

*Master's Thesis at the Chair of Banking*



# **The Adoption of Electronic Banking: Evidence from Liechtenstein**

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### **Abstract**

The thesis at hand adds to the line of research concerned with the adoption of electronic banking. Drawing on a unique dataset, provided by the major retail bank of the Principality of Liechtenstein - the Liechtensteinische Landesbank AG - it presents evidence of electronic banking adoption in the year 2018. Building upon a cross-sectional sample of 31'511 individual client observations, the thesis set out to answer questions regarding the determinants of electronic banking adoption. Based on the two theoretical concepts of perceived usefulness, from the technology acceptance model (TAM), and relative advantage, from the diffusion of innovation theory (DOI), this thesis derives the hypothesis that larger distances to a bank branch are positively correlated with electronic banking adoption. In addition to identifying these major theoretical frameworks, the literature review enables us to derive two more hypotheses with regard to the impact of a client's age and sex on the likelihood of electronic banking adoption. The subsequent analysis of the data sample adds to the literature by presenting additional evidence for a negative correlation between a consumer's age and her likelihood of adopting electronic banking. It further shows that male clients are more likely to adopt e-banking services - confirming the gender gap, found in previous research projects. Finally, we find a statistically significant, positive relation between distance and e-banking adoption, i.e., people living further away from a bank branch are more likely to have an e-banking agreement with the bank.

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## 1 Introduction

With the rapid spread of the internet, the banking industry had to catch up eventually and offer their customers the advantages of this new world. Electronic banking services give its users the opportunity to save both money and time. The troubles of going to a bank branch, waiting there in line and explaining your needs to an employee, have been replaced by a much more efficient process, where the user can log into his account from a PC, laptop or even mobile phone and handle many issues from the comfort of his home, or on the go. This process allows the customer to have easier access to some of the bank's services. Moreover, they avoid a loss of time waiting in line or driving to the bank branch. Over the past three decades, the numerous new information and communication technologies within the financial industry have impacted the way banks service their customers. In other words, the Internet has sparked an IT-based revolution in the financial services sector that has radically altered the way that banking services are delivered. In particular, self-service technologies have enabled banks to pursue an electronically mediated multi-channel strategy (Jo Black, Lockett, Ennew, Winklhofer, & McKechnie, 2002). These new technologies referred to as Internet banking (IB), electronic banking or mobile banking, have enabled busy people to complete their financial activities in a cost-effective and efficient manner at any time of the day, without the hassle of actually going to a bank branch (Makris, Koumaras, Koumaras, Konstantopoulou, & Konidis, 2009). Regardless of their physical location, electronic banking allows bank customers to engage in a vast array of financial services such as paying bills, checking account information or transferring funds through bank websites (Tan & Teo, 2000). From the consumer's perspective these new technologies provide new modes of data access, analysis and decision-making regarding one's financial management (Lee, 2009; Luo, Li, Zhang, & Shim, 2010). Electronic banking also helps consumers to decide which banking product fits best to their personal needs (Lee, 2009; Luo et al., 2010). Railton (1985) states that the first self-service technologies in the finance sector emerged in the 1970s, when banks installed the first automated teller machines (ATMs). This was followed by telephone banking services in the 1980s (Ahmad & Buttle, 2002), and in the 1990s, with the emergence of the Internet, banks further extended their existing distribution channels by offering web-based banking applications (Tan & Teo, 2000; Bhattacharjee, 2001; Suh & Han, 2002). Over the past decade, the rapid increase in the number of mobile technologies such as mobile phones and smartphones have encouraged banks to provide mobile banking applications (Barnes & Corbitt, 2003; Laukkanen & Lauronen, 2005; Scornavacca, Barnes, & Huff, 2006). Web-based banking applications, as well as mobile banking services, are also included in the Online and Mobile Banking offerings at the Liechtensteinische Landesbank AG. This major retail bank located in the Principality of Liechtenstein, provided us with the dataset that will be at the core of this research.

Nevertheless, not only consumers gain from the electronic banking revolution. There have also been benefits for the financial institutions. For instance, it increases service quality, which is a necessary factor for survival in competitive markets (Rouibah, Thurasamy, & May, 2009). Moreover, it reduces costs relative to other forms of banking, and provides more timely and complete customer information. Moving clients to e-channels is, therefore, an important issue for the banking industry (Gerrard & Cunningham, 2003). Nonetheless, without the customers actually adopting electronic banking these goals cannot be reached. Thus, financial service providers must aim to have a comprehensive understanding of their client's impressions of this technology (Lassar, Manolis, & Lassar, 2005).

However, there are not only positive aspects to the adoption of these technologies. Especially in the early years, the number of people who actually used electronic banking services was not very high. Usage rates, published by Deutsche Bank research in 2010, suggest that, while each month

73% of all European banking customers use ATM machines, only 30% use Internet banking services (Deutsche Bank research, 2010). Of course, the adoption of electronic banking has increased since 2010 and nowadays, 56% of Europeans who own a smartphone used mobile banking apps in (2016) according to Ipsos.

Summing things up, the importance and increased interest in the adoption of electronic banking is undeniable. Both the clients and financial service providers stand to gain a lot from this technology. Thus, it is only the logical consequence that research tries to explore this phenomenon. The adoption of these electronic banking services is and has been an interesting topic to study. The vast amount of research, published in decision support system journals, is only the legitimate consequence. The popularity of this line of research becomes particularly evident when one looks at the significant increase in research output with regard to the topic over the past decades (Shaikh & Karjaluoto, 2015; Hanafizadeh, Keating, & Khedmatgozar, 2014; Hoehle, Scornavacca, & Huff, 2012). Based on innovation diffusion theory (Rogers, 2003), the technology acceptance model (Davis, 1989), and the theory of planned behaviour (Ajzen, 1991), a large number of studies have examined variables that motivate individuals to adopt electronic banking services. Consequently, an extensive body of research has been developed to understand the adoption and use of electronic banking channels at the individual level. The use of surveys has so far been the most common method to examine the adoption of electronic banking (Hoehle et al., 2012). By those means, previous studies have found that male consumers are more likely to adopt electronic banking (Flavián, Guinalú, & Torres, 2006; Kräuter & Breiteneker, 2011). Moreover, as early as in the year (2000), J. Kolodinsky et al. have found that younger people are more likely to adopt e-banking services. (J. Kolodinsky et al., 2000). A finding that has been confirmed many times in the following years (Mattila, Karjaluoto, & Pento, 2003; J. M. Kolodinsky, Hogarth, & Hilgert, 2004; Izogo, Nnaemeka, Onuoha, & Ezema, 2012).

By avoiding the biases associated with survey research (Krosnick, 1999), this thesis will contribute to the line of research by analysing a unique dataset, provided by the major retail bank of the Principality of Liechtenstein. By doing that, the study explores the impact of a new determinant of electronic banking adoption - the distance of a client to the next bank branch. The study finds a statistically significant, positive relation between distance and e-banking adoption. Meaning that people living further away from a bank branch are more likely to have an e-banking agreement with the bank. The derivation of the underlying hypothesis will be grounded in two well established theoretical frameworks - the diffusion of innovation theory (Rogers, 2003) and the technology acceptance model (Davis, 1989). Moreover, this paper presents additional evidence for a negative correlation between a consumer's age and her likelihood of adopting electronic banking. It further shows that male clients are more likely to adopt e-banking services - confirming the gender gap found in previous research projects (Flavián et al., 2006; Kräuter & Breiteneker, 2011).

The thesis is organised as follows. Section 2 presents the peculiarities of banking in Liechtenstein and establishes the institutional background for this paper. In section 3 of this thesis, one can find a review of previous literature on the adoption of electronic banking. A paper written by Hoehle et al. in (2012) summarises three decades - from 1984 to 2010 - of previous research on the topic and is the foundation for identifying the research gap. The section concludes with the derivation of the hypothesis. The subsequent section, section 4, is meant to present the dataset examined in this research project and the methodology used to study it. Afterwards, section 5 exhibits the results and main findings of this thesis, before they are going to be discussed in section 6. Section 7 concludes.

## 2 Banking in Liechtenstein

This section presents the peculiarities of banking in Liechtenstein. It will also present a more detailed discussion of one of the major players in this branch of industry, the Liechtensteinische Landesbank AG. The dataset, used in this thesis, was contributed by this bank. However, we will open this section with a few remarks on the country in question itself.

### 2.1 The Principality of Liechtenstein

2019 will see the 300th anniversary of sovereignty for the country of Liechtenstein. Liechtenstein is a tiny, mountainous country in the middle of Europe. Remarkably, it is so central that it is one of only two so called "doubly landlocked" countries in the entire world, surrounded by the landlocked countries of Switzerland and Austria (Boslaugh, 2013). One can find a map depicting the Principality of Liechtenstein with its municipalities, as well as its borders to neighbouring countries, in figure 2.1.



**Figure 2.1.** Map of the Principality of Liechtenstein.

*Notes:* In the figure above the reader can see a map of the Principality of Liechtenstein. It displays the municipalities of the country as well as the two constituencies. Moreover, we can see the borders to the two neighbouring countries of Switzerland and Austria. Finally, some larger rivers and the highest mountain are displayed.

*Source:* Encyclopædia Britannica, Inc.

With an area of only 160 km<sup>2</sup> the German-speaking principality is the world's sixth smallest country (Youngblood-Coleman, 2014). Despite its tiny size and limited natural resources, Liecht-

enstein has developed into a prosperous, well-diversified and highly industrialised economy. Its major economic sectors include manufacturing, tourism and financial services. Additionally, it is one of very few countries in the world still ruled by a prince. Moreover, in contrast to the British royal family for example, the Prince of Liechtenstein has some actual political power. After all, he possesses a veto to every legislation that is passed by the government (The Government of the Principality of Liechtenstein, 2003, Chapter II, Art.9). In table A1 in appendix A, one can find a fact sheet with some additional information about the country from where evidence is presented in this thesis.<sup>1</sup>

Measured by GDP per capita, Liechtenstein is the richest country in the world, with the lowest unemployment rate. A comparison of these two economic indicators can be found in table 2.1 below. This does not come as a surprise, since the country offers as many jobs as there are inhabitants. This also means that a great portion of the workforce working daily in Liechtenstein comes from commuters from its neighbour countries Austria and Switzerland or even Germany (Central Intelligence Agency, 2018).

Country / Aggregate	GDP per capita (current US\$)	Unemployment, total (% of total labor force)	Individuals using the internet (% of population)
Liechtenstein	164'437	2.3	98.1
Luxembourg	100'739	6.3	97.5
European Union	32'250	8.5	80.8
High income	40'826	6.2	82.0
OECD members	38'881	6.3	78.6
World	10'192	5.7	45.9

**Table 2.1.** Comparison of economic indicators.

*Notes:* This table demonstrates the economic soundness of the Principality of Liechtenstein in comparison to other countries. As a benchmark aggregates such as the European Union, High Income States, OECD members and the World average are used. In our comparison, we further make use of another small European country - Luxembourg. The figures depicting the GDP per capita, as well as the numbers reflecting the total unemployment rate are from the year 2016. To give an indication about internet usage in general, the indicator in the last column shows the percentage of individuals using the internet in the year 2016.

*Sources:* The World Bank Group (2018), Trading Economics (2018) and Kushnir (2018).

Another astonishing feature of the Liechtenstein economy is the fact that the country is one of only four countries in the world which does not have any debt obligations (Central Intelligence Agency, 2018). This great economic success is also due to the importance of the financial center. We will now turn to a discussion of said financial center in the subsequent subsection.

## 2.2 The Financial Center

The Financial Center Liechtenstein e. V., the Liechtenstein Bankers Association as well as the Financial Market Authority are the main authorities regarding the financial services industry in Liechtenstein. Their publications are the main sources of information to provide an overview of the country's financial center in particular. This subsection presents the main characteristics of the banking industry in Liechtenstein and thus, allows the reader to gain some essential background information and insights.

There are currently 15 banks in Liechtenstein, which are under the supervision of the Financial Market Authority (Financial Center Liechtenstein, 2017). At the end of 2016 these 15 licensed

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<sup>1</sup>For further information on the Principality of Liechtenstein see <https://www.liechtenstein.li/>

banks had cumulative assets in excess of 230 billion Swiss Francs (Financial Market Authority Liechtenstein, 2017). With a contribution to the GDP of about 25%, the financial sector is one of the main economic sectors of the Principality (Amt für Statistik, 2018). After the industry and manufacturing sector, financial services represent the largest economic sector and consequently a key pillar of Liechtenstein's economy. Even more astonishing is the number of employees broken down according to the economic sectors. There we find that a majority of 61% of all employees work within the general financial and other services branches of the economy. One reason for the financial sector's high relevance are the manifold location benefits for financial service providers. The Financial Center Liechtenstein e. V. lists the following location benefits:

- Free access to the European market
- Stable social, legal and economic system
- High degree of political continuity and stability
- Liberal economic policy and liberal company law
- Moderate corporate taxation
- Flexibility and short decision-making channels

The *free access to the European market* is ensured to Liechtenstein by the customs and currency union with Switzerland. Moreover, Liechtenstein has joined the European Economic Area (EEA) in the year 1995. The free movement of goods, people, services and capital simplifies business relations with 31 states and around 500 million people in Europe. Clients as well as financial service providers benefit from *political continuity and economic stability*. As we have seen before, Liechtenstein is one of only four debt-free countries around the world. A lean public administration is another crucial characteristic for Liechtenstein. With general government spending as a percentage of GDP at 24.2%, we see that this is the lowest value among all European countries (OECD, 2018). Among other things, this is the consequence of an efficient public administration with a high degree of *flexibility and short decision-making channels*, which produces results rapidly and non-bureaucratically. Standard & Poor's confirms the country's high attractiveness (Standard & Poor's, 2018). For years, they have awarded Liechtenstein an AAA rating and underscored the country's stable outlook, as one can also observe in the fact sheet in table A1. The *business-friendly company law*, introduced some 100 years ago, offers a wide range of opportunities and is a role model for other financial centers around the globe to this day. In addition to common legal forms such as stock corporations, Liechtenstein's company law also permits the formation of structures such as foundations, protected cell companies, and - uniquely in continental Europe - trusts. The *tax framework for companies* in Liechtenstein is immensely attractive (Liechtenstein Marketing, 2018). The flat corporate income tax rate for Liechtenstein companies is 12.5%. Payment of this flat tax settles all fiscal obligations, for Liechtenstein does not impose any capital tax or coupon tax. Equivalently, no distribution surcharge or taxes on dividends, capital and liquidation earnings on shareholdings are imposed. At the international level, the introduction of the Automatic Exchange of Information (AEOI) as well as various double taxation agreements and tax information treaties, safeguard legal security and recognition. Liechtenstein has concluded bilateral tax treaties with 56 countries . These include Germany, Austria and the United Kingdom. Banks, insurers, fiduciaries, investment fund companies, asset managers and common-benefit foundations all value the Liechtenstein financial center. The Principality of Liechtenstein is stable and sovereign, and its financial center is transparent, secure and professional.

The country places additional emphasis on two other subjects - *innovation* and *sustainability*. The quick decision-making procedures mentioned before as one of Liechtenstein's main advantages is of particular importance when it comes to innovation. The digital revolution is one of many great innovation drivers for the international financial services industry. The Liechtenstein financial center is also trying to position itself at the top of the competition for the best FinTech solutions. With one of the three principal strategic pillars of the Roadmap 2020 of the Liechtenstein Bankers Association being digitisation, it does not come as a surprise that a special focus is put on Blockchain technology and electronic banking services (Liechtenstein Marketing, 2016).

Sustainability is another one of the three principal strategic pillars of the Roadmap 2020 of the Liechtenstein Bankers Association (Liechtenstein Marketing, 2016). In fact, Liechtenstein is one of the most sustainable and innovative countries in the world. In 2017 Liechtenstein was ranked 17th out of 180 countries in the Global Sustainable Competitiveness Index (SolAbility, 2017). Greater cultural emphasis is to be placed on Liechtenstein being a responsible and sustainable financial center. Liechtenstein is to be seen as a respectable and stable financial center that operates in accordance with sustainable principles and is characterised by its high innovative strength and efficiency as well as its proven expertise in the private banking field.<sup>2</sup>

Banks in Liechtenstein have long-standing expertise in the private banking field. Liechtenstein has traditionally specialised in private banking and wealth management. The first bank was founded back in the year 1861. This bank still is amongst the largest in the country and also the one which provided the dataset for this thesis - the Liechtensteinische Landesbank AG. One of the bank's special features is its dominance on the retail banking market. In the subsequent subsection one can find information about this bank in particular, as well as in comparison to the other two large competitors VP Bank and LGT Bank.

### **2.3 Liechtensteinische Landesbank AG**

The evidence on the adoption of electronic banking services presented in this thesis was contributed by one of the major players in the financial center of Liechtenstein, namely the Liechtensteinische Landesbank AG. The prominence of the bank, which is not the national bank of the country, is undeniable. After all, it is the largest retail bank in the country. Therefore, it makes only sense to briefly address the company and discuss it in the context of the financial center. As we have seen before, there are 15 banks in Liechtenstein. The biggest three are the LGT Group, the VP Bank Ltd. and the Liechtensteinische Landesbank AG. A comparison of these three major players in Liechtenstein's financial services industry can be found in table 2.2.

With three branches across the country and 20 ATM's - one in almost every municipality - the LLB is the country's largest retail bank. Moreover, LLB's three bank branches, located in Eschen, Vaduz and Balzers, are well distributed across the country. This is of major interest for the following explanations about the electronic banking adoption, because one of the main hypotheses is concerned with the client's distance to the LLB bank branches. The e-banking adoption variable is in direct relation to the bank's electronic banking agreement. This agreement governs the use of e-banking services that covers both LLB Online Banking and LLB Mobile Banking. In order to have such an agreement with the bank, a client has to sign it and provide indications about the intended use: Asset information, Payment orders, Stock market orders (excluding derivatives), Money market orders, Electronic mail, PhotoTAN reader. Yet, regardless of the intended use, all clients sign the same e-banking agreement. At LLB, the Online Banking services have been

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<sup>2</sup>For further information on the financial center please refer to <https://www.finance.li/en/>

Key Facts & Figures	LLB AG <sup>1</sup>			LGT Bank <sup>2</sup>			VP Bank Ltd. <sup>3</sup>		
	2017	2016	±%	2017	2016	±%	2017	2016	±%
in CHF millions									
Total assets	20'017	19'958	0.3	41'900	35'752	17.2	12'778	11'794	8.3
Equity	1'883	1'806	4.2	4'113	3'643	12.9	994	937	6.1
Assets under management (AuM)	50'252	46'428	8.2	201'782	152'101	32.7	40'386	35'754	13.0
Operating income	399	371	7.5	1'529	1'206	26.8	300	273	9.9
Operating expenses	-267.0	-258.2	3.4	-1'209	-951	27.4	230	212	8.5
Net profit	111	104	7.1	283	230	23.0	66	58	13.8
Cost-Income-Ratio (in percent)	69.6	62.8		74.1	74.2		64.2	68.4	
Return on equity (in percent)	6.1	5.9		6.9	6.6		6.9	6.3	
Tier 1 capital ratio (in percent)	22.2	21.0		18.8	20.2		25.7	27.1	
Employees (FTE's, in positions)	867	858	1.1	3'188	2'632	21.1	800	738	8.4
Strategic orientation	Retail Banking			Private Banking and Wealth Management			Intermediaries Business and Private Banking		

**Table 2.2.** Comparison of key facts and figures between the three major banks in Liechtenstein.

*Notes:* In order to compare the three major banks in Liechtenstein's financial center, the table above shows key facts and figures. For each bank the value as of the end of 2017 and 2016 is presented. Additionally, one can find the change from 2016 to 2017 in percentage points.

*Sources:* Annual reports of the respective banks.

<sup>1</sup> Annual report (Liechtensteinische Landesbank AG, 2018)

<sup>2</sup> Annual report (LGT Group Foundation, 2017) and Business Portrait (LGT Group Foundation, 2018)

<sup>3</sup> Annual report (VP Bank Ltd., 2018)

available since 1999<sup>3</sup> and in the year 2003<sup>4</sup> the Mobile Banking was introduced to the clients (T. Seiler, personal communication, April 30, 2018). The most important information is the fact that per default a client does *not* have such an agreement and has to request it. Therefore, the client has to voluntarily adopt electronic banking at LLB.<sup>5</sup>

To summarise the above explanations, we can say that the Principality of Liechtenstein is a tiny European country with a disproportionately significant financial center. The financial center distinguishes itself from others with free access to the European market and a stable social, legal and economic system. A high degree of political continuity and stability as well as the country's liberal economic policy and liberal company law facilitates the work of the financial service providers. Moreover, the moderate corporate taxation is a success factor. With the Liechtensteinische Landesbank AG this thesis investigates a sample contributed by the major retail bank of this country. Also, we have seen that the default option for clients at LLB is to not have an e-banking agreement and that consequently, the adoption of electronic banking depends on a client's voluntary request. After we have now presented the institutional background of this thesis we will move on to the literature review. There, we will find a summary of previous research in the field of electronic banking adoption and we will identify the research gap where this thesis will make its contribution to this literature.

<sup>3</sup>Revised in 2011 and 2017 (T. Seiler, personal communication, April 30, 2018)

<sup>4</sup>Revised in 2017 (T. Seiler, personal communication, April 30, 2018)

<sup>5</sup>Additional information on the Liechtensteinische Landesbank AG can be found on the company's website <https://www.llb.li/en/private>

### 3 Literature Review

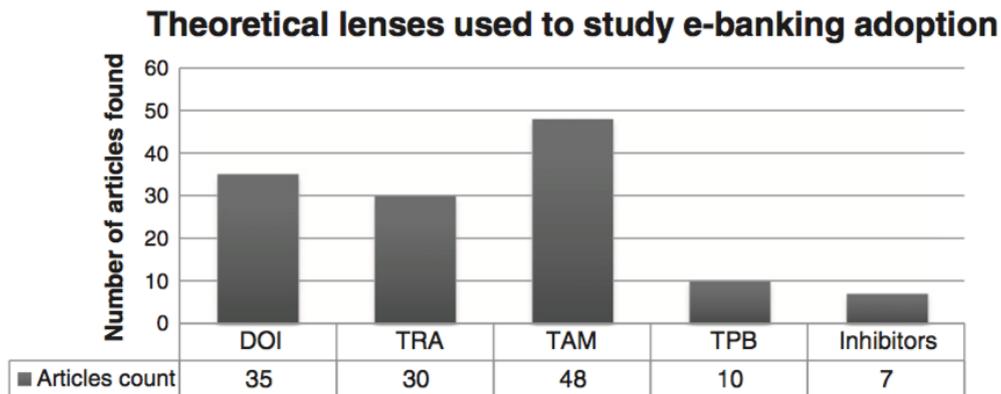
The literature concerned with electronic banking adoption is fragmented. Meaning that one distinctive feature of this stream of literature is, that it touches at least three distinct areas of research. The topic is discussed within Information Systems (IS), Bank Marketing and Finance journals, each covering one specific aspect and approaching it from different angles. However, the most interesting and substantial contributions come from the IS field of study. Consequently, we will review this kind of literature in a bit more detail than the others. Moreover, a lot of research articles are focusing their analysis on one specific country or region, which is a similar approach to the one implemented in this thesis. The aim of this section is to give the reader an overview on the literature that has been published on the topic of electronic banking adoption. Furthermore, we will identify the research gap this thesis tries to address and formulate our hypotheses, which we are going to test in the empirical part that follows. The section is organised along this lines of thinking and we start by presenting the previous research on this topic.

#### 3.1 Previous research

In (2012), the field of research concerned with the adoption of electronic banking has seen an influential publication. The paper "Three decades of research on consumer adoption and utilization of electronic banking channels: A literature analysis" written by Hoehle et al. analyses 247 peer-reviewed articles from key research outlets. It aims at revealing theories and methods used to study the adoption of electronic banking channels at the individual level. Said paper was published in the journal "Decision Support Systems", one of the most influential journals in this area of study (The SCImago Journal & Country Rank, 2016). The thesis at hand builds on the findings presented in this paper. However, we will also take other papers, which contributed to the research with literature reviews, into consideration. Moreover, to address the fragmented nature of this topic, we will look at publications in the fields of Bank Marketing and Finance.

In their paper, Hoehle et al. highlight the methodologies used and theoretical frameworks employed to study e-banking adoption over the last three decades. As this thesis, the paper also analyses the *individual* adoption of electronic banking. This is to say, it did not look at organisational adoption, e.g., business-to-business e-banking channel adoption. Also, their research focuses on the consumer adoption and use of four electronic banking channels: ATMs, touch-dial telephone banking, Internet banking, and mobile banking. In correspondence with this thesis we will only look at the results concerned with internet banking and mobile banking, because these two electronic banking channels are represented within our dataset. Hereby, we define *internet banking* as a banking channel that allows clients to perform different financial and non-financial services through a bank's webpage (Tan & Teo, 2000). Furthermore, we define *mobile banking* as a channel, that enables a bank's client to interact with the bank through non-voice applications using a mobile device, such as a mobile phone (Hoehle & Lehmann, 2008). During its first step, of examining the overall research output between 1984 and 2010, the study finds a steady increase. More importantly, most of the papers are concerned with internet and mobile banking, whereas ATMs and telephone banking are of lesser importance. Only 45 of the 247 peer-reviewed articles are exclusively investigating ATMs and telephone banking. Besides, the research output increased substantially after the year 2000, with more than 200 of the articles published in the period between 2000 and 2010. According to Alavi and Carlson the paper categorised the articles into non-empirical research and empirical research. Only 53 of all articles were of non-empirical nature. Since the thesis at hand is of empirical nature we will focus on these findings. The majority of the articles (148) was quantitative research using a survey questionnaire. At a next step the key theories and

models used by the authors to study electronic banking channels were identified. Five theoretical lenses predominate in the literature. Figure 3.1 exhibits the main theoretical frameworks used to examine e-banking adoption. One can see that the dominant theory is the Technology Acceptance Model (Davis, 1989).



**Figure 3.1.** Theoretical lenses used to study e-banking adoption.

*Notes:* The figure above shows the major theoretical lenses that were used to study e-banking adoption in previous research. From left to right, these are: Diffusion of Innovation (DOI), Theory of reasoned action (TRA), Technology acceptance model (TAM), Theory of planned behaviour (TPB) and Technology resistance theory (Inhibitors). One can find the number of published articles for each theoretical framework. This demonstrates the predominance of these theoretical frameworks and gives an indication about their relative importance. The articles count is as of 2010, the year in which the literature review was carried out.

*Source:* Figure 1 in Hoehle et al., (2012), Three decades of research on consumer adoption and utilization of electronic banking channels: A literature analysis.

We will now briefly explain the theoretical frameworks. By doing that, we will also provide the reasoning for the theoretical framework within this study about the relation between one’s distance to a bank branch and one’s likelihood of adopting electronic banking.

**Technology resistance theory** Traditional adoption and acceptance theories focus on the encouraging factors leading to technology, or in particular electronic banking adoption. It is, however, important to show that there are researchers out there, who try to understand the influences of inhibiting factors that prevent individuals from using a given technology (Lapointe & Rivard, 2005; Cenfetelli, 2004). Cenfetelli and Schwarz tested the inhibitors of technology usage model (ITU) and define them as attitudes held by a user about a given technology with consequent effects on the decision whether to use that technology or not (Cenfetelli & Schwarz, 2011). A look at prior research further suggests that a rich literature exists concerning consumer resistance to using mobile banking services (Kuisma, Laukkanen, & Hiltunen, 2007; Laukkanen, Sinkkonen, Laukkanen, & Kivijärvi, 2008; Laukkanen, Sinkkonen, & Laukkanen, 2009; Laukkanen & Kiviniemi, 2010; Iddris, 2013). However, since this thesis is not concerned with identifying another inhibiting factor, but rather tries to investigate the relation between adoption and the distance to a client’s closest bank branch, we will not delve further into this theory.

**Theory of reasoned action (TRA) and theory of planned behaviour (TPB)** Rooted in psychology research, the theory of reasoned action (TRA) was originally brought forward by Fishbein and Ajzen. It argues that individual behaviour is driven by behavioural intentions, which can be viewed as a function of the individual’s attitudes towards behaviour and their subjective

norms. In this context, the attitude towards behaviour has to be understood as the feelings an individual has about performing a certain behaviour (Fishbein & Ajzen, 1975). Also, subjective norm can be explained as the individual's impression of whether she should behave in a certain way. This impression heavily relies on the willingness of an individual to comply with opinions of people who are important to her (Fishbein & Ajzen, 1975).

The theory of planned behaviour (TPB) extends the original TRA by adding a perceived behavioural control construct (Ajzen, 1991). Ajzen argued that behavioural intention, as defined above under the TRA, can find expression in behaviour only if the behaviour in question is under volitional control. That is to say, if the person can decide at will to perform or not perform the behaviour. In many instances behaviour would be influenced by non-motivational factors such as availability of resources (Ajzen, 1991). Many prior studies, within the IT and Bank Marketing field of study, applied either the theory of reasoned action or the theory of planned behaviour to examine the consumer behaviour towards electronic banking channels (AbuShanab, Pearson, & Setterstrom, 2010; Püschel, Mazzon, & Hernandez, 2010; Zolait, 2010).

**Technology acceptance model (TAM)** The TAM was originally developed by Davis and is one of the most significant adaptations to the TRA. The theory argues that perceived usefulness on the one hand and perceived ease of use on the other hand are the most important determinants of acceptance and usage of a technology (Davis, 1989). Both, perceived usefulness and perceived ease of use are directly related to an individual's intention to use a technology. Perceived usefulness was also seen as being directly influenced by perceived ease of use (Davis, 1989). As many others, Benbasat and Barki refer to the TAM as one of the most influential and most often used theories in information systems (Benbasat & Barki, 2007; Venkatesh, Morris, Davis, & Davis, 2003). Moreover, as previously mentioned, the technology acceptance model is also the most common theoretical framework in electronic banking adoption studies. In one instance of such a study, Suh and Han, argued that one of the most significant determinants of customer acceptance of internet banking was trust. Integrating this concept into the TAM, the authors found that trust had a more direct effect on a customer's attitude than perceived ease of use in the internet banking context. Nonetheless, they found that perceived ease of use had a greater overall effect on a customer's actual use (Suh & Han, 2002). Several more researchers have examined consumers' acceptance of various electronic banking channels using the technology acceptance model or numerous modifications of it (Lai & Li, 2005; Lee, 2009; Ozdemir & Trott, 2009; Pikkarainen, Pikkarainen, Karjaluoto, & Pahnla, 2004).

**Diffusion of innovation (DOI)** Diffusion of innovation theory states that innovations are communicated through different channels over time and within a particular social system (Rogers, 2003). Since the 1960s it is one of the standard theories when it comes to exploring the adoption of technologies. Due to the fact that consumers possess different degrees of willingness to adopt innovations, Rogers divided consumers into five distinct categories of individual innovativeness starting from early to late adopters: innovators, early adopters, early majority, late majority and laggards. Moreover, Rogers identified five factors determining the rate of adoption of innovations: *relative advantage*, compatibility, trialability, observability, and complexity. While the first four factors would generally positively correlate with rate of adoption, complexity would normally negatively affect the diffusion rate. This thesis will argue that a client's distance to the next bank branch will positively affect the relative advantage of electronic banking and therefore is positively correlated with adoption. In their study, Moore and Benbasat drew upon the DOI theory and developed an instrument to measure the adoption of IT. They found support for the factor of relative advantage

impacting the adoption of IT (Moore & Benbasat, 1991). Tan and Teo explored the determinants of internet banking adoption and extended Rogers’s diffusion of innovation framework by combining it with TRA and TPB, which are discussed above. Their study provided a comprehensive way to understand how an individual’s attitude and perceived behavioural control influence their intention to use banking services on the Internet.

The following explanations will focus on two main theoretical constructs that were identified in the theoretical frameworks above. Those are *perceived usefulness (TAM)*<sup>6</sup> and *relative advantage (DOI)*<sup>7</sup>. The underlying reasoning being that a larger distance to a bank branch strengthens the perceived usefulness of electronic banking and, therefore, makes an adoption of electronic banking on the individual level more likely. Moreover, an increase in the distance to the next bank branch enhances the electronic banking channel’s relative advantage compared to going to the bank branch, which again makes the adoption of e-banking more likely.

Yet, almost all studies included demographic variables such as age, gender, income, and education in models of consumers’ behaviour towards electronic banking channels. Prior literature has considered various determinants that influence the internet banking adoption decision (Camilleri & Grech, 2017). Surprisingly, there was no convergent understanding of the ways in which these variables impact on the adoption of electronic banking channels. Since our research in this thesis will also include the two demographic variables *age* and *sex*, table 3.1 provides examples for studies who investigated their relationship with electronic banking adoption. To show that there was not a convergent understanding of the impact we provide examples for studies who found a positive relation, as well as some who found a negative relation or no significant relation at all.

Demographic variable	Relation to electronic banking adoption		
	(+)	(-)	inconclusive
Age		(J. Kolodinsky et al., 2000) (Mattila et al., 2003) (J. M. Kolodinsky et al., 2004) (Izogo et al., 2012)	(Khan et al., 2017)
Sex	(Flavián et al., 2006) (Kräuter & Breiteneker, 2011)		(Izogo et al., 2012) (Munusamy et al., 2012) (Khan et al., 2017)
Income	(Lockett & Littler, 1997) (J. Kolodinsky et al., 2000) (J. M. Kolodinsky et al., 2004) (Godolja & Spaho, 2014)	(Izogo et al., 2012)	(Munusamy et al., 2012)
Educational level	(J. Kolodinsky et al., 2000) (Karjaluoto et al., 2002) (Sarel & Marmorstein, 2003)		(Munusamy et al., 2012)

**Table 3.1.** Previous research on demographic variables.

*Notes:* The table above summarises some exemplary studies concerned with demographic variables and their impact on electronic banking adoption. As the literature review suggests, there are both studies which find a positive relation and studies which find a negative relation to electronic banking. Moreover, there are studies that present inconclusive or insignificant results. Sex is defined as a dummy variable which is 1 for men and 0 for women.

*Source:* Own table, based on the literature review.

Moreover, it was interesting to see that another factor from the TAM was the by far most frequently cited factor influencing the adoption of electronic banking. 97 studies recommended

<sup>6</sup>"The degree to which an innovation is perceived as being better than its precursor" (Davis, 1989)

<sup>7</sup>"The degree to which a person believes that using a particular system would enhance his or her performance" (Moore & Benbasat, 1991)

that e-banking services must be easy to use (Hoehle et al., 2012).

## **3.2 Contribution of this thesis**

After we have now discussed previous research on the topic of electronic banking adoption and have established a common understanding of the literature in this field of study, it is now time to explain the contribution this thesis hopes to make.

### **3.2.1 Research Gap**

As we have seen before, previous research predominantly focused on survey questionnaires. Following the suggestion that researchers may learn more about electronic banking adoption in the future by applying methodological approaches that have been under-utilised until now (Hoehle et al., 2012), this thesis will not use any survey. Rather, we have here in this thesis a dataset from a large retail bank and, therefore, do not rely on the same biases as the ones associated with surveys (Krosnick, 1999). The dataset in this thesis, thus, is not biased by any personal perceptions that are inevitable in survey based research, but relies solely on facts, such as whether a client has an e-banking agreement or her distance to a bank branch. This is one major advantage of this study. Also, since studies focusing on particular geographical areas are popular in this field of study, this thesis fills a locational gap by adding another country to the body of literature. The United States of America, Finland and the United Kingdom have been the most popular targets of electronic banking adoption research (Hoehle et al., 2012). Finally, there has not been any prior study trying to investigate the relationship between a client's distance to her next bank branch and electronic banking adoption. By focusing on a dataset, provided by a large retail bank, from a particular country, rather than a survey and coming up with an original connection with regard to electronic banking adoption, this thesis addresses the identified research gap. The subsequent step is to summarise the underlying hypotheses, before we delve into the results of this study.

### **3.2.2 Hypotheses**

The review of previous literature enabled us to identify the common theoretical frameworks, concepts and constructs. We have seen that so far research heavily relied on four major theories, which are associated with a variety of theoretical constructs. This thesis will examine two main theoretical constructs that were identified in the literature review. Those are perceived usefulness and relative advantage. Our understanding is that a larger distance to a bank branch strengthens the perceived usefulness of electronic banking. Moreover, an increase in the distance to the next bank branch strengthens the electronic banking channel's relative advantage compared to going to the bank branch. This reasoning leads to the third hypothesis that a larger distance to the next bank branch is positively correlated with electronic banking adoption. These theories are associated with e-banking characteristics, which are often used to explain electronic banking adoption. Additionally, we saw that the use of demographic variables is common in this field of study and this thesis will follow this established research methodology by including the two demographic variables Age and Sex. However, the findings with regard to these two variables are not conclusive within the previous literature (see 3.1). Finally, the use of surveys seems to be the standard procedure in the literature so far. Yet, this study aims at circumventing the biases associated with survey research, by solely relying on the dataset provided by a large retail bank (Krosnick, 1999). These findings which are common in literature reviews on the topic of electronic banking adoption (Hanafizadeh et al., 2014; Shaikh & Karjaluoto, 2015).

Concluding the literature review we deduce the following hypotheses with regard to our sample at hand, provided by the LLB:

1. Hypothesis: Males are more likely to adopt electronic banking<sup>8</sup>
2. Hypothesis: Age has a negative effect on electronic banking adoption<sup>9</sup>
3. Hypothesis: Larger distances to a bank branch are positively correlated with electronic banking adoption<sup>10</sup>

We will address these hypotheses in the next sections. The first two hypotheses follow the literature and we try to see whether we are able to confirm those findings with our dataset or not. The third one is the original hypothesis of this thesis, which will make a contribution to the literature as a new variable determining electronic banking adoption. Firstly, one can find a description of the sample that is used in the examination of the above mentioned hypotheses. After that follows a brief explanation of the research methodology, before we turn to the presentation of this study's results.

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<sup>8</sup>As seen in (Flavián et al., 2006; Kräuter & Breitenecker, 2011)

<sup>9</sup>As seen in (J. Kolodinsky et al., 2000; Mattila et al., 2003; J. M. Kolodinsky et al., 2004; Izogo et al., 2012)

<sup>10</sup>As we have argued with regard to the perceived usefulness (TAM)(Davis, 1989) and the relative advantage (DOI)(Moore & Benbasat, 1991) of electronic banking.

## 4 Data and Methodology

The purpose of this section is to link the explanations about the Principality of Liechtenstein, its financial sector and the Liechtensteinische Landesbank AG to the dataset, which is the foundation of this master's thesis. Therefore, we will give some information about the data collection process and describe, in a next step, the dataset we obtained. The section concludes with a brief description of the research methodology, before we will move on to the presentation of the results.

### 4.1 The Dataset from LLB

As we have seen before in section two, the dataset, which is at the core of this research, was obtained from the Liechtensteinische Landesbank AG. We will now turn our discussion to the collection process.

#### 4.1.1 Data Collection

In order to obtain the dataset at hand, a cooperation with a major player in the banking sector was inevitable. Fortunately, such a practice partner could be found with the LLB. However, the data collection was not that straightforward. Many privacy and legal issues regarding the client data had to be considered before the dataset could be finalised. Of course, the request for data from the research perspective included many more variables than what was actually feasible for the bank to provide. Yet, under the close collaboration with the bank it has been possible to agree on a dataset containing four variables, namely the sex of the client, the ZIP code of her postal address, her year of birth and whether she has an e-banking agreement or not. These variables were retrieved from the bank's databases and provided in an excel sheet. To illustrate the layout of the dataset, its first 10 observations are shown in appendix B. For the sake of privacy and anonymity of the clients, the year of birth was obliterated for observations with less than six individuals. The following subsection briefly describes the aforementioned variables in general. It further presents descriptive statistics with regard to our outcome variable - electronic banking adoption.

#### 4.1.2 Data Description

The original cross-sectional dataset contained 33'928 individual client observations. According to the information provided in table A1 the population of the whole country is 37'000 people. This suggests, that 91.70% of all citizens living in the principality have, in fact, a bank account at LLB. This figure becomes even more impressive, if we take into account that not even every citizen has a bank account at all. Although no data for Liechtenstein is available, data from the Global Findex database suggests that in the neighbour country Switzerland 98% of the population has at least one bank account.<sup>11</sup> Arguably, this value will be close to the one in Liechtenstein. After cleaning the dataset of observations with a missing value for the year of birth variable we are left with 31'511 observations - or 85.17% of the whole population. The following explanations will focus on each variable in turn to give a brief overview of the sample and present descriptive statistics with regard to our outcome variable - electronic banking adoption. This part focuses on absolute and percentage differences within each independent variable, with regard to the outcome variable. At this point, no statistical inference is made.

**Electronic Banking Users** The main variable of interest in the following deliberations is the dummy variable, which indicates whether a LLB client has an electronic banking agreement with

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<sup>11</sup>For further information see <http://datatopics.worldbank.org/financialinclusion/country/switzerland>

the bank (=1), or not (=0). This is the outcome variable of our whole analysis and the dependent variable within our regression models. All that is to say at this point, is that the sample is fairly balanced, with 49.09% of clients having such an agreement and 50.91% not. In other words, the likelihood of any random LLB client having an e-banking agreement is 49.09%. This line of thinking will be at the centre of interpreting the regression models. When we now delve into the description of the independent variables, we will first discuss the variable in general terms, before looking at descriptive statistics with regard to the outcome variable.

**Age** The age range within the sample covers newborns up until elderly people, who are up to 93 years old. At the same time, the median client in the dataset is approximately 44 years old, with the median age for females 45 and the median age for males 43. These values resemble the ones for the whole population very closely (Central Intelligence Agency, 2018). Table 4.1 shows the number of clients in each age category as well as a distinction between the ownership of the account. This distinction is based on the fact that LLB clients younger than 15 years old can only have an account established by their parents. It is only after the client turns 15 when she can set up an account on her own and therefore decide whether she uses electronic banking or not.

Account ownership	Age category	Absolute frequency	Percentage [%]	Cumulative	
Children's account	under 15 years old	3'318	10.53	10.53	
	15 to 24	3'713	11.78	22.31	
	25 to 34	4'412	14.00	36.31	
	35 to 44	4'731	15.01	51.33	
	Own account	45 to 54	5'681	18.03	69.36
		55 to 64	4'714	14.96	84.32
		65 to 75	3'166	10.05	94.36
		75 and older	1'776	5.64	100.00
Total		31'511 (=n)	100.00		

**Table 4.1.** Age categories of the sample.

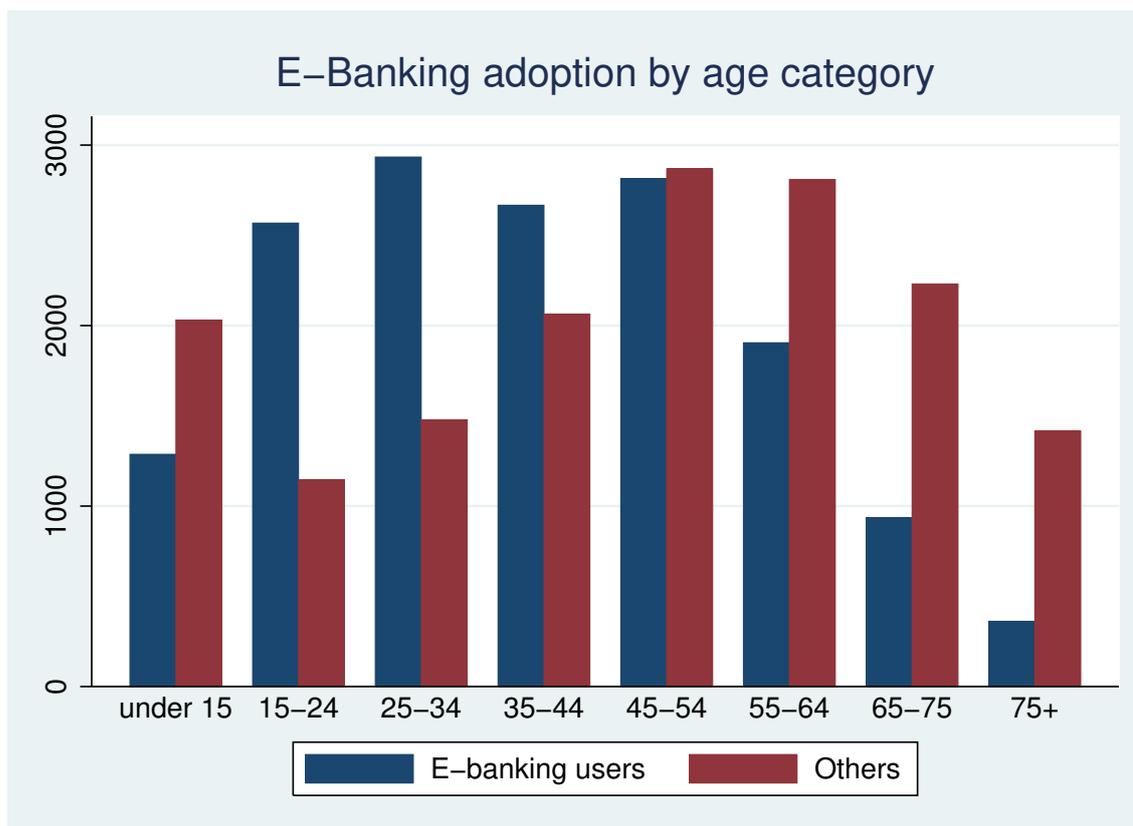
*Notes:* The table above visualises the number of clients within the respective age category. It also draws a line at the age of 15, in order to distinguish between accounts, which can legally only be owned by the parents of the client and accounts that are presumably owned by the client herself.

*Source:* Own table, based on the LLB dataset.

Also, the sample contains 2'030 children (6.44%) between the age of 0 and 9, 2'999 teenagers (9.52%), and 26'482 adults (84.04%) 20 years old or older. It is interesting to see that the distribution within the sample so evidently corresponds to the population's distribution. This, however, does not come as a surprise if we take into consideration that the sample reflects more than 85% of the population.

**Age and Electronic Banking Adoption** Figure 4.1 exhibits the two groups of e-banking users and others, divided by our eight age categories. One can observe a majority of e-banking users in in the rather younger categories between 15 and 44 years. The category ranging from 45 to 54 years old clients seems fairly equal with only a small majority of non-users of e-banking services. This finding points into the direction of our second hypothesis that younger individuals are more likely to adopt electronic banking services.

If we draw a line at the age of 15, the year after which a client can legally manage his own bank account, we see that the group of under 15 years old individuals is quite balanced. The group with clients above the age of 15 shows a rather clear tendency toward non-users, with only 38.79%



**Figure 4.1.** Electronic banking adoption by age category.

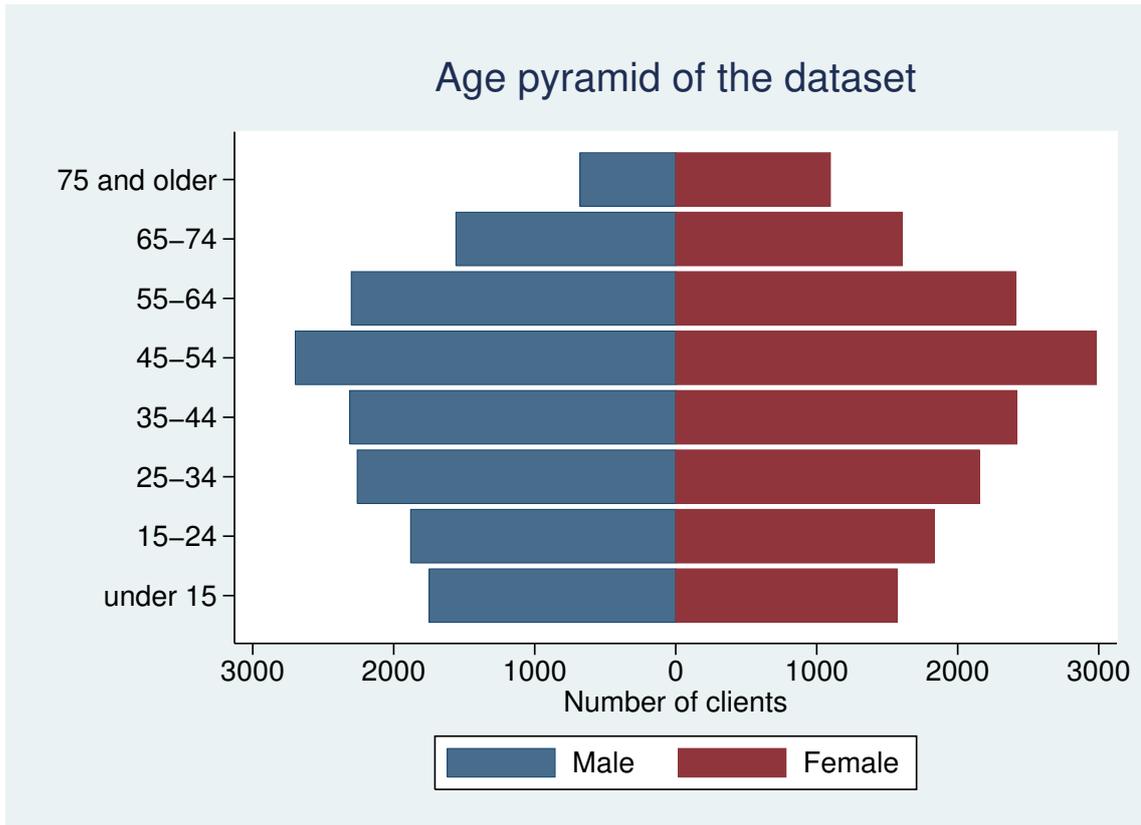
*Notes:* The figure above breaks our outcome variable e-banking adoption down by each age category. On the y-axis one can see the frequencies of e-banking users for each age category. The x-axis displays our eight age categories. For each age category one can observe two bars. The blue one representing e-banking users, while at the same time the red one exhibits all other clients without an e-banking agreement with LLB.

*Source:* Own figure, based on the LLB dataset.

of them having an e-banking agreement with the bank. Looking at the three groups of children, teenagers and adults we only find a tendency towards non-adoption within the children group. The other two seem to be more or less equally distributed.

**Sex** Overall, the dataset comprises 16'075 female client observations (51.01%) and 15'436 male client observations (48.99%). This slight majority of female clients reflects the majority of females in the overall population (Amt für Statistik, 2018). In figure 4.2, one can see the age-sex structure of the dataset, which shows the frequency of male and female clients per age category. The pyramid shows the expected shape of any developed country, with a much more pronounced middle and fewer people in the low and high age categories (Weeks, 2008). Moreover, the shape of the sample population pyramid corresponds to the one of the overall population of Liechtenstein (Central Intelligence Agency, 2018).

**Sex and Electronic Banking Adoption** As we mentioned before, our sample, as well as the population, consists of slightly more women than men. If we now break this down to our variable of interest, e-banking adoption, we find that the proportion of e-banking users is substantially higher with men. Only 45.06% of females have an e-banking agreement with LLB. At the same time, the fraction of male electronic banking adopters is 53.28%. At a first glance, this seems to coincide



**Figure 4.2.** Population pyramid of the dataset.  
*Notes:* This figure shows the distribution of male and female clients for each age category. The age categories are shown on the y-axis, whereas the number of clients is displayed on the x-axis.  
*Source:* Own figure, based on the LLB dataset.

with our first hypothesis that males are more likely to adopt e-banking.

**Municipality** The following paragraph provides information about the client’s distribution across the municipalities in the sample. One can find a comparison between the number of clients and number of citizens in table 4.2. On a percentage base, the differences are very small, which means that the sample represents the whole population quite well. There are only 3 municipalities, which show a difference of more than one percentage between the sample and the population. In two of those cases this is due to a different categorisation in the sample and the population. The differences in the two municipalities of Eschen and Mauren can be explained by the omission of two small municipalities - Nendeln and Schaanwald - in the source of our population figures. This suggests, that these citizens have been subsumed to either Eschen or Mauren. This leaves us with only one municipality where the sample differs more than one percentage from the population - Balzers. All in all, it is fair to say that the sample matches the population substantially, at least with regard to the distribution of the citizens in each municipality.

**Municipality and Electronic Banking Adoption** With regard to the municipalities and our outcome variable it is of interest to see whether the adoption is lower in municipalities with a bank branch compared to the others. This would correspond to our hypothesis that larger distances to a bank branch are positively correlated with electronic banking adoption. As we have seen before, the overall fraction of e-banking adopters is 49.09%. Compared to this benchmark two of the three municipalities featuring a bank branch show a lower proportion. With Vaduz and Balzers showing

Municipality	Sample		Population		Difference	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Ruggell	1'863	5.91	2'224	5.88	361	0.03
Schellenberg	695	2.21	1'080	2.86	385	0.65
Gamprin-Bendern	1'379	4.38	1'657	4.38	278	0.00
Eschen	2'559	8.12	4'390	11.61	1'831	3.49
Mauren	3'004	9.53	4'268	11.29	1'264	1.76
Nendeln	1'081	3.43	-	-	-	-
Schaanwald	366	1.16	-	-	-	-
Lower Country	10'947	34.74	13'619	36.02	2'672	1.28
Planken	80	0.25	450	1.20	370	0.95
Schaan	5'060	16.06	5'992	15.85	932	0.21
Vaduz	4'510	14.31	5'407	14.30	897	0.01
Triesenberg	2'293	7.28	2'624	6.94	331	0.34
Triesen	4'308	13.67	5'096	13.48	788	0.19
Balzers	4'313	13.69	4'622	12.22	309	1.47
Upper Country	20'564	65.26	24'191	63.98	3'627	1.28
Total	31'511 (=n)	100.00	37'810	100.00	6'299	

**Table 4.2.** Sample broken down by municipalities.

*Notes:* Above table shows the number of clients living in each municipality, as well as the subtotal for the two constituencies. The numbers from the sample are compared to the total population within the respective municipalities. All figures are presented as absolute frequencies and percentages. The numbers for the population are based on a publication from the bureau of statistics from the year 2018. However, the numbers are from the 31.12.2016.

*Source:* Own table, based on the LLB dataset and Liechtenstein in Zahlen (Amt für Statistik, 2018).

values of 44.48% and 47.99% respectively, we are tempted to say that this is a first sign that our hypothesis might be valid. However, there are other municipalities in the sample that show lower than average e-banking adoption. Moreover, with Eschen, there even is a municipality with a bank branch that exhibits a higher fraction of e-banking adopters, contradicting our hypothesis. We will examine this ambiguous findings further with statistically more sophisticated methods when we turn our discussion to the results of the t-tests.

The next subsection will explain how the above mentioned variables were used to make statements about the electronic banking adoption in Liechtenstein and specifically to answer the research question at hand. For a list with all used variables, including a definition, please refer to appendix C, particularly to table C1.

## 4.2 Research Methodology

Since we are in possession of the client's postal code, it is possible to deduce the client's distance to each bank branch. Of course, the distances do not indicate the exact distance for each individual client, but rather show the average distance of a client living in a certain municipality. Table 4.3 summarises these distances. All distances refer to the distance by car.

With these distances we are able to construct four more variables to describe the distance between a client and the bank branches. These four variables represent first of all the distance of each municipality to the headquarters of LLB in Vaduz and, moreover, the distance to the closest branch. Both distances will be examined with respect to the actual distance in kilometres and the time needed to cover it in minutes. Summary statistics of these four variables are provided in table 4.4. It is for example possible to see that the average time to a LLB bank branch is below

Municipality	Distance to headquarters		Distance to branch Eschen		Distance to branch Balzers	
	(km)	(min)	(km)	(min)	(km)	(min)
Ruggell	18.1	17	<b>7.0</b>	<b>10</b>	26.2	22
Schellenberg	18.7	17	<b>7.7</b>	<b>10</b>	26.8	22
Gamprin-Bendern	12.8	11	<b>1.1</b>	<b>2</b>	20.9	16
<i>Eschen</i>	<i>14.4</i>	<i>14</i>	<b>0.8</b>	<b>2</b>	<i>22.5</i>	<i>20</i>
Mauren	16.0	16	<b>2.3</b>	<b>4</b>	24.1	21
Nendeln	8.4	14	<b>2.5</b>	<b>4</b>	24.2	21
Schaanwald	10.5	18	<b>4.1</b>	<b>6</b>	25.9	23
Planken	<b>12.8</b>	25	13.8	<b>23</b>	20.8	36
Schaan	<b>4.4</b>	10	7.0	<b>9</b>	17.5	17
<i>Vaduz</i>	<b>0.7</b>	<b>2</b>	<i>13.4</i>	<i>11</i>	<i>8.7</i>	<i>13</i>
Triesenberg	<b>11.9</b>	<b>19</b>	23.8	27	14.7	22
Triesen	<b>3.2</b>	<b>6</b>	15.1	14	5.1	<b>6</b>
<i>Balzers</i>	<i>11.3</i>	<i>11</i>	<i>20.8</i>	<i>15</i>	<b>0.1</b>	<b>1</b>

**Table 4.3.** Distance of Municipalities to each bank branch.

*Notes:* The table above shows the distances, from each municipality to the three bank branches of the Liechtensteinische Landesbank AG, in kilometres (km) and minutes (min). Also, all distances refer to the distance by car. The municipalities, where a bank branch is situated are written in italics and to highlight the closest bank branches for each municipality, those distances appear in bold.

*Source:* Google Maps

six minutes. However, there is quite a variability in this measure if we consider that the maximum distance amounts to 23 minutes.

Variable	Obs.	Mean	Std. Dev.	Min.	25%	50%	75%	Max.
Distance to headquarters (km)	31'511	8.84	5.82	0.70	3.20	11.30	14.4	18.70
Distance to headquarters (min)	31'511	10.88	5.22	2	6	11	16	25
Distance to closest branch (km)	31'511	3.21	3.20	0.10	0.7	2.30	4.40	12.80
Distance to closest branch (min)	31'511	5.78	4.90	1	2	4	9	23

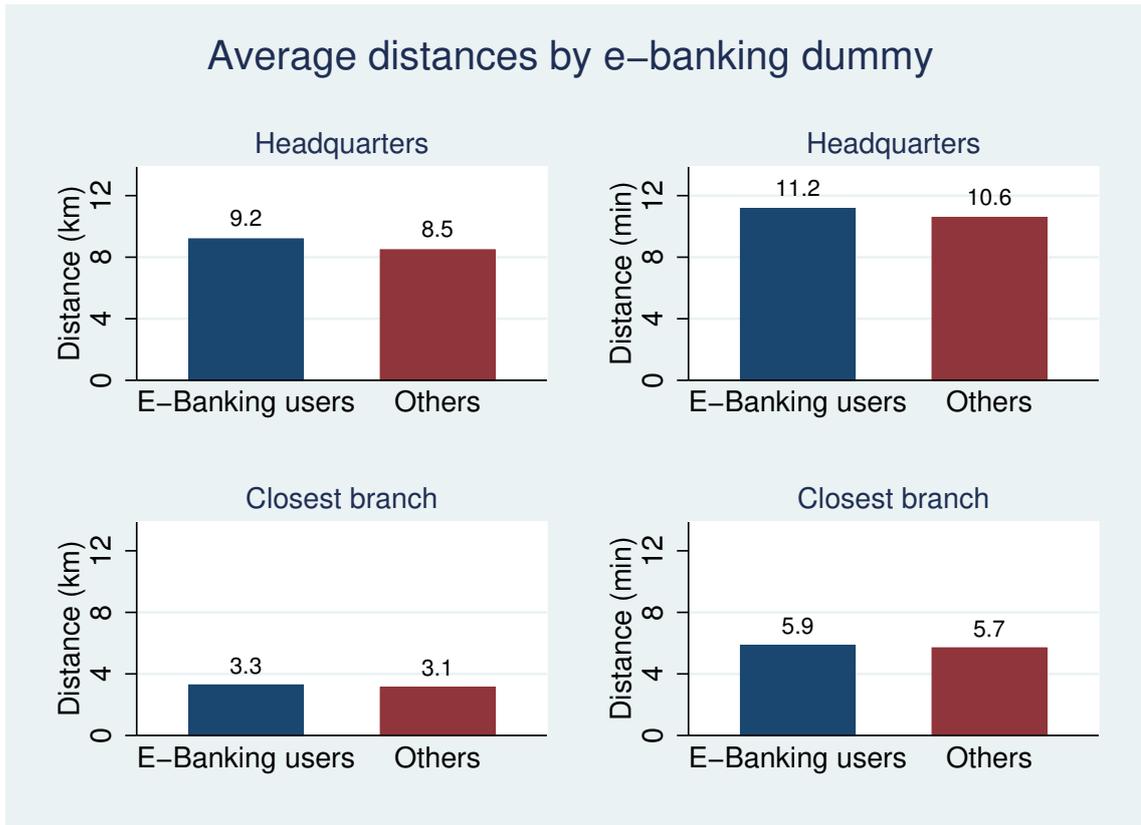
**Table 4.4.** Summary statistics of the distance variables.

*Notes:* The four variables on the table above are meant to measure the distance between a client and the LLB headquarters, as well as to the closest possible bank branch. The table reports the number of observations, the mean, the standard deviation in addition to the minimum and maximum values of each variable. To provide an indication about the distribution, we also report the 25th, 50th and 75th percentile.

*Source:* Own table, based on the LLB dataset

**Distance measures and Electronic Banking Adoption** Figure 4.3 clearly shows the differences in the average distance to the LLB headquarters and the closest LLB branch divided by the two groups of e-banking adopters and others. The figure shows a bar chart for each distance measure. As we expected, all four measures show larger distance values within the e-banking user group. Overall, with regard to these bar charts, we can say that these findings are in line with our third hypothesis that larger distances to a bank branch are associated with a higher probability of e-banking adoption.

The previous explanations displayed evidence pointing into the direction that our hypotheses are accurate. However, this conclusion comes more or less only from eyeballing the data and descriptive statistics. The following comments focus on statistical inference methods to check for differences in the mean of various outcome variables.



**Figure 4.3.** Average distances by e-banking adoption.

*Notes:* Each of the four figures above represents one of our distance measures. The top two show the average distance of a client to the headquarters of LLB in Vaduz. The two on the bottom display the average distance of a client to her closest LLB bank branch. The two bar graphs on the left show these distances in kilometres, while at the same time the two on the right depict the distances in minutes. Every graph features two bars representing e-banking users in blue and others in red.

*Source:* Own figure, based on the LLB dataset.

**t-Tests** In order to further examine the findings from the descriptive statistics, we will perform independent samples t-tests. The independent samples t-test compares the difference in the means of two groups to a given value (usually 0). Since the outcome variable, which we are interested in, is binary, we will be able to utilise this tool for our purposes. Provided we have a random sample, the sample mean of this binary variable is an unbiased estimate of the unconditional probability, that any particular client in fact has an electronic banking agreement with the bank. Therefore, this statistical tool allows us to test the hypotheses we formulated in the literature review part of this thesis. Consequently, we will perform different kinds of t-tests. Firstly, we will test whether there is, in fact, a statistically significant difference between the means in the outcome variable across both sexes. According to our first hypothesis, we expect to find a higher mean for males. Secondly, we will test for differences in the mean age between the two groups of electronic banking adopters and others. According to our second hypothesis, we expect to find a lower average age within the group of e-banking adopters. Thirdly, we will test for differences in the mean distance to bank branches between the two distinct groups of e-banking adopters and others. According to our third hypothesis, we expect to find a higher mean for all distance measures within the group of e-banking adopters. Finally, we will address hypothesis three with yet another t-test. This time we examine the difference in the mean of the dummy variable, which divides the sample into e-banking adopters and other, with respect to the group of people living in a municipality with a bank branch

and others. Following our third hypothesis, we expect a lower mean within the group of clients living in a municipality with a bank branch. This is due to the fact that as one can observe in table 4.3, those clients live closer to a bank branch. With that being said, all two-sample t-tests we perform assume equal variances within the two groups and are conducted on the 99% confidence level. We will test the robustness of our findings from this part by formulating regression models. Explanations how these models are specified follow in the next paragraph.

**Regressions** The main purpose of the regression models in this part of the thesis is to provide some kind of robustness analysis of our results from the t-tests. The distance measures mentioned above enable us to build regression models to investigate the relationship even further. We are interested in investigating the relationship between the e-banking adoption dummy variable and the distance to the branch. This means that we deal with a limited dependent variable (LDV), since the outcome variable can only take the value 1 for an e-banking user or 0 for the others. Since the outcome variable is therefore binary, these regressions fall into a special category of regression models. They are called binary response or binary choice models. Whenever we want to model a binary outcome variable it is only reasonable to think about this in terms of probability. In this particular case, the question would be: *How does the distance of an individual client to a bank branch influence the probability of said client adopting electronic banking?*

We have already seen that, provided we have a random sample, the sample mean of this binary variable is an unbiased estimate of the unconditional probability, that any particular client in fact has an electronic banking agreement with the bank. That is, letting  $y$  denote our binary dependent variable (e-banking adoption), we have

$$\Pr(y = 1) = E(y) = \frac{\sum_i y_i}{N},$$

where  $N$  is the number of observations in the sample. Estimating the unconditional probability is trivial, but certainly not the most interesting thing we can do with the data. In this case, for instance, we want to analyse what factors determine changes in the probability that  $y$  equals one. The most straightforward approach is to use the linear regression framework. Because of its easy implementation and the clear interpretation of the estimates, this approach serves as a valuable starting point for modelling the relationship between e-banking adoption and a clients distance to a bank branch. Now, just like the unconditional probability that  $y$  equals one is equal to the unconditional expected value of  $y$ , i.e  $E(y) = Pr(y = 1)$ , the conditional probability that  $y$  equals one is equal to the conditional expected value of  $y$ :

$$\Pr(y = 1|\mathbf{x}) = \mathbf{x}\boldsymbol{\beta}. \tag{4.1}$$

Equation 4.1 is a binary response model. In this particular model the probability of success (i.e.  $y = 1$ ) is a linear function of the explanatory variables in the vector  $\mathbf{x}$ . This is why using ordinary least square (OLS), with a binary dependent variable, is called the linear probability model (LPM). Notice that in the LPM the parameter  $\beta_j$  measures the change in the probability of the dummy equaling 1, resulting from a change in the variable  $x_j$ , holding other factors fixed:

$$\Delta \Pr(y = 1|\mathbf{x}) = \beta_j \Delta x_j.$$

This can be interpreted as a partial effect on the probability of the dummy being 1. In the particular

case of this thesis, this will lead to the following LPM regression equations:

$$y = \beta_1 + \beta_2 \times Distance + u \tag{4.2}$$

$$y = \beta_1 + \beta_2 \times Distance + \beta_3 \times Age + u \tag{4.3}$$

$$y = \beta_1 + \beta_2 \times Distance + \beta_4 \times Sex + u \tag{4.4}$$

$$y = \beta_1 + \beta_2 \times Distance + \beta_3 \times Age + \beta_4 \times Sex + u \tag{4.5}$$

where  $y$  is the electronic banking adoption dummy variable we want to explain. Equation 4.2 is the simplest form of the model and tries to estimate the probability of e-banking adoption with one single explanatory variable - the distance to the branch. This model is equivalent to estimating a t-test with those variables. Equations 4.3 to 4.5 add the age and sex of the client, as well as both explanatory variables, respectively, to the equation. This allows to control for possible effects of those variables.

However, this approach has some shortcomings that need to be addressed. For instance, one issue with the LPM is that it can predict values for the outcome variable which are greater than one or less than zero. Since a probability, by definition, has to lay within the  $[0,1]$  interval, such predictions are meaningless. Also, it does, conceptually, not make sense to say that a probability is linearly dependent on a continuous independent variable - such as a distance measure - for all possible values. If it were, then continually increasing the distance would eventually drive  $P(y = 1|x)$  above one or below zero. Moreover, the residual of the LPM is, by definition, heteroskedastic. This last problem, however, can easily be solved by obtaining estimates of the standard errors that are robust to heteroskedasticity - such as the Eicker-Huber-White standard errors, which we report in our results. All in all, the LPM is used as a first step in the analysis of the binary outcome variable e-banking adoption, because of its easy interpretation of estimates. Besides, the main purpose of this thesis is not to come up with a prediction model, but rather to clarify whether there is a relationship between a client's distance to a bank branch and electronic banking adoption or not. Yet, since logit and probit regression models solve the aforementioned problems of the LPM, results from those models are also included into the result section, even though their estimates are not as intuitive as the ones obtained by the OLS method.<sup>12</sup> However, the general idea of those two models is that they are of the form

$$\Pr(y = 1|x) = G(\mathbf{x}\boldsymbol{\beta}), \tag{4.6}$$

where  $G$  is a function taking on values strictly between zero and one:  $0 < G(z) < 1$ , for all real numbers  $z$ . The model 4.6 is often referred to in general terms as an index model, because  $\Pr(y = 1|x)$  is a function of the vector  $x$  only through the index

$$\mathbf{x}\boldsymbol{\beta} = \beta_1 + \beta_2 x_2 + \dots + \beta_k x_k,$$

which is simply a scalar. Notice that  $0 < G(x) < 1$  ensures that the estimated response probabilities are strictly between zero and one, which, thus, addresses the main worries we had about using LPM. The subsequent section will now present the results of the analysis.

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<sup>12</sup>For a detailed explanation on why these models solve the aforementioned problems, please refer to *Mostly Harmless Econometrics: An Empiricist's Companion* (2009), by Joshua D. Angrist and Jörn-Steffen Pischke. *Econometric Analysis of Cross Section and Panel Data* (2010), by Jeffrey M. Wooldridge.

## 5 Results

This section will contain all insights that came from the analysis of the dataset at hand. We will see the relation between the explanatory variables and the electronic banking adoption variable. More specifically, it will address the research question about the relationship between electronic banking adoption and the distance to the bank branch. Following the research methodology, formulated in the preceding section, the results are presented in form of t-tests, as well as various regression models. We will start the discussion with the findings from our t-tests.

### 5.1 t-Tests

As we have seen in the research methodology section we run different kinds of t-tests to examine our hypotheses. We structure this subsection along those hypotheses.

**Males are more likely to adopt electronic banking** In order to check this hypothesis we check for differences in the mean of our outcome variable across the the two sexes. The  $p$ -value of 0.0000 is smaller than our confidence level of 0.01 and we find a  $t$ -statistic of -14.6415. Therefore, we can reject our null hypothesis in favour of the alternative hypothesis that the fraction of e-banking adopters is larger for males. The 99% confidence interval for the likelihood of adopting electronic banking for a male is 52.25%-54.32%, compared to the one for females 44.05%-46.08%. Consequently, with 99% certainty, we can conclude that our first hypothesis holds true within the sample at hand and males are indeed more likely to adopt electronic banking.

**Age has a negative effect on electronic banking adoption** We address this hypothesis by looking at the average age within the the groups of electronic banking users and others. With a  $t$ -statistic of 33.5096 and a  $p$ -values of 0.0000 we are able to reject the null hypothesis in favour of our working hypothesis that the average age within the group of e-banking adopters is significantly lower compared to the others. The 99% confidence intervals lets us conclude that the mean age is somewhere between 38.21 and 38.96 for the e-banking users and between 45.77 and 46.66 for the others.

**Larger distances to a bank branch are positively correlated with electronic banking adoption** In order to test this hypothesis we first check for differences in the mean distance between e-banking users and others. For the sake of better comprehensibility one can find the  $t$ -statistics,  $p$ -values as well as the conclusion for each t-test concerning the four distance measures in table 5.1 below. All these t-test are conducted with regard to our third null hypothesis, stating that there is no difference in the mean distance between e-banking users and other. Besides, one can also observe the previously mentioned results concerning sex and age in table 5.1.

All in all, we can say that all t-tests regarding our distance measures give us conclusive evidence that our third hypothesis seems to be valid on the 99% confidence level. However, regarding our test for differences in the mean of the e-banking dummy across municipalities with a bank branch and the others we find opposing evidence. On the 99% confidence level we are only able to reject the null hypothesis when we look at the fraction of e-banking users in Vaduz in comparison to the others. There we find a  $t$ -statistic of 6.6973 and a corresponding  $p$ -value of 0.000, which lets us conclude that the share of electronic banking adopters in Vaduz is indeed smaller then in the other municipalities. This is in line with our third hypothesis that larger distances are associated with a higher e-banking adoption. Nonetheless, we do not find this for the other two municipalities with a bank branch Eschen and Balzers. There, we cannot reject the null hypothesis.

Variable	<i>t</i> -statistic	<i>p</i> -value	Rejection threshold	Conclusion
Distance to headquarters (km)	-10.7840	0.0000	0.01	rejecting $H_0$
Distance to headquarters (min)	-9.9035	0.0000	0.01	rejecting $H_0$
Distance to closest branch (km)	-4.4793	0.0000	0.01	rejecting $H_0$
Distance to closest branch (min)	-2.9561	0.0016	0.01	rejecting $H_0$
Sex	-14.6415	0.0000	0.01	rejecting $H_0$
Age	33.5096	0.0000	0.01	rejecting $H_0$

**Table 5.1.** T-test results.

*Notes:* In the table above one can find the results for every single t-test conducted for our four distance measures. Moreover, the results from the t-tests, concerned with the client’s age and sex, are displayed. We report the *t*-statistic as well as the *p*-value and the conclusion with regard to the null hypothesis. The rejection threshold on the 99% confidence level is 0.01.

*Source:* Own table, based on the LLB dataset

Summarising our findings from all t-tests, with regard to our three hypotheses, we can say with a 99% certainty that they all seem to hold true within the sample at hand. Even though, we have to appreciate the limiting findings with regard to our last set of t-tests. We will now delve into our results from the regression models.

## 5.2 Regression Models

In order to check for the robustness of the findings in our previous subsection we will now look at six regression models. As explained in the research methodology section, the main idea of those models is to examine the effect of our distance measures on the outcome variable e-banking adoption. The variables Age and Sex will be added to the regression equation to control for the effects of those two variables. Additionally, we will estimate the model with both controls also as a probit and logit model. The first four models use the OLS method. Table 5.2 shows the regression output for model 4, 5 and 6, with the distance to the closest branch in minutes as the main explanatory variable. These three models present the most interesting findings. Since model 4 combines the first three specifications and is consistent with them, those estimates are shown in Appendix D.<sup>13</sup> The results for the remaining three distance measures, i.e. distance to headquarters in kilometres and minutes and distance to the closest branch in kilometres, point in the same direction. The regression outputs, with those measures as the main explanatory variables, can be found in Appendix D.

**Model 4** The fourth specification of our model, stated in equation 4.5, adds both controlling variables to the regression. In this model we combine all previous findings and see that the effects are robust. For the distance variable we find that an increase of one minute is linked to an increase in the likelihood of e-banking adoption of about 0.19%. The age effect is still negative and the estimate suggests that for every additional year the probability of e-banking adoption decreases about 0.44%. For the sex of the client the effect is still biased towards males and proposes that males are 7.35% more likely to adopt electronic banking. This specification gives us the highest  $R^2$  of 0.04, meaning we are able to explain 4% of variability.

**Model 5** Our main goal is to determine the effects on the response probability  $\Pr(y = 1|x)$  resulting from a change in one of the explanatory variables, say  $x_j$ . In linear models the marginal

<sup>13</sup>The first three model specifications show  $R^2$ s of 0.000 (1), 0.035 (2) and 0.007 (3). They are part of model 4, shown in table 5.2.

Dependent variable	Electronic Banking Adoption		
	(4)	(5)	(6)
Distance to closest branch (min)	0.0019*** (0.0006)	0.0049*** (0.0015) [0.0019]	0.0079*** (0.0024) [0.0019]
Age	-0.0044*** (0.0001)	-0.0114*** (0.0004) [-0.0044]	-0.0183*** (0.0006) [-0.0044]
Sex	0.0735*** (0.0055)	0.1894*** (0.0143) [0.0734]	0.3051*** (0.0230) [0.0735]
Constant	0.632	0.335	0.544
$R^2$	0.040		
Pseudo $R^2$		0.029	0.029
Observations	31'511	31'511	31'511
Method	OLS	Probit	Logit

Robust standard errors in parentheses  
Marginal effects for the probit and logit models in brackets  
\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

**Table 5.2.** Regression models distance to closest branch (min).

*Notes:* The dependent variable in this regression is Electronic Banking Adoption. Column (4) shows a model in which the distance to the closest branch in minutes operates as the explanatory variable and we simultaneously control for a client's age and sex. Column (5) and (6) replicate the model from column (4) with a non-linear probit and logit model. For each variable we report the raw coefficients from the regression, together with robust standard errors in parentheses. For the probit and logit regression models we add the marginal effects in brackets. To give an indication about the model's goodness of fit, we report McFadden's  $R^2$  for the probit and logit models, as well as the  $R^2$  known from OLS. Definitions of the variables are provided in Appendix C.

*Source:* Own table, based on the LLB dataset.

effect of a unit change in some explanatory variable on the dependent variable is simply the associated coefficient on the relevant explanatory variable. However, for logit and probit models obtaining measures of the marginal effect is more complicated, due to the fact that these models are non-linear. We, therefore, follow the best practices for interpreting these results presented in Hoetker (2007). When  $x_j$  is a continuous variable, such as *age* in our model, its partial effect on  $\Pr(y = 1|x)$  is obtained from the partial derivative

$$\begin{aligned} \frac{\partial \Pr(y = 1|x)}{\partial x_j} &= \frac{\partial G(\mathbf{x}\boldsymbol{\beta})}{x_j} \\ &= g(\mathbf{x}\boldsymbol{\beta}) \cdot \beta_j, \end{aligned}$$

where

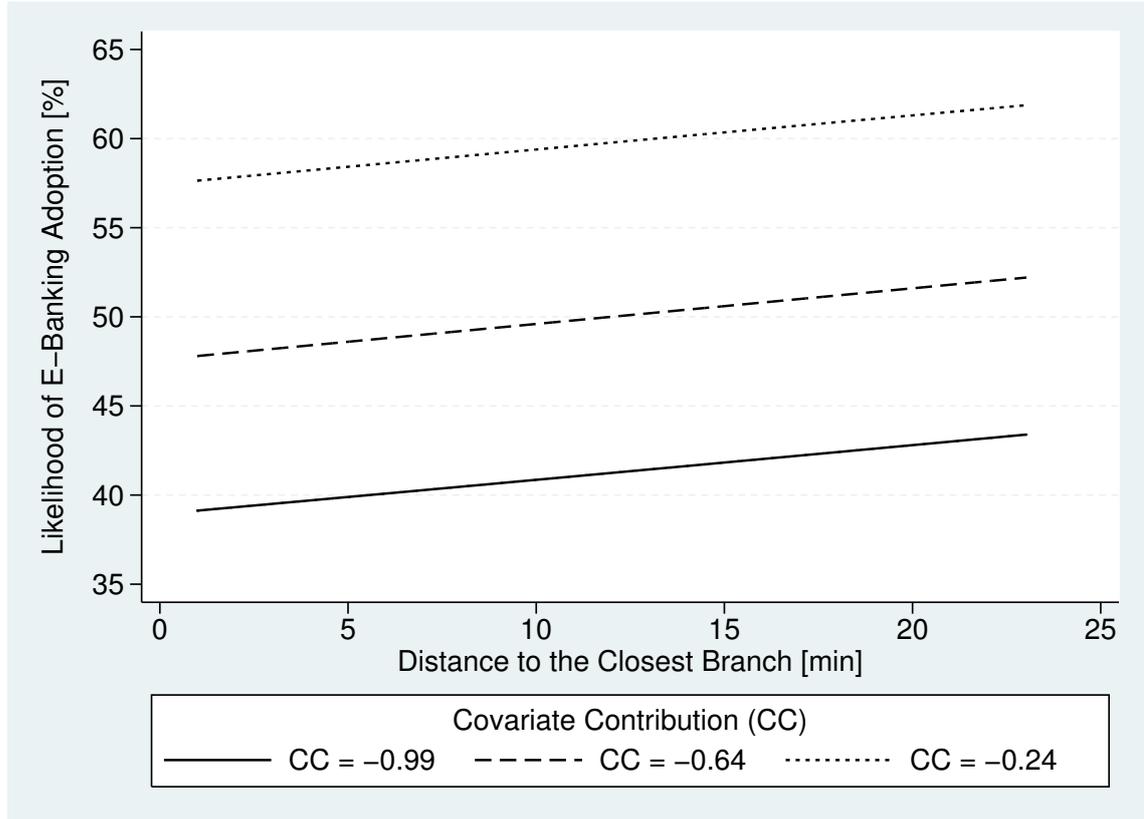
$$g(z) = \frac{dG(z)}{dz}$$

is the probability density function associated with  $G$  and where  $G$  is a function taking on values strictly between zero and one:  $0 < G(z) < 1$ , for all real numbers  $z$ . Notice that  $0 < G(x) < 1$  ensures that the estimated response probabilities are strictly between zero and one, which, thus, addresses the main worries we had about using LPM. Because the density function is non-negative, the partial effect of  $x_j$  will always have the same sign as  $\beta_j$ . Since our coefficients in table 5.2

exhibit the same signs as the ones estimated in our previous models we can say that they are robust. This means, the positive effect of distance on the e-banking probability, while controlling for the age and sex of the individuals, is persistent in our non-linear probit model. We notice that the partial effect depends on  $g(x)$ , i.e. for different values of  $x_1, x_2, \dots, x_k$  the partial effect will be different. We, therefore, can only say something about the average marginal effects for the respective variables. Otherwise, we would have to evaluate them at specific values. Following common practice, we calculate the effect for each variable at their mean value. However, we want to make sure to mention that this is not the "average effect" (Hoetker, 2007). As one can easily observe in table 5.2, the increase in the distance to the closest branch by one minute is associated with a 0.19% increase in the probability of an individual adopting electronic banking. The increase of age by one year is linked to a 0.44% decrease in the likelihood of an individual adopting electronic banking. Finally, the marginal effect of the individual being male is related to an increase in the probability of e-banking adoption of about 7.34%. McFadden's  $R^2$  shows us that this model explains 2.9% of the variability. For the interpretation of all these partial effects it is assumed that the others are held constant.

**Model 6** For the results of this logit model we can rely on much that has been explained above in case of the probit model. The only thing that changes is the underlying non-linear function  $G$ . Along the same line of reasoning, we find that the signs of our explanatory variables are again persistent in this model specification. Thus, we directly move on to the marginal effects of those variables. For the marginal effect of the distance to the closest bank branch we find that an increase by one minute leads to an increase in the probability of e-banking adoption of about 0.19%. The decrease in the probability of e-banking adoption associated with the age of the individual is 0.44% per year. The effect of the client's sex is that the likelihood of e-banking adoption is 7.35% higher for males. McFadden's  $R^2$  shows us that this model again explains 2.9% of the variability.

For a better illustration of the findings in model 6 we provide a visualisation of the effects in figure 5.1. Examining the graph in figure 5.1, we can see that when the collective contribution of age and sex is low (at the 20th percentile), the relationship between the distance to the next branch in minutes and electronic banking adoption is almost linear. An increase to the 50th and 80th percentiles does not affect this relationship. Thus, we conclude that the positive relationship between a client's distance to the next bank branch and electronic banking adoption is robust.



**Figure 5.1.** Predicted probabilities of e-banking adoption as a function of distance to the next bank branch and the collective contribution of age and sex.

*Notes:* Above figure depicts the predicted probabilities of e-banking adoption as a function of distance to the next bank branch, whilst taking the collective contribution of age and sex into account. The y-axis show the predicted probabilities and the x-axis exhibits the distance to the next bank branch in minutes. The three lines depict the 20th (-0.99), 50th (-0.64) and 80th (-0.24) percentile effect of the collective contribution from the covariates age and sex respectively.

*Source:* Own figure, based on the LLB dataset and Mitchell and Chen (2005)

We have now seen evidence in favour of our three hypotheses within the descriptive statistics as well as the t-test subsection. After we have also checked the robustness of these findings with our regression models, one can now find a discussion of them in the following section.

## **6 Discussion**

The following remarks will give some perspective to the findings of this thesis and will discuss the contribution to the literature on electronic banking adoption as well as their implications for the Liechtensteinische Landesbank AG. In addition, we will highlight the limitations of the research presented in this thesis and point out possibilities for future studies. Subsequently, the next section concludes.

### **6.1 Contribution to the Literature on Electronic Banking Adoption**

Reflecting on the results presented in the previous section one can find that this thesis makes a valuable contribution to the literature on electronic banking adoption by presenting evidence which confirms previous findings. First of all, even though, some prior studies did not find any significant relation between a client's sex and their likelihood of adopting electronic banking (Izogo et al., 2012; Munusamy et al., 2012; Khan et al., 2017), the difference between the sexes presented in this study is in line with other authors' findings. By showing on the 99% confidence level that male clients are more likely to adopt e-banking services, we find the same kind of gender gap that was already proposed by Flavián et al. (2006) and confirmed by Kräuter and Breiteneker (2011). Second of all, we find evidence which claims that younger clients are more likely to adopt electronic banking. Again we are able to support this statement on the 99% confidence level. These findings are in line with what has been proposed by J. Kolodinsky et al. (2000). Moreover, this inverse relationship between a client's age and her likelihood to adopt electronic banking has been found to be true many times thereafter (Mattila et al., 2003; J. M. Kolodinsky et al., 2004; Izogo et al., 2012). Besides, this relationship is a common finding for the adoption of any new technology (Morris & Venkatesh, 2000). Finally, we tested the original hypothesis of this thesis. By coming up with a hypothesis, based on the prevailing theories in this area of research - the TAM and DOI - we set out to examine a new determinant for the adoption of electronic banking. This hypothesis, stating that larger distances to a bank branch are positively correlated with electronic banking adoption, also holds true on the 99% confidence level. Consequently, this thesis adds this distance measure, as an explanatory variable for the adoption of e-banking services, to the literature on electronic banking adoption.

### **6.2 Implications for the Liechtensteinische Landesbank AG**

Lassar et al. (2005) stated in their research that financial service providers must aim to have a comprehensive understanding of their client's impressions of electronic banking. This statement becomes particularly crucial paired with other studies' findings that this technology reduces costs relative to other forms of banking, and provides more timely and complete customer information (Nui Polatoglu & Ekin, 2001; Gerrard & Cunningham, 2003). Moreover, Rouibah et al. (2009) find that it increases service quality, which is an inevitable factor for survival in competitive markets (Rouibah et al., 2009). Thus, this thesis' findings should be of major interest to LLB. The discovered gender gap, as well as the inverse relationship between age and the client's likelihood of adoption, ask for additional efforts to make e-banking more accessible to female and older clients. With regard to the identified relationship between a client's distance to the bank branches and her likelihood of having an e-banking agreement with LLB, the implications are less straightforward. However, one possible implication for the bank is that the closure of one of the bank branches could increase the number of client's using electronic banking. With one of the three principal strategic pillars of the Roadmap 2020 of the Liechtenstein Bankers Association being digitisation

(Liechtenstein Marketing, 2016), this could be one imaginable way of accomplishing a higher rate of adoption at LLB. After all, this is only one possible outcome and it stands to reason whether it holds true in future research on this matter. With regard to future research, the following subsection highlights the limitations of the research project at hand, before we point out possibilities for further research on this topic.

### **6.3 Limitations and Further Research**

Without taking away any validity from the explanations and findings stated above, there are a few shortcomings to this thesis that have to be discussed. For instance, even though this is a common research design within this area of study, the research in this paper is only concerned with one particular country. Still, the sample at hand represents more than 85% of the population in this country and is therefore highly representative. Another shortcoming is the limited use of demographic variables. However, this is due to the privacy and anonymity restrictions imposed by LLB. The request for the dataset included variables for total assets, income (proxied by the largest monthly credit to the client's account), educational level, marital status and whether the account features a mortgage with the bank. Furthermore, the initial outline for the research included data on the actual usage of the electronic banking services and the distances to the bank branches on an individual level, in contrast to the averages for each municipality we used instead. All these variables that would have made the research more sophisticated fell victim to privacy concerns and have to be considered as limitations. Nonetheless, these limitations supply possibilities for further research to build on this thesis' findings. Also, the adoption dummy used in this thesis does not allow for any distinction or even comparison between the two services of online banking and mobile banking. Rather the findings in this study are limited to the adoption of electronic banking in general. We, furthermore, rely solely on cross-sectional data. The development of e-banking adoption over time would be another interesting research opportunity. Characteristics of the electronic banking service itself have often been found to have the largest impact on e-banking adoption (J. M. Kolodinsky et al., 2004; Cheng, Lam, & Yeung, 2006; Yaghoubi & Bahmani, 2010). However, no statement was made about such characteristics in the case of electronic banking services from LLB. In conclusion, the dataset in future research projects could be improved, in the ways outlined above, to make more sophisticated statements about the adoption and usage of electronic banking.

The results of this study, together with the limitations presented above, open up many possibilities for further research. Future research projects should pick up the limitations mentioned above and build on the findings in this thesis, to determine whether distance to a bank branch really impacts the adoption of electronic banking. For instance, it would be interesting to examine how frequently the clients actually use the e-banking services and also for which tasks. This poses questions such as:

- Are the clients using the services at all?
- Are they checking their balance on a regular basis?
- Do they execute payments on a regular basis?

The subsequent section concludes with some final remarks.

## 7 Conclusions

Summarising the results and implications, we can say that this thesis identified a positive relationship between a client's distance to the next bank branch and electronic banking adoption. This was expected, following the reasoning that for any client the perceived usefulness and the relative advantage, compared to other banking channels, increases with a larger distance to the bank branch. In other words, based on the theoretical framework commonly used in this line of research, we have been able to identify a new predictor of electronic banking adoption. Moreover, this thesis confirms findings with respect to the age and sex of bank clients and their influence on e-banking adoption found in previous studies. One can find evidence supporting the hypothesis that male clients are more likely to adopt electronic banking. Additionally, we see that a client's age is negatively correlated with the likelihood of e-banking adoption. Consequently, the thesis adds a valuable contribution to the stream of literature that tries to identify the predictors of e-banking adoption. However, a few qualifying remarks have to be made. The dataset at hand focuses on only one particular bank in one particular country. On the other hand, as we have seen, the sample represent more than 85% of all bank clients in Liechtenstein. Generalisations beyond the borders of this particular country are difficult to support. Another limitation is the low prediction power of our models. Even though we have seen a statistical significant and robust relationship, the models only explain about 4% of the variation in the dataset. To address this issue it would be of major interest to expand the dataset with more controlling variables, such as the clients total assets, whether her account features a mortgage or not, or her income. Furthermore, it would be fascinating to analyse the actual usage of the electronic banking and not simply focus on whether the account features an e-banking agreement or not. Future research is needed to expand the scope of this thesis and to build on its findings.

## References

- AbuShanab, E., Pearson, J. M., & Setterstrom, A. J. (2010). Internet Banking and Customers' Acceptance in Jordan: The Unified Model's Perspective. *Communications of the Association for Information Systems, 26*, 493–524. Retrieved from <https://pdfs.semanticscholar.org/5aa8/27865ec3ede5b5767e2dd6449d7caa8179d4.pdf>
- Ahmad, R., & Buttle, F. (2002, feb). Retaining telephone banking customers at Frontier Bank. *International Journal of Bank Marketing, 20*(1), 5–16. Retrieved from <https://www.emeraldinsight.com/doi/10.1108/02652320210415944> doi: 10.1108/02652320210415944
- Ajzen, I. (1991, dec). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. Retrieved from [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T) doi: 10.1016/0749-5978(91)90020-T
- Alavi, M., & Carlson, P. (1992, mar). A Review of MIS Research and Disciplinary Development. *Journal of Management Information Systems, 8*(4), 45–62. Retrieved from <http://www.tandfonline.com/doi/full/10.1080/07421222.1992.11517938> doi: 10.1080/07421222.1992.11517938
- Amt für Statistik. (2018). *Liechtenstein in Zahlen 2018*. Retrieved 2018-04-06, from <https://www.llv.li/files/as/liechtenstein-in-zahlen-2018.pdf>
- Barnes, S. J., & Corbitt, B. (2003). Mobile banking: concept and potential. *International Journal of Mobile Communications, 1*(3), 273. Retrieved from <http://www.inderscience.com/link.php?id=3494> doi: 10.1504/IJMC.2003.003494
- Benbasat, I., & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems, 8*(4), 211–218. Retrieved from <https://pdfs.semanticscholar.org/0766/d655ec78d789f9c8aa1ce849c858b29546ad.pdf>
- Bhattacharjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems, 32*, 201–214. doi: [https://doi.org/10.1016/S0167-9236\(01\)00111-7](https://doi.org/10.1016/S0167-9236(01)00111-7)
- Boslaugh, S. (2013). *Health Care Systems Around the World: A Comparative Guide*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc. Retrieved from <http://sk.sagepub.com/reference/healthcare-systems-around-the-world> doi: 10.4135/9781452276212
- Camilleri, S. J., & Grech, G. (2017). The Relevance of Age Categories in explaining Internet Banking Adoption Rates and Customers' Attitudes towards the Service The Relevance of Age Categories in explaining Internet Banking Adoption Rates and Customers' Attitudes towards the Service. *Journal of Applied Finance & Banking, 7*(2), 29–47. Retrieved from <https://mpa.ub.uni-muenchen.de/77745/>
- Cenfetelli, R. T. (2004). Inhibitors and Enablers as Dual Factor Concepts in Technology Usage. *technology Usage Journal of the Association for Information Systems, 5*(11-12), 472–492. Retrieved from <https://pdfs.semanticscholar.org/f8dc/fcff6bb5c39b45cd33355cd742fba9495394.pdf>
- Cenfetelli, R. T., & Schwarz, A. (2011, dec). Identifying and Testing the Inhibitors of Technology Usage Intentions. *Information Systems Research, 22*(4), 808–823. Retrieved from <http://pubsonline.informs.org/doi/abs/10.1287/isre.1100.0295> doi: 10.1287/isre.1100.0295
- Central Intelligence Agency. (2018). *The World Factbook*. Retrieved 2018-03-26, from <https://www.cia.gov/library/publications/the-world-factbook/geos/ls.html>

- Cheng, T. C. E., Lam, D. Y. C., & Yeung, A. C. L. (2006). Adoption of Internet Banking: An Empirical Study in Hong Kong. *Decision support systems*, 42(3), 1558–1572. Retrieved from <http://hdl.handle.net/10397/625>
- Davis, F. D. (1989, sep). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319–340. doi: 10.2307/249008
- Deutsche Bank research. (2010). *Online banking and research: the state of play in 2010*.
- Financial Center Liechtenstein. (2017). *Financial Center Liechtenstein*. Vaduz: Financial Center Liechtenstein e. V. and Liechtenstein Marketing. Retrieved from [https://www.finance.li/fileadmin/Dateiliste/finance.li/Daten/LIM\\_BRO\\_Finanzplatz\\_englisch\\_Web\\_DS.PDF](https://www.finance.li/fileadmin/Dateiliste/finance.li/Daten/LIM_BRO_Finanzplatz_englisch_Web_DS.PDF)
- Financial Market Authority Liechtenstein. (2017). *Liechtenstein Financial Market* (Tech. Rep.). Financial Market Authority Liechtenstein. Retrieved from <https://www.fma-li.li/files/fma/fma-financial-market-liechtenstein-edition-2017.pdf>
- Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*. Reading, Massachusetts: Addison-Wesley Publishing Company.
- Flavián, C., Guinaliú, M., & Torres, E. (2006). How bricks-and-mortar attributes affect online banking adoption. *International Journal of Bank Marketing*, 24(6), 406–423. Retrieved from <https://www.emeraldinsight.com/doi/10.1108/02652320610701735> doi: 10.1108/02652320610701735
- Gerrard, P., & Cunningham, J. B. (2003). The diffusion of Internet banking among Singapore consumers. *International Journal of Bank Marketing*, 21(1), 16–28. Retrieved from <https://doi.org/10.1108/02652320310457776>
- Godolja, M., & Spaho, A. (2014, jun). Internet Banking Adoption and Usage in Albania: An Empirical Study. *Journal of Educational and Social Research*, 4(4), 460–465. Retrieved from <http://www.mcser.org/journal/index.php/jesr/article/view/3536/3477>
- Hanafizadeh, P., Keating, B. W., & Khedmatgozar, H. R. (2014). A systematic review of Internet banking adoption. *Telematics and Informatics*, 31, 492–510. Retrieved from [https://ac.els-cdn.com/S0736585313000300/1-s2.0-S0736585313000300-main.pdf?\\_tid=90e302b4-de3f-4b0e-b020-856e7f2bf8bd&acdnat=1524904119\\_ae8a9a89b7c658b82c08ecd416f7e56e](https://ac.els-cdn.com/S0736585313000300/1-s2.0-S0736585313000300-main.pdf?_tid=90e302b4-de3f-4b0e-b020-856e7f2bf8bd&acdnat=1524904119_ae8a9a89b7c658b82c08ecd416f7e56e) doi: 10.1016/j.tele.2013.04.003
- Hoehle, H., & Lehmann, H. (2008). Exploring the state-of-the art of mobile banking literature. In *7th global mobility roundtable conference*. Auckland: University of Auckland.
- Hoehle, H., Scornavacca, E., & Huff, S. (2012). Three decades of research on consumer adoption and utilization of electronic banking channels: A literature analysis. *Decision Support Systems*, 54, 122–132. doi: 10.1016/j.dss.2012.04.010
- Hoetker, G. (2007). The Use of Logit and Probit Models in Strategic Management Research: Critical Issues. *Strategic Management Journal*, 28, 331–343. Retrieved from [http://www.public.asu.edu/~ghoetker/resources/research/Hoetker\\_2007\\_SMJ.pdf](http://www.public.asu.edu/~ghoetker/resources/research/Hoetker_2007_SMJ.pdf) doi: 10.1002/smj.582
- Iddris, F. (2013). Barriers to Adoption of Mobile banking: Evidence from Ghana. *International Journal of Academic Research in Business and Social Sciences*, 3(7), 356–370. Retrieved from [www.hrmar.com/journals](http://www.hrmar.com/journals) doi: 10.6007/IJARBSS/v3-i7/59
- Ipsos. (2016). *World on the move for mobile banking*.
- Izogo, E. E., Nnaemeka, O. C., Onuoha, O. A., & Ezema, K. S. (2012). Impact of Demographic Variables on Consumers' Adoption of E-banking in Nigeria: An Empirical Investigation. *European Journal of Business and Management*, 4(17), 27–39. Retrieved from [http://pakacademicsearch.com/pdf-files/ech/517/27-39Vo14,No17\(2012\).pdf](http://pakacademicsearch.com/pdf-files/ech/517/27-39Vo14,No17(2012).pdf)

- Jo Black, N., Lockett, A., Ennew, C., Winklhofer, H., & McKechnie, S. (2002). Modelling consumer choice of distribution channels: an illustration from financial services. *International Journal of Bank Marketing*, 20(4), 161–173. Retrieved from <https://www.emeraldinsight.com/doi/10.1108/02652320210432945> doi: 10.1108/02652320210432945
- Karjaluoto, H., Mattila, M., & Pentto, T. (2002, nov). Factors underlying attitude formation towards online banking in Finland. *International Journal of Bank Marketing*, 20(6), 261–272. Retrieved from <https://www.emeraldinsight.com/doi/10.1108/02652320210446724> doi: 10.1108/02652320210446724
- Khan, A. P., Khan, S., & Xiang, I. A. R. (2017). Factors Influencing Consumer Intentions to Adopt Online Banking in Malaysia. *Business & Economic Review*, 9(2), 101–134. Retrieved from <https://www.imsciences.edu.pk/files/journals/2017-vol-2/New5.pdf> doi: 10.22547/BER/9.2.5
- Kolodinsky, J., Hogarth, J. M., & Shue, J. F. (2000). Bricks or Clicks? Consumers' Adoption of Electronic Banking Technologies. *Consumer Interests Annual*, 46, 180–184. Retrieved from <http://www.consumerinterests.org/assets/docs/CIA/CIA2000/kolodinskyhogarthshue.pdf>
- Kolodinsky, J. M., Hogarth, J. M., & Hilgert, M. A. (2004, jun). The adoption of electronic banking technologies by US consumers. *International Journal of Bank Marketing*, 22(4), 238–259. Retrieved from <http://www.emeraldinsight.com/doi/10.1108/02652320410542536> doi: 10.1108/02652320410542536
- Kräuter, S. G., & Breitenecker, R. J. (2011). Factors influencing online banking adoption: evidence from the Austrian market. *International Journal of Internet Marketing and Advertising*, 6(4), 333–351. Retrieved from <http://www.inderscience.com/link.php?id=43655> doi: 10.1504/IJIMA.2011.043655
- Krosnick, J. A. (1999). Survey Research. *Annual Review of Psychology*, 50(1), 537–567. Retrieved from <http://www.annualreviews.org/doi/10.1146/annurev.psych.50.1.537> doi: 10.1146/annurev.psych.50.1.537
- Kuisma, T., Laukkanen, T., & Hiltunen, M. (2007). Mapping the reasons for resistance to Internet banking: A means-end approach. *International Journal of Information Management*, 27, 75–85. Retrieved from [https://ac.els-cdn.com/S0268401206001149/1-s2.0-S0268401206001149-main.pdf?\\_tid=4cb74155-8825-4025-825c-1954e9b0270d&acdnat=1524838767\\_14a6944f8f956f634dc28e916b75e10b](https://ac.els-cdn.com/S0268401206001149/1-s2.0-S0268401206001149-main.pdf?_tid=4cb74155-8825-4025-825c-1954e9b0270d&acdnat=1524838767_14a6944f8f956f634dc28e916b75e10b) doi: 10.1016/j.ijinfomgt.2006.08.006
- Kushnir, I. (2018). *Liechtenstein. Gross domestic product, 1970-2016*. Retrieved 2018-05-10, from <http://www.ivanstat.com/en/gdp/li.html>
- Lai, V. S., & Li, H. (2005). Technology acceptance model for internet banking: an invariance analysis. *Information & Management*, 42, 373–386. Retrieved from <https://pdfs.semanticscholar.org/6b48/2961affdeb52a85df7f85b50d8430f03dca4.pdf> doi: 10.1016/j.im.2004.01.007
- Lapointe, L., & Rivard, S. (2005). A Multilevel Model of Resistance to Information Technology Implementation A Multilevel Model of Resistance to Information Technology Implementation. *Source: MIS Quarterly*, 29(3), 461–491. Retrieved from <http://www.jstor.org/stable/25148692>
- Lassar, W. M., Manolis, C., & Lassar, S. S. (2005). The relationship between consumer innovativeness, personal characteristics, and online banking adoption. *International Journal of Bank Marketing*, 23(2), 176–199. Retrieved from <https://doi.org/10.1108/02652320510584403300>

- Laukkanen, T., & Kiviniemi, V. (2010). The role of information in mobile banking resistance. *International Journal of Bank Marketing International Journal of Bank Marketing*, 28(5), 372–388. Retrieved from <https://doi.org/10.1108/02652321011064890>
- Laukkanen, T., & Lauronen, J. (2005). Consumer value creation in mobile banking services. *International Journal of Mobile Communications*, 3(4), 325–338. Retrieved from <http://www.inderscience.com/link.php?id=7021> doi: 10.1504/IJMC.2005.007021
- Laukkanen, T., Sinkkonen, S., & Laukkanen, P. (2009). Communication strategies to overcome functional and psychological resistance to Internet banking. *International Journal of Information Management*, 29(2), 111–118. doi: 10.1016/j.ijinfomgt.2008.05.008
- Laukkanen, T., Sinkkonen, S., Laukkanen, P., & Kivijärvi, M. (2008). Segmenting bank customers by resistance to mobile banking. *Int. J. Mobile Communication J. Mobile Communication*, 6(3), 309–320. Retrieved from <https://www.inderscienceonline.com/doi/pdf/10.1504/IJMC.2008.017513>
- Lee, M.-C. (2009). Factors influencing the adoption of internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic Commerce Research and Applications*, 8, 130–141. Retrieved from <https://pdfs.semanticscholar.org/92ca/fe5ae797542cf12a5563ea531880a92071d2.pdf> doi: 10.1016/j.eierap.2008.11.006
- LGT Group Foundation. (2017). *Annual Report 2016*. Vaduz: LGT Group Foundation.
- LGT Group Foundation. (2018). *Business Portrait 2017*. Vaduz: LGT Group Foundation.
- Liechtenstein Marketing. (2016). *Liechtenstein financial centre spotlights sustainability*. Retrieved 2018-04-19, from <https://www.liechtenstein.li/en/news-detail/article/liechtenstein-financial-centre-spotlights-sustainability/>
- Liechtenstein Marketing. (2018). *Corporate taxation*. Retrieved 2018-04-19, from <https://www.liechtenstein-business.li/en/for-entrepreneurs/corporate-taxation/>
- Liechtensteinische Landesbank AG. (2018). *Annual Report 2017*. Vaduz: Liechtensteinische Landesbank AG.
- Lockett, A., & Littler, D. (1997, nov). The adoption of direct banking services. *Journal of Marketing Management*, 13(8), 791–811. Retrieved from <https://doi.org/10.1080/0267257X.1997.9964512> doi: 10.1080/0267257X.1997.9964512
- Luo, X., Li, H., Zhang, J., & Shim, J. P. (2010). Examining multi-dimensional trust and multi-faceted risk in initial acceptance of emerging technologies: An empirical study of mobile banking services. *Decision Support Systems*, 49(2), 222–234. doi: 10.1016/j.dss.2010.02.008
- Makris, M., Koumaras, V., Koumaras, H., Konstantopoulou, A., & Konidis, S. (2009). Quantifying Factors Influencing the Adoption of Internet Banking Services in Greece. *International Journal of E-Adoption*, 1(1), 20–32. Retrieved from <http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/jea.2009010102> doi: 10.4018/jea.2009010102
- Mattila, M., Karjaluoto, H., & Pentto, T. (2003, sep). Internet banking adoption among mature customers: early majority or laggards? *Journal of Services Marketing*, 17(5), 514–528. Retrieved from <https://doi.org/10.1108/08876040310486294> doi: 10.1108/08876040310486294
- Mitchell, M. N., & Chen, X. (2005). Visualizing main effects and interactions for binary logit models. *The Stata Journal*, 5(1), 130–141.
- Moore, G. C., & Benbasat, I. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Innovation. *Information Systems Research*, 2(3), 192–222. Retrieved from [http://130.18.86.27/faculty/warkentin/SecurityPapers/Merrill/MooreBenbasat1991\\_ISR2\\_3\\_DevelopInstrumentMeasurePerceptAdoptITInnovation.pdf](http://130.18.86.27/faculty/warkentin/SecurityPapers/Merrill/MooreBenbasat1991_ISR2_3_DevelopInstrumentMeasurePerceptAdoptITInnovation.pdf)
- Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Im-

- plications for a changing work force. *Personnel Psychology*, 53(2), 375–403. Retrieved from [http://www.vvenkatesh.com/wp-content/uploads/2015/11/PP\\_Morris\\_Venkatesh.pdf](http://www.vvenkatesh.com/wp-content/uploads/2015/11/PP_Morris_Venkatesh.pdf)
- Munusamy, J., De Run, E. C., Chelliah, S., & Annamalah, S. (2012). Journal of Internet Banking and Commerce Adoption of Retail Internet Banking: A Study of Demographic Factors. *Journal of Internet Banking and Commerce*, 17(3). Retrieved from <http://www.arraydev.com/commerce/jibc/>
- Nui Polatoglu, V., & Ekin, S. (2001, jul). An empirical investigation of the Turkish consumers' acceptance of Internet banking services. *International Journal of Bank Marketing*, 19(4), 156–165. Retrieved from <https://www.emeraldinsight.com/doi/10.1108/02652320110392527> doi: 10.1108/02652320110392527
- OECD. (2018). *General government spending (indicator)*. doi: 10.1787/a31cbf4d-en
- Ozdemir, S., & Trott, P. (2009, mar). Exploring the adoption of a service innovation: A study of Internet banking adopters and non-adopters. *Journal of Financial Services Marketing*, 13(4), 284–299. Retrieved from <http://link.springer.com/10.1057/fsm.2008.25> doi: 10.1057/fsm.2008.25
- Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., & Pahnla, S. (2004). Consumer acceptance of online banking: an extension of the technology acceptance model. *Internet Research*, 14(3), 224–235. Retrieved from <http://www.emeraldinsight.com/doi/10.1108/10662240410542652> doi: 10.1108/10662240410542652
- Püschel, J., Mazzon, J. A., & Hernandez, J. M. C. (2010). Mobile banking: proposition of an integrated adoption intention framework. *International Journal of Bank Marketing*, 28(5), 389–409. Retrieved from <https://www.emeraldinsight.com/doi/pdfplus/10.1108/02652321011064908> doi: 10.1108/02652321011064908
- Railton, J. (1985, nov). Automated teller machines. *Computer Law & Security Review*, 1(4), 12. Retrieved from <https://www.sciencedirect.com/science/article/pii/0267364985900238> doi: 10.1016/0267-3649(85)90023-8
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- Rouibah, K., Thurasamy, R., & May, O. S. (2009). User Acceptance of Internet Banking In Malaysia. *International Journal of E-Adoption*, 1(1), 1–19. Retrieved from <http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/jea.2009010101> doi: 10.4018/jea.2009010101
- Sarel, D., & Marmorstein, H. (2003, dec). Marketing online banking services: The voice of the customer. *Journal of Financial Services Marketing*, 8(2), 106–118. Retrieved from <http://link.springer.com/10.1057/palgrave.fsm.4770111> doi: 10.1057/palgrave.fsm.4770111
- Scornavacca, E., Barnes, S. J., & Huff, S. L. (2006). Mobile Business Research Published in 2000-2004: Emergence, Current Status, and Future Opportunities. *Communications of the Association for Information Systems*, 17, 635–646. Retrieved from [http://aisel.aisnet.org/cais](http://aisel.aisnet.org/caishttp://aisel.aisnet.org/cais)
- Shaikh, A. A., & Karjaluoto, H. (2015, feb). Mobile banking adoption: A literature review. *Telematics and Informatics*, 32(1), 129–142. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S0736585314000367> doi: 10.1016/J.TELE.2014.05.003
- SolAbility. (2017). *The Global Sustainable Competitiveness Index*. Retrieved 2018-04-19, from <http://solability.com/the-global-sustainable-competitiveness-index/the-index>
- Standard & Poor's. (2018). *Liechtenstein 'AAA/A-1 Ratings' Affirmed; Outlook Stable*. Retrieved 2018-04-19, from [https://www.standardandpoors.com/en\\_US/web/guest/](https://www.standardandpoors.com/en_US/web/guest/)

- article/-/view/type/HTML/id/1986209
- Suh, B., & Han, I. (2002). Effect of trust on customer acceptance of Internet banking. *Electronic Commerce Research and Applications*, 1, 247–263. Retrieved from <http://iranarze.ir/wp-content/uploads/2015/02/customer-acceptance-of-Internet-banking.pdf>
- Tan, M., & Teo, T. S. H. (2000). Factors Influencing the Adoption of Internet Banking. *Journal of the Association for Information Systems*, 1(5), 1–43. Retrieved from [http://130.18.86.27/faculty/warkentin/SecurityPapers/Leigh/ZafarClark2009OtherReferences/TanTeo2000\\_JAIS1\\_FactorsInfluencingInternetBankingAdoption.pdf](http://130.18.86.27/faculty/warkentin/SecurityPapers/Leigh/ZafarClark2009OtherReferences/TanTeo2000_JAIS1_FactorsInfluencingInternetBankingAdoption.pdf)
- The Government of the Principality of Liechtenstein. (2003). *Constitution of the Principality of Liechtenstein*. Legal Service of the Gouvernement of the Principality of Liechtenstein.
- The SCImago Journal & Country Rank. (2016). *Journal Rankings on Information Systems and Management*. Retrieved 2018-04-25, from <http://www.scimagojr.com/journalrank.php?category=1802>
- The World Bank Group. (2018). *World Development Indicators*. Retrieved 2018-05-10, from <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>
- Trading Economics. (2018). *Liechtenstein Unemployment Rate*. Retrieved 2018-05-10, from <https://tradingeconomics.com/liechtenstein/unemployment-rate>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *Source: MIS Quarterly*, 27(3), 425–478. Retrieved from <http://www.jstor.org/stable/30036540>
- VP Bank Ltd. (2018). *Annual Report 2017*. Vaduz: VP Bank Ltd. Retrieved from <http://www.igis.govt.nz/assets/Annual-Reports/Annual-Report-2016.pdf>
- Weeks, J. R. (2008). *Population: An introduction to concepts and issues* (10th ed.). Belmont: Thomson Higher Education.
- Yaghoubi, N.-M., & Bahmani, E. (2010). An Integration of Technology Acceptance Model and Theory of Planned Behavior. *International Journal of Business and Management*, 5(9), 159–165. Retrieved from [www.ccsenet.org/ijbm](http://www.ccsenet.org/ijbm)
- Youngblood-Coleman, D. (2014). Country Review: Liechtenstein. *CountryWatch*, 1–237.
- Zolait, A. H. S. (2010). An examination of the factors influencing Yemeni Bank users behavioural intention to use Internet banking services. *Journal of Financial Services Marketing*, 15(1), 76–94. Retrieved from <http://dx.doi.org/10.1057/fsm.2010.1> doi: 10.1057/fsm.2010.1

## Appendix A Fact sheet: Principality of Liechtenstein

Fact Sheet: Principality of Liechtenstein	
Area	160 square kilometers
Population	37'000
Form of government	Constitutional monarchy with the rank of principality
Head of state	Prince Hans-Adam II
Government	Collegial Government with five members
Parliament	25 members of the parliament
Municipalities	11
Capital	Vaduz
Language	German
Religion	79% Roman Catholicism
Currency	Swiss franc (CHF)
Standard and Poor's credit rating	Triple A with stable outlook

**Table A1.** Fact Sheet: Principality of Liechtenstein.

*Notes:* This table is meant to provide the reader with some additional information about Liechtenstein and consequently building a basic understanding of the institutional setting of this thesis.

*Source:* Liechtenstein Marketing.

## Appendix B Excerpt from the dataset

	A	B	C	D	E
<b>1</b>	<b>COUNT(*)</b>	<b>YEAR OF BIRTH</b>	<b>SEX_ID</b>	<b>ZIP</b>	<b>NUMBER_EB_USERS</b>
<b>2</b>	<b>48</b>	<b>1964</b>	<b>male</b>	<b>9494</b>	<b>32</b>
<b>3</b>	<b>33</b>	<b>1999</b>	<b>female</b>	<b>9495</b>	<b>22</b>
<b>4</b>	<b>33</b>	<b>1957</b>	<b>female</b>	<b>9497</b>	<b>10</b>
<b>5</b>	<b>6</b>	<b>1938</b>	<b>male</b>	<b>9497</b>	<b>0</b>
<b>6</b>	<b>18</b>	<b>1955</b>	<b>female</b>	<b>9493</b>	<b>6</b>
<b>7</b>	<b>1</b>		<b>female</b>	<b>9498</b>	<b>1</b>
<b>8</b>	<b>28</b>	<b>1982</b>	<b>male</b>	<b>9496</b>	<b>22</b>
<b>9</b>	<b>23</b>	<b>1990</b>	<b>male</b>	<b>9492</b>	<b>16</b>
<b>10</b>	<b>34</b>	<b>1954</b>	<b>male</b>	<b>9496</b>	<b>8</b>

**Figure B1.** Excerpt from the dataset.

*Notes:* The figure above shows the first 10 observations of the dataset provided by the LLB. It shows the variables year of birth, sex, ZIP and electronic banking users as well as the number of individual clients with these characteristics. As one can see in cell B7, the year of birth is obliterated for observations with less than six individuals.

*Source:* Own figure, based on the LLB dataset.

## Appendix C Variable definitions

Variable name	Definition	Mean	Min.	Max.
Dependent variable (n=31'511)				
E-Banking adoption	Dummy = 1 if bank relation features an electronic banking agreement, 0 otherwise	0.49	0	1
Client characteristics (n=31'511)				
Year of birth	Year in which the client was born	1975	1924	2017
Age	Age of the client in years	42.47	0	93
Age category	Summarising the age variable into 8 categories	4.32	1	8
Sex	Dummy = 1 if client is male, 0 if client is female	0.49	0	1
Life stages	Summarising the age variable into 3 categories (Children, Teenager, Adults)	2.78	1	3
Children	Dummy = 1 if client is between 0 and 9 years old	0.06	0	1
Teenagers	Dummy = 1 if client is between 10 and 19 years old	0.10	0	1
Adults	Dummy = 1 if client is 20 years old or older	0.84	0	1
Ownership of bank account	Dummy = 1 if account belongs to a child	0.11	0	1
Distance variables (n=31'511)				
Municipalities	ZIP codes indicating where a client lives	-	9485	9498
Ruggell	Dummy = 1 if the client lives in Ruggell	0.06	0	1
Schellenberg	Dummy = 1 if the client lives in Schellenberg	0.02	0	1
Gamprin-Bendern	Dummy = 1 if the client lives in Gamprin-Bendern	0.04	0	1
Eschen	Dummy = 1 if the client lives in Eschen	0.08	0	1
Nendeln	Dummy = 1 if the client lives in Nendeln	0.03	0	1
Schaanwald	Dummy = 1 if the client lives in Schaanwald	0.01	0	1
Planken	Dummy = 1 if the client lives in Planken	0.003	0	1
Schaan	Dummy = 1 if the client lives in Schaan	0.16	0	1
Vaduz	Dummy = 1 if the client lives in Vaduz	0.14	0	1
Triesenberg	Dummy = 1 if the client lives in Triesenberg	0.07	0	1
Triesen	Dummy = 1 if the client lives in Triesen	0.14	0	1
Balzers	Dummy = 1 if the client lives in Balzers	0.14	0	1
Constituency	Dummy = 1 if the municipality belongs to the Lower Country, 0 otherwise	0.35	0	1
Distance to headquarters (km)	Distance between each municipality and the headquarters	8.84	0.70	18.70
Distance to headquarters (min)	Distance between each municipality and the headquarters	10.88	2	25
Distance to closest branch (km)	Distance between each municipality and the closest branch	3.21	0.10	12.8
Distance to closest branch (min)	Distance between each municipality and the closest branch	5.78	1	23

**Table C1.** Variable definitions.

*Notes:* The table above shows all variables used in this thesis. Moreover, it gives a brief definition of each variable and shows the respective mean, maximum and minimum values.

*Source:* Own table, based on the LLB dataset.

## Appendix D Additional regression tables

Dependent variable	<i>Electronic banking adoption</i>		
	(1)	(2)	(3)
Distance to closest branch (min)	0.0017*** (0.0006)	0.0019*** (0.0006)	0.0017*** (0.0006)
Age		-0.0045*** (0.0001)	
Sex			0.0822*** (0.0561)
Constant	0.481	0.672	0.441
R-squared	0.000	0.035	0.007
Observations	31511	31511	31511
Method	OLS	OLS	OLS

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table D1.** Regression models 1-3 distance to closest branch (min).

*Notes:* The dependent variable in this regression is Electronic banking adoption. Column (1) displays the model in which the distance to the closest branch in minutes operates as the sole explanatory variable. Column (2) adds the age of the client as an explanatory variable. Column (3) adds the dummy variable Sex to the first regression. For each variable we report the raw coefficients from the regression, together with robust standard errors in parentheses. To give an indication about the model's goodness of fit, we report the  $R^2$ . Definitions of the variables are provided in Appendix C.

*Source:* Own table, based on the LLB dataset.

Dependent variable	<i>Electronic banking adoption</i>					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance to headquarters (km)	0.005*** (0.00)	0.004*** (0.00)	0.005*** (0.00)	0.004*** (0.00)	0.010*** (0.00) [0.004]	0.017*** (0.00) [0.004]
Age		-0.004*** (0.00)		-0.004*** (0.00)	-0.011*** (0.00) [-0.004]	-0.018*** (0.00) [-0.004]
Sex			0.082*** (0.01)	0.074*** (0.01)	0.191*** (0.01) [0.074]	0.307*** (0.02) [0.074]
Constant	0.45	0.64	0.40	0.60	0.26	0.43
$R^2$	0.004	0.036	0.010	0.042		
Pseudo $R^2$					0.031	0.031
Observations	31'511	31'511	31'511	31'511	31'511	31'511
Method	OLS	OLS	OLS	OLS	Probit	Logit

Robust standard errors in parentheses

Marginal effects for the probit and logit models in brackets

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

**Table D2.** Regression models distance to headquarters (km).

*Notes:* The dependent variable in this regression is Electronic banking adoption. Column (1) displays the model in which the distance to the headquarters in kilometres operates as the sole explanatory variable. Column (2) adds the age of the client as an explanatory variable. Column (3) adds the dummy variable Sex to the first regression. Column (4) shows a model in which we simultaneously control for age and sex of the client. Column (5) and (6) replicate the model from column (4) with a non-linear probit and logit model. For each variable we report the raw coefficients from the regression, together with robust standard errors in parentheses. For the probit and logit regression models we add the marginal effects in brackets. To give an indication about the model's goodness of fit, we report McFadden's  $R^2$  for the probit and logit models, as well as the  $R^2$  known from OLS. Definitions of the variables are provided in Appendix C.

*Source:* Own table, based on the LLB dataset.

Dependent variable	<i>Electronic banking adoption</i>					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance to headquarters (min)	0.005*** (0.00)	0.004*** (0.00)	0.005*** (0.00)	0.004*** (0.00)	0.011*** (0.00) [0.004]	0.018*** (0.00) [0.004]
Age		-0.004*** (0.00)		-0.004*** (0.00)	-0.011*** (0.00) [-0.004]	-0.018*** (0.00) [-0.004]
Sex			0.082*** (0.01)	0.074*** (0.01)	0.190*** (0.01) [0.074]	0.306*** (0.02) [0.074]
Constant	0.43	0.63	0.39	0.59	0.23	0.38
$R^2$	0.003	0.036	0.010	0.042		
Pseudo $R^2$					0.031	0.031
Observations	31'511	31'511	31'511	31'511	31'511	31'511
Method	OLS	OLS	OLS	OLS	Probit	Logit

ERobust standard errors in parentheses

Marginal effects for the probit and logit models in brackets

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

**Table D3.** Regression models distance to headquarters (min).

*Notes:* The dependent variable in this regression is Electronic banking adoption. Column (1) displays the model in which the distance to the headquarters in minutes operates as the sole explanatory variable. Column (2) adds the age of the client as an explanatory variable. Column (3) adds the dummy variable Sex to the first regression. Column (4) shows a model in which we simultaneously control for age and sex of the client. Column (5) and (6) replicate the model from column (4) with a non-linear probit and logit model. For each variable we report the raw coefficients from the regression, together with robust standard errors in parentheses. For the probit and logit regression models we add the marginal effects in brackets. To give an indication about the model's goodness of fit, we report McFadden's  $R^2$  for the probit and logit models, as well as the  $R^2$  known from OLS. Definitions of the variables are provided in Appendix C.

*Source:* Own table, based on the LLB dataset.

Dependent variable	<i>Electronic banking adoption</i>					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance to closest branch (km)	0.004*** (0.00)	0.004*** (0.00)	0.004*** (0.00)	0.004*** (0.00)	0.010*** (0.00) [0.004]	0.016*** (0.00) [0.004]
Age		-0.005*** (0.00)		-0.004*** (0.00)	-0.011*** (0.00) [-0.004]	-0.018*** (0.00) [-0.004]
Sex			0.082*** (0.01)	0.073*** (0.01)	0.189*** (0.01) [0.073]	0.305*** (0.02) [0.074]
Constant	0.48	0.67	0.44	0.63	0.33	0.54
$R^2$	0.001	0.035	0.007	0.040		
Pseudo $R^2$					0.030	0.030
Observations	31'511	31'511	31'511	31'511	31'511	31'511
Method	OLS	OLS	OLS	OLS	Probit	Logit

Robust standard errors in parentheses

Marginal effects for the probit and logit models in brackets

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

**Table D4.** Regression models distance to closest branch (km).

*Notes:* The dependent variable in this regression is Electronic banking adoption. Column (1) displays the model in which the distance to the closest branch in minutes operates as the sole explanatory variable. Column (2) adds the age of the client as an explanatory variable. Column (3) adds the dummy variable Sex to the first regression. Column (4) shows a model in which we simultaneously control for age and sex of the client. Column (5) and (6) replicate the model from column (4) with a non-linear probit and logit model. For each variable we report the raw coefficients from the regression, together with robust standard errors in parentheses. For the probit and logit regression models we add the marginal effects in brackets. To give an indication about the model's goodness of fit, we report McFadden's  $R^2$  for the probit and logit models, as well as the  $R^2$  known from OLS. Definitions of the variables are provided in Appendix C.

*Source:* Own table, based on the LLB dataset.

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