examine the applicability of these models.

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Appendix A

Technological integration

Did your firm's IT systems for managing orders link automatically with any of the following IT systems during January 2006? (Yes No)

a) Internal system for re-ordering replacement supplies

b) Invoicing and payment systems

c) Your system for managing production, logistics or service operations

d) Your suppliers' business systems (for suppliers outside your firm group)

e) Your customers' business systems (for customers outside your firm group)

Internal security applications

Did your firm use the following internal security applications, during January 2006? (Yes No)

a) Virus checking or protection software

b) Firewalls (software or hardware)

c) Secure servers (support secured protocols such as http)

d) Off-site data backup

e) Subscription of a security service (e.g. antivirus or network intrusion alert)

f) Anti-spam filters (unsolicited e-mails)

Access to the IT system of the firm

Did any of those people access the firm's computer system from the following places during January 2006? (Yes No)

a) From home

b) From customers or other external business partners' premises

c) From other geographically dispersed locations of the same firm or firm group

d) During business travels, e.g. from the hotel, airport etc.

Appendix B

A1. Dependent variables

A.1.1.Internet Adoption

Did your firm have access to the Internet during January 2006? (Yes No)

A.1.2 Web site adoption

Did your firm have a Web Site / Home Page during January 2006? (Yes No)

A.1.3. E-commerce adoption

Did your firm perform sales via the Internet during 2005 (excluding manually typed e-mails)? (Yes No)

A2. Independent variables

A2.1. Technology Readiness

A2.1.1. IT Infrastructures

Did your firm have the following information and communication technologies during January 2006? (Yes No)

a) Computers
b) e-mail
c) Intranet
d) Extranet
e) Own networks that are not the Internet (own exclusive networks)
f) Wired LAN
g) Wireless LAN
h) WAN

A2.1.2. IT skills

Did the firm have working personnel exclusively devoted to Information and Communication Technologies in January 2006? (Yes No)

A2.2. Technological integration

Did your firm's IT systems for managing orders link automatically with any of the following IT systems during January 2006? (Yes No)

a) Internal system for re-ordering replacement supplies

b) Invoicing and payment systems

c) Your system for managing production, logistics or service operations

d) Your suppliers' business systems (for suppliers outside your firm group)

e) Your customers' business systems (for customers outside your firm group)

A2.3. Security applications

Did your firm use the following security applications, during January 2006? (Yes No)

a) Virus checking or protection software

b) Firewalls (software or hardware)

c) Secure servers (support secured protocols such as http)

d) Off-site data backup

e) Subscription of a security service (e.g. antivirus or network intrusion alert)

f) Anti-spam filters (unsolicited e-mails)

A2. 4. Firm size

How many employees did your firm have during January 2006?

a) 1 up to 4 employees

b) 5 up to 9 employees

c) 10 up t 49 employees

A2. 5. Perceived benefits of electronic correspondence

Did electronic correspondence become the main medium of business communication, substituting traditional postal mail (e.g. for sending invoices, direct mail, etc. to customers and other firms), in the last 5 years? (Yes No)

A2. 6. IT training programs

Did the company develop training programs (on its premises or elsewhere) related to computers / informatics targeted at its working personnel in 2005? (Yes No)

A2. 7. Access to the IT system of the firm

Did any of those people access the firm's computer system from the following places during January 2006? (Yes No)

a) From home

b) From customers or other external business partners' premises

c) From other geographically dispersed locations of the same firm or firm group

d) During business travels, e.g. from the hotel, airport etc.

A2. 8. Internet and e-mail norms

Did the company have defined norms about Internet and e-mail use in January 2006? (Yes No)

A2. 9. Main perceived obstacle

Concerning the sale of goods and/or services through the Internet, indicate what is the main barrier/difficulty encountered by your firm in 2005 (tick only one):

a) Security problems related to the payment and uncertainty about the legal framing of Internet sales (contracts, terms of delivery and warranty).

b) The goods and/or services provided by the company are not susceptible of being sold through the Internet.

c) Customers are not ready to buy through the Internet.

e) Development and maintenance costs of the Internet sales system.

f) Other

A2.10.Type of industry

What was the main activity of firms in January 2006?

Appendix C

MCA is a statistical technique designed to represent associations in a low-dimension space. It is used to reduce the dimension when the variables are binary. We applied an MCA to reduce the dimension of the questions about IT Infrastructures and IT Skills. The first dimension's inertia is 43%. As can be seen from Table 4, on the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. The coordinates of this axis are used to compute the variable "Technology Readiness".

Table 5.3: MCA for IT infrastructures and IT skills

Var (-)	Dim[1]	AC[2]	RC[3]	Var (+)	Dim	AC	RC
No computers	-0.971	0.079	0.446	**Computers**	0.460	0.037	0.446
No e-mail	-0.849	0.079	0.531	**E-mail**	0.626	0.059	0.531
No intranet	-0.424	0.034	0.500	**Intranet**	1.179	0.096	0.500
No Wired LAN	-0.398	0.032	0.569	**Wired LAN**	1.430	0.116	0.569
No extranet	-0.300	0.019	0.412	**Extranet**	1.371	0.088	0.412
No own networks	-0.249	0.014	0.375	**Own networks**	1.507	0.084	0.375
No wireless LAN	-0.237	0.013	0.377	**Wireless LAN**	1.591	0.085	0.377
No WAN	-0.191	0.009	0.406	**WAN**	2.123	0.097	0.406
No *IT skills*	-0.120	0.003	0.234	***IT skills***	1.953	0.057	0.234

Note: [1]Dim – Dimension; [2] AC – Absolute Contribution; [3] RC – Relative Contribution.

Appendix D

The MCA is a method of "multidimensional exploratory statistic" that is used to reduce the dimension when the variables are binary. For more details see [Johnson and Wichern, 1998]. We applied a MCA for question about IT Infrastructures and IT Skills. The first dimension explains 38% of inertia. As can be seen from Table 5, in the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. This axis is labelled "Technology Readiness".

Table 6.5: MCA for IT infrastructures and IT skills

Var (-)	Dim[1]	AC[2]	RC[3]	Var (+)	Dim_1	AC_1	RC_1
No computers	-3.000	0.055	0.189	**WAN**	0.861	0.090	0.512
No e-mail	-2.441	0.075	0.266	**IT skills**	0.762	0.068	0.381
No wired LAN[4]	-1.094	0.114	0.565	**Wireless LAN**	0.748	0.067	0.379
No intranet	-0.943	0.087	0.438	**Own network**	0.623	0.054	0.351
No WAN[5]	-0.595	0.062	0.512	**Extranet**	0.609	0.049	0.298
No own network	-0.563	0.049	0.351	**Wired LAN**	0.516	0.054	0.565
No wireless LAN	-0.507	0.045	0.379	**Intranet**	0.464	0.043	0.438
No IT skills	-0.500	0.045	0.381	**E-mail**	0.109	0.003	0.266
No extranet	-0.490	0.039	0.298	**Computers**	0.063	0.001	0.189

[1]Dim – Dimension ; [2]AC – Absolute Contribution ; [3]RC – Relative Contribution ; [4]LAN – Local Area Network; [5]WAN – Wide Area Network.

Appendix E

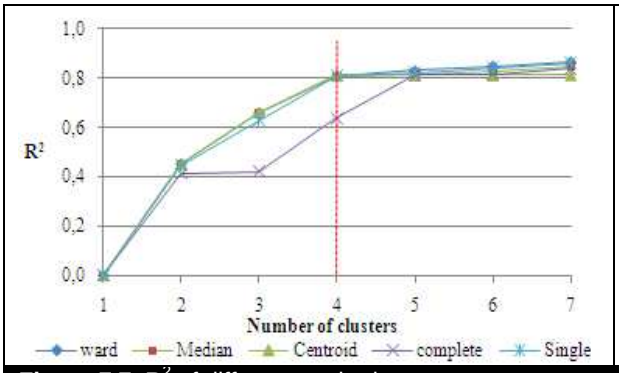

Figure 7.7. R^2 of different methods

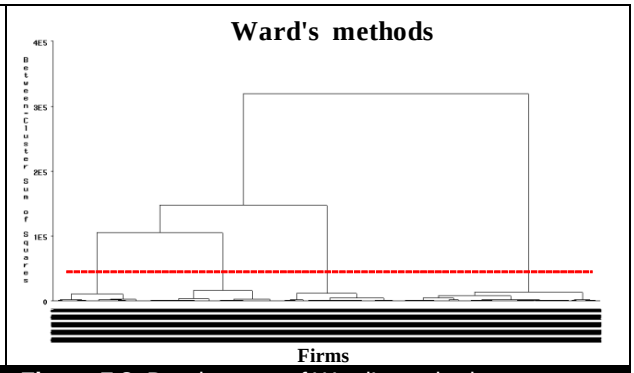

Figure 7.8. Dendrogram of Ward's methods

Appendix F

Table 9.5: Sample characteristics

Country	Obs.	(%)
Austria	268	3.84%
Belgium	227	3.26%
Cyprus	97	1.39%
Czech Republic	397	5.69%
Denmark	214	3.07%
Estonia	162	2.32%
Finland	384	5.51%
France	521	7.47%
Germany	522	7.49%
Greece	223	3.20%
Hungary	372	5.33%
Ireland	219	3.14%
Italy	395	5.66%
Latvia	146	2.09%
Lithuania	199	2.85%
Luxembourg	66	0.95%
Netherlands	278	3.99%
Poland	348	4.99%
Portugal	232	3.33%
Romania	193	2.77%
Slovakia	182	2.61%
Slovenia	289	4.14%
Spain	392	5.62%
Sweden	234	3.36%
UK	413	5.92%
Total	6,973	100%

Respondent's position	Obs.	(%)
Owner/Proprietor	2,070	29.69%
Managing Director/Board Member	1,436	20.59%
Head of IT/DP	1,373	19.69%
Other senior member of IT/DP Department	627	8.99%
Strategy development/organization	336	4.82%
Other	1,131	16.22%
Total	6,973	100%

Industry	Obs.	(%)
Food and beverages	890	12.76%
Footwear	482	6.91%
Pulp and Paper	701	10.05%
ICT Manufacture	1,069	15.33%
Consumer electronics	387	5.55%
Construction	1,189	17.05%
Tourism	1,273	18.26%
Telecommunications	982	14.08%
Total	6,973	100%

Appendix G

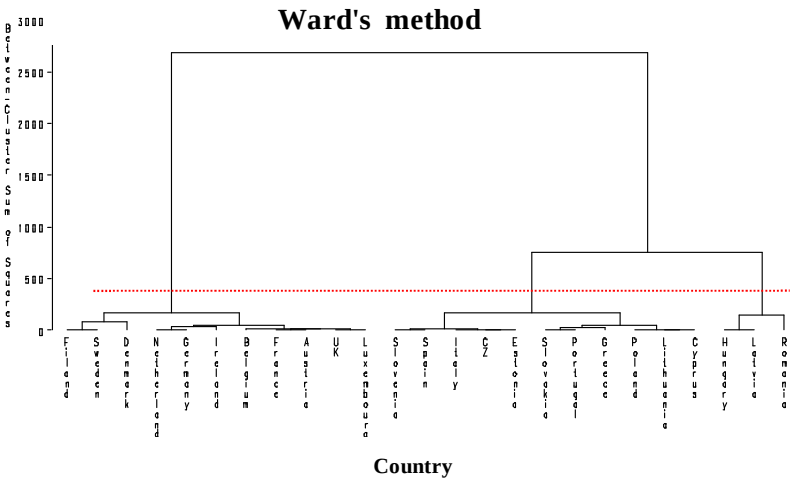

Figure 9.5. Dendrogram of Ward's method