

From clicks to profits: how internet banking adoption drives Swedish bank profitability across different age groups

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Abstract

Purpose – This paper aims to understand the impact of the adoption of Internet banking (INB) on banks' profitability. It further investigates this relationship among different age groups of customers.

Design/methodology/approach – A large panel data set of 19 commercial banks in Sweden over the period of 2007–2022 is used, and both static models (ordinary least squares (OLS), fixed effect (FE)) and a dynamic model (generalized method of moments (GMM)) are applied to deal with potential concerns of unobserved heterogeneity and endogeneity.

Findings – The analysis of the data reveals that the adoption of INB is positively related to banks' profitability, but the magnitude of this relationship depends on the age of the customers. In particular, the effect is most pronounced for middle-aged and older customers (45–74 years old), which is inconsistent with the common assumption that young, digitally savvy customers are the main drivers of digital value in banking.

Practical implications – This research contributes to understanding the role of age in the digitalization–profitability link, which is relevant for bank managers and policymakers. These results imply that targeting digital services at middle-aged and older customers may be more likely to benefit banks' profitability. Additionally, policymakers can develop initiatives to facilitate digital inclusion among older age groups.

Originality/value – The paper extends previous research on the link between INB adoption and banks' profitability in one of the most digitalized societies in the world. It particularly explores the less investigated aspect of generational differences in INB adoption and its impact on bank profitability. To the best of our knowledge, this is also the first study within the Swedish context to investigate generational differences in INB adoption and its impact on banks' profitability.

Keywords Internet banking, Bank marketing, Customer segmentation, Bank profitability, GMM method, Sweden

Paper type Research article

1. Introduction

Technological advancements and evolving consumer behavior have greatly affected the banking sector, primarily through Internet banking (INB). Previous studies show that information technology is a key factor in gaining a competitive edge by better understanding customers' behavior, improving customer satisfaction and increasing loyalty (Karjaluoto *et al.*, 2015; Verhoef *et al.*, 2021). In addition, INB provides cross-selling opportunities and revenue generation (Pierri and Timmer, 2022), as well as improving on costs such as labor and



transaction costs (Zhai *et al.*, 2022). All these benefits suggest a positive impact of INB on the bank's profitability. However, empirical findings are not conclusive. While most of the previous research has established a positive effect of the internet on banking on banks' profitability (e.g. Del Gaudio *et al.*, 2021; Huang *et al.*, 2023), some have reported no significant effect or even an adverse effect (e.g. Beccalli, 2007; Onay and Ozsoz, 2013; Yang and Masron, 2024). Thus, the impact of INB on profitability is not straightforward (Citterio *et al.*, 2024; Manta *et al.*, 2024), requiring further exploration (Nguyen-Thi-Huong *et al.*, 2023).

In this context, the present study seeks to explore further this relationship in Sweden, one of the most digitally evolved societies in the world. Sweden is characterized by strong technological infrastructure, high levels of digital literacy and an early adoption of INB services (Podgorny and Volokhova, 2020). Almost all individuals 16–64 years of age have access to the internet (The Swedish Internet Foundation, 2024), making the country a digital pioneer.

Using a panel dataset of 19 Swedish commercial banks from 2007 to 2022, we examine the use of INB by different age groups (16–24, 25–34, 35–44, 45–54 and 55–74) and its influence on Swedish banks' profitability. INB in this study refers to bank customers' use of internet-connected devices to perform banking transactions. While traditionally associated with desktop or laptop computers, the term in today's context encompasses a broader range of devices, including mobile phones, tablets and internet-enabled televisions. This broad definition has been adopted in several prior studies (e.g. Alwan and Al-Zubi, 2016; Lee and Kim, 2020; Mohd Thas Thaker *et al.*, 2022; Rahi *et al.*, 2021; Sayar and Wolfe, 2007), which treat INB as a general indicator of customers' engagement with digital banking platforms, regardless of the specific device used. To capture the effect of INB on profitability, we include bank-specific controls, including capital adequacy, growth, age and size, as well as macro-level factors such as GDP, inflation, stock market capitalization (SMC), money supply (MSP) growth and banking sector development (BSD). We use static models (least squares (OLS) and fixed effects (FE)) and a dynamic model (generalized method of moments (GMM)) for analysis.

The results show a statistically significant, albeit modest, effect of INB adoption on profitability, mainly among middle-aged and older users (45–54 and 55–74). These findings challenge the common belief that younger, more digitally proficient customers drive profitability in INB. One explanation for this trend might be that younger customers, while more comfortable with INB, often use it for small-scale payments. In contrast, middle-aged and older customers are likelier to use INB for bigger payments such as mortgages, investments, or business-related services. Additionally, the results of this study highlight the importance of a bank's profitability history. That is, the current profitability of a bank is to some extent determined by its past profitability. This persistence of profitability implies that banks with a solid financial foundation are more likely to leverage the benefits of INB effectively.

Theoretical implications of this research lie in its contribution to digital banking and fintech, and more specifically, the generational perspective on INB adoption and its effect on profitability. It questions the hypothesis that digitalization benefits profitability across all ages and calls for re-examining the theoretical frameworks. This research also adds to the theories on market segmentation in the financial services sector by highlighting the limitations of traditional segmentation models that primarily rely on demographic factors such as age and income. Our findings emphasize the need for frameworks beyond simply categorizing individuals as tech-savvy or less familiar with technology. Instead, they should acknowledge each age group's user characteristics and engagement patterns. The result of this study also contributes to the literature on bank profitability by highlighting the importance of past profitability in determining current profitability. It also reveals that banks' internal factors, such as capital adequacy, are more critical in shaping banks' profitability than external factors such as macroeconomic or industry-specific factors.

The results of this study can also have important practical implications for managers and policymakers. For bank practitioners, it means that just increasing the number of online users may not necessarily lead to profitability for banks. Instead, banks should adopt a more targeted approach, particularly focusing on customers with more financial potential. This may include tailoring services and products to middle-aged and older customers, such as simplified mortgage applications or customized retirement plans. Moreover, the persistence of profitability revealed by this study highlights the importance of creating a strong financial foundation from the outset. That is, only adopting INB services alone does not guarantee profitability. Banks should view digitalization as an ongoing process rather than a one-time transition to online channels. The results can also benefit government officials and policymakers by recognizing the crucial role of middle-aged and older individuals in driving banks' profitability. In this regard, specific initiatives and policies can be developed to foster financial inclusivity and digital literacy among the middle-aged and elderly. Encouraging these demographics to engage in INB may lead to even broader economic benefits, such as higher savings rates and better access to credit.

In the following sections of this paper, a review of the previous findings and the hypotheses of this study are presented in [Section 2](#). [Section 3](#) explains the study's methodological approach, including the sample, econometric models and variables. [Section 4](#) presents the analysis results, and [Section 5](#) discusses the theoretical and practical implications of the findings and suggests directions for future research. The paper ends with a conclusion in [Section 6](#).

2. Literature review and hypotheses development

2.1 Internet banking adoption and bank profitability

Most previous studies have argued for and established a positive impact of INB adoption on banks' profitability. At the same time, some studies could not find a significant relationship. Previous studies have argued mainly that adoption of INB by consumers decreases costs and increases efficiency, enhancing banks' profitability ([Del Gaudio et al., 2021](#); [Huang et al., 2023](#); [Lee et al., 2021](#)). Furthermore, INB can help reduce information asymmetry and adverse selection risk, enhancing lending decisions and performance ([Agarwal and Hauswald, 2006](#)). For instance, [Pierri and Timmer \(2022\)](#) found that banks with higher levels of technology spend less on non-performing loans and have higher credit growth during the global financial crisis. Other researchers have also pointed out that digital channels can enhance the relationship with the customers and, in turn, the profitability ([Taiminen and Karjaluoto, 2015](#)). Similarly, the ability to serve multiple customer segments simultaneously with the help of digital platforms has been found to enhance bank performance ([Sheth et al., 2022](#); [Zhai et al., 2022](#)). Customers also benefit from reduced search costs and multiple communication channels, increasing satisfaction ([Verhoef et al., 2021](#)).

Furthermore, many previous studies have also tried to measure the impact of INB adoption and its influence on banks' profitability measures such as return on assets (ROA) or return on equity (ROE). The majority of these studies have also reported a positive influence of INB adoption on banks' financial performance, such as profitability (e.g. [Campanella et al., 2017](#); [Del Gaudio et al., 2021](#); [Dong et al., 2020](#); [Hernando et al., 2007](#); [Nguyen-Thi-Huong et al., 2023](#); [Rega, 2017](#); [Tunay et al., 2015](#)). These studies have been done within contexts with developed Internet infrastructure and contexts with less developed Internet infrastructure. For example, the studies by [Campanella et al. \(2017\)](#), [Del Gaudio et al. \(2021\)](#), and [Tunay et al. \(2015\)](#) on 28 European countries, or the study by [Rega \(2017\)](#) on 38 European banks have all established a positive impact of INB adoption on the banks' profitability.

Similar results have been reported from contexts with less developed Internet infrastructure. For example, [Binuyo and Aregbeshola \(2014\)](#) assessed the impact of IT on the performance of South African banks using annual bank data for 1990–2012. Their findings revealed that IT increased return on capital and ROA. [Nguyen-Thi-Huong et al. \(2023\)](#),

employing a dataset of 32 commercial banks in Vietnam from 2010 to 2021, found similar results. Specifically, a 1% increase in digitalization led to a 0.2%–0.6% increase in banks' profitability in Vietnam. The study by [Potapova et al. \(2022\)](#) on 16 Russian banks showed that banks with more transactions through digital channels have a higher ROA. In the study conducted by [Kumar \(2022\)](#) on Indian banks throughout 2009–2019, a positive correlation between the number of online transactions and the ROA was found. [Dong et al. \(2020\)](#) also reported that Chinese commercial banks have benefited from the development of Internet finance, promoting diversification and profitability.

However, some other studies could not establish a significant relationship between INB adoption and banks' profitability or even have reported a negative relationship (e.g. [Beccalli, 2007](#); [Onay and Ozsoz, 2013](#); [Martín-Oliver and Salas-Fumás, 2011](#); [Yang and Masron, 2024](#)). For example, [Beccalli \(2007\)](#) found a weak relationship between total IT investments and increased profitability or efficiency of banks, using a sample of 737 European banks from 1995 to 2000. Similarly, [Martín-Oliver and Salas-Fumás \(2011\)](#) found no evidence that investments in IT increase the demand for loans or the supply of deposits. Previous studies have also reported negative influences of INB on profitability (e.g. [Arora and Arora, 2013](#); [Ho and Mallick, 2010](#); [Onay and Ozsoz, 2013](#); [Yang and Masron, 2024](#)). For example, [Onay and Ozsoz \(2013\)](#) analyzed the Turkish market and showed that the adoption of INB undermines profits because of increased competition, leading to lower interest income. [Yang and Masron \(2024\)](#), using data from 118 Chinese banks from 2014 to 2021, found that banks' digital transformation hurt their profitability to some extent. Some studies, such as [Xiang and Jiang \(2023\)](#) on Chinese banks or [Shanti et al. \(2023\)](#) on Indonesian banks, have reported a nonlinear relationship, that is, a deterioration of profitability in the short run due to the huge IT investment.

Thus, previous studies reveal that while adopting INB can increase banks' profitability, this is not true in all contexts. In this regard, [Dewan and Kraemer \(2000\)](#) conducted a country-level analysis to find out how an investment in IT affects firms in developed countries vis-à-vis developing countries. Their study concluded that IT investments increased firms' productivity in developed countries, which is supplemented by well-developed human capital and infrastructure. On the other hand, the lack of supporting infrastructure can lead to inefficient utilization of IT investments in developing countries.

Applying these insights to the Swedish context suggests that INB may positively impact bank profitability due to the country's highly developed digital infrastructure and strong technological foundation. Sweden is a leading example of a country with a robust technological infrastructure, widespread digital literacy and an early track record of adopting digital banking services ([Podgorny and Volokhova, 2020](#)). Almost all the Swedish population has access to the internet, and 90% use payment apps ([Internet Stiftelsen, 2024](#)). The combination of robust infrastructure and tech-savvy consumers has enabled a comprehensive digitalization of the banking sector over recent decades ([Copenhagen Economics, 2019](#)). This transformation has led to a sharp decline in cash usage ([Sveriges Riksbank, 2025](#)) and greater reliance on electronic payment systems ([Arvidsson, 2019](#)).

In parallel, Swedish banks operate in a highly competitive market with low switching barriers and high customer mobility. Between 2017 and 2022, Sweden recorded the highest share of consumers in the EU who changed financial service providers ([Copenhagen Economics, 2025](#)). This competitive pressure incentivizes continuous innovation and operational efficiency. For example, operational costs as a percentage of total assets were 0.4 percentage points below the European average in 2017—a trend primarily driven by customers' increasing use of digital banking channels over branch-based services ([Copenhagen Economics, 2019](#)). Despite relatively low lending margins, Swedish banks maintain strong profitability through efficiency gains and diversified revenue streams ([Copenhagen Economics, 2025](#)).

Therefore, based on prior studies that primarily report a positive relationship between INB and bank profitability, and considering Sweden's advanced digital banking environment, we propose the following hypothesis:

- H1. The adoption of Internet banking in Sweden increases the profitability of Swedish banks.

2.2 Internet banking adoption across age groups

One of the main demographic factors influencing the adoption of technological advancements such as INB is the user's age. Most previous studies have found a negative relationship between age and the likelihood of adopting a new technology (e.g. [Chung et al., 2010](#); [Czaja and Sharit, 1998](#); [Kolodinsky et al., 2004](#); [Morris and Venkatesh, 2000](#)). Similar results have been reported regarding the adoption of INB (e.g. [Narteh and Owusu-Frimpong, 2011](#); [Sum Chau and Ngai, 2010](#); [Treiblmaier et al., 2006](#)). For example, [Sum Chau and Ngai \(2010\)](#), in a study of university students, found that young people (age 16–29) had more positive attitudes and a tendency towards using INB than other user groups. Similarly, [Treiblmaier et al. \(2006\)](#), in a study on online banking, found that service quality had a more substantial impact on satisfaction for younger people than older adults.

Moreover, younger customers are widely regarded as future consumers ([Foscht et al., 2010](#)). While their current disposable incomes may be relatively modest, their discretionary incomes are often higher, giving them more flexibility in non-essential spending ([Sum Chau and Ngai, 2010](#)). Therefore, attracting and engaging this segment is a forward-looking strategy for financial institutions aiming to build long-term customer value. By investing in relationships with younger customers today, banks can lay the foundation for more profitable relationships in the future as these individuals progress through life stages involving increased income, borrowing, saving and investment needs.

Establishing strong early relationships with young customers also creates opportunities for cross-selling additional financial products and services over time. Prior research suggests that early engagement often leads to higher customer lifetime value, as the initial relationship becomes a gateway to deeper, more comprehensive financial involvement ([Martensen, 2007](#); [Foscht et al., 2010](#); [Thwaites and Vere, 1995](#)). From a marketing perspective, INB provides an accessible and cost-effective channel through which banks can attract and retain younger users, cultivating future revenues by embedding the bank into their financial routines from an early age ([Sum Chau and Ngai, 2010](#); [Lewis and Bingham, 1991](#); [Thwaites and Vere, 1995](#)).

In addition, younger individuals are typically more technologically proficient and adept at navigating digital environments. This makes them early adopters of INB services and positions them as influencers within their households and social networks. As [Foscht et al. \(2010\)](#) note, young people often help older consumers—such as parents or grandparents—navigate digital services, indirectly influencing other demographic groups' adoption decisions. Their role as both users and digital intermediaries further enhances the strategic importance of engaging younger customers in the context of digital banking.

Therefore, against this backdrop, and based on these age-related differences in terms of technology adoption and usage, we propose the second hypothesis as follows:

- H2. The impact of Internet banking adoption on bank profitability varies by age group, with younger users exerting a more positive influence on profitability.

3. Research methodology

3.1 Sample

The sample for this study was taken from the Swedish banking sector, which includes commercial banks, foreign banks, savings banks and cooperative banks. However, we only

concentrate on commercial banks. Bank-specific data were collected from the annual reports of these institutions; we got detailed information on income statements and balance sheets. We excluded banks with less than ten years of data and any missing cases to deal with missing data and outliers. The final sample includes 19 commercial banks from 2007 to 2022, which provides 304 observations. In addition, macroeconomic indicators and industry-specific data were collected from credible institutions such as Statistics Sweden (SCB) and the Swedish Central Bank (Riksbanken) to ensure that both micro- and macro-level factors were incorporated in our analysis. This robust dataset can be used to demonstrate the dynamics of bank profitability properly.

3.2 Econometric model

To evaluate the impact of both internal and external factors on bank profitability, we first use a linear model as our baseline model, which is commonly employed in the literature (Athanasoglou *et al.*, 2008; Dietrich and Wanzenried, 2011; García-Herrero *et al.*, 2009). This baseline model is presented by Equation (1), where.

- (1) Π_{it} is the profitability of bank i at time t ,
- (2) c is the constant term,
- (3) INB_t captures the effect of internet banking with coefficient β_1 ,
- (4) X_{it} is a vector of bank-specific variables with coefficient β_2 ,
- (5) Z_t represents macroeconomic and industry-specific variables with coefficient β_3 and
- (6) ε_{it} is the error term accounting for other unobserved factors.

$$\Pi_{it} = c + \beta_1 INB_t + \beta_2 X_{it} + \beta_3 Z_t + \varepsilon_{it} \quad (1)$$

As unobserved time-invariant factors, such as the specific bank or institutional characteristics, may also have a bearing on profitability, we proceed further with our analysis by estimating a FE model. Equation (2) is shown below to incorporate this control, where α_i is the bank-specific FE:

$$\Pi_{it} = \alpha_i + \beta_1 INB_t + \beta_2 X_{it} + \beta_3 Z_t + \varepsilon_{it} \quad (2)$$

Furthermore, previous studies have shown that banks' profits persist over time (Dietrich and Wanzenried, 2011; Klein and Weill, 2022; Trujillo-Ponce, 2013). To account for this, we include a lagged dependent variable in our model, which makes it a dynamic panel model. Thus, traditional least squares estimation techniques are inappropriate for this situation since they lead to biased and inconsistent estimates (Baltagi, 2001). Moreover, there is also concern for endogeneity. For example, more profitable banks may have the ability to hold earnings and strengthen their equity base (García-Herrero *et al.*, 2009). Thus, to account for the dynamic nature of banks' profitability and endogeneity issues, we employ the GMM estimator by Arellano and Bover (1995), which uses lagged levels and differences as instruments to solve the endogeneity problem. Equation (3) specifies the dynamic model as given by Π_{it-1} – one period lag of profitability – and λ , the speed of adjustment to equilibrium, within the range of 0 and 1.

$$\Pi_{it} = c + \lambda \Pi_{it-1} + \beta_1 INB_t + \beta_2 X_{it} + \beta_3 Z_t + \varepsilon_{it} \quad (3)$$

The GMM is our primary estimation strategy in this study, and the OLS and FE models are presented only as a baseline comparison.

3.3 Variables

Table 1 presents the variables used in the study. Bank profitability is measured by ROA, a popular measure that indicates the effectiveness of a bank in creating value from its assets (Almaqtari *et al.*, 2019; Athanasoglou *et al.*, 2008). The primary independent variable is the adoption of INB, defined as the share of the population of Sweden aged 16–74 who used INB services within the last three months. This includes INB services received through different devices such as computers, mobile phones, tablets and other digital platforms. Similar approaches are found in studies of digital transformation and banking profitability (e.g. Xiang and Jiang, 2023), where market-level mobile or Internet usage rates are used as proxies for digital readiness. While this is a macro-level indicator and not bank-specific, it reflects the broader digital maturity of the market — a key environmental factor influencing banks' service delivery models, customer engagement strategies, and ultimately, profitability. To further reduce the abstraction, we also use the rate of the adoption of INB services segmented by

Table 1. List of variables

Variable	Definition	Proxy/measurement
ROA	Profitability	Return on Assets (ROA): Net Income/Total Assets
CAP	Capital Ratio of the bank	Equity/Total Assets
GRW	Revenue growth rate	Percentage change in total revenue
SIZ	Size of the bank	Natural logarithm of total assets
AGE	Age of the bank	Natural logarithm of years since establishment
GDP	Real GDP	Inflation-adjusted GDP (economic output)
INF	Inflation	Change in Consumer Price Index
SMC	Stock Market Capitalization	Ration of total market cap over GDP
MSP	Broad money supply (M3)	Growth of cash, deposits, and other liquid assets
BSD	Banking Sector Development	Banks Total Assets/GDP
INB	Internet Banking	Percentage of individuals in Sweden aged 16–74 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms
INB 16–24	Internet Banking among 16–24	Percentage of individuals in Sweden aged 16–24 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms
INB 25–34	Internet Banking among 25–34	Percentage of individuals in Sweden aged 25–34 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms
INB 35–44	Internet Banking among 35–44	Percentage of individuals in Sweden aged 35–44 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms
INB 45–54	Internet Banking among 45–54	Percentage of individuals in Sweden aged 45–54 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms
INB 55–74	Internet Banking among 54–74	Percentage of individuals in Sweden aged 54–74 who reported using Internet banking services within the last three months. This includes banking conducted via internet-connected devices such as computers, mobile phones, tablets, and other digital platforms

Source(s): Authors' own work

different age groups of 16–24, 25–34, 35–44, 45–54 and 55–74 represented respectively by variables INB16–24, INB 25–34, INB 35–44, INB 45–54 and INB 55–74 in Table 1. This allows us to relate changes in adoption among key demographic segments to bank profitability, acknowledging that banks may differ in their age-based customer composition and marketing focus.

Moreover, our model includes bank-level and macro-level control variables. Concerning the bank-level factors, we use capital adequacy (CAP), revenue growth (GRW), bank size (SIZ) and age (AGE). The research suggests that a higher capital ratio is linked with higher profitability (Borio *et al.*, 2017; Charitou, 2019; Dietrich and Wanzenried, 2011; Goddard *et al.*, 2004; Hutchison and Cox, 2007). The impact of bank size on profitability is somewhat unclear; some studies report a positive relationship between the two (Borio *et al.*, 2017; Demirgüç-Kunt and Huizinga, 1999; Goddard *et al.*, 2004), while other studies indicate that profitability increases initially with size and then decreases (Athanasoglou *et al.*, 2008; Cardone-Riportella *et al.*, 2013). Likewise, the impact of a bank's age on its performance is also not well established; some works establish positive impacts (Berteji and Hammami, 2016), while other works show that new banks are more efficient than old banks (Beck *et al.*, 2005; Dietrich and Wanzenried, 2011). Another critical factor is revenue growth; it is widely accepted that higher revenue growth would enable a bank to secure more resources and hence gain competitive advantages that lead to higher profitability (Demirgüç-Kunt and Huizinga, 2001; Doumpos *et al.*, 2016; Goddard *et al.*, 2004; Lepetit *et al.*, 2008).

For macro-level variables, inflation (INF), real GDP (GDP), the growth of MSP, the SMC and the development of the banking sector (BSD) are included in the model. Econometric studies have established a positive relationship between economic growth and profitability by enhancing credit expansion, investment, and borrowers' risk quality (Athanasoglou *et al.*, 2014; Bikker and Hu, 2002; Demirgüç-Kunt and Huizinga, 2001). However, the link between inflation and profitability has been somewhat complicated; some works report a positive relationship between the two variables (Dietrich and Wanzenried, 2014), while others (e.g. Goddard *et al.*, 2011) find no significant effect. Similarly, findings regarding the impact of MSP on bank profitability are inconclusive. Some researchers have reported a positive impact of MSP on banks' profitability (e.g. Haron, 1996), while others established a negative relationship. Previous findings regarding the effect of SMC on banks' profitability have been both positive (e.g. Pasiouras and Kosmidou, 2007) and negative (e.g. Bikker and Hu, 2002; Dermiguc-Kunt and Huizinga, 2001). Lastly, the sophistication of the banking sector, captured through a measure of BSD, is posited to support better bank performance by expanding market opportunities, enhancing resource utilization and promoting innovation (Tan and Floros, 2012a, b; Tan, 2016).

4. Data analysis and results

4.1 Descriptive statistics

The descriptive statistics for all the variables are shown in Table 2. As such, the mean ROA is approximately 0.018 with a relatively low standard deviation; however, there is significant variation in the minimum and maximum values. This means that while all the banks have positive returns, some have had better growth and others have had worse results at some points in time. The mean of the capital adequacy (CAP) is about 0.12, which indicates that the banks are on average well capitalized, and the size (SIZ) measure has a broader spread, which is in line with the diverse operational sizes in the sample. The data on age (AGE) and revenue growth (GRW) also show heterogeneity, thus indicating the existence of both small and large firms, some relatively young and others that have grown relatively fast. Macro-economic factors include GDP growth, which is highly volatile, to capture substantial growth and weak growth periods. Inflation (INF) is moderately high on average but has very high variation, which means that some years were more volatile than others. BSD and MSP growth (MSP) are other factors that have been used, and they are pretty wide. The adoption of INB averages

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ROA	304	0.018	0.04	-0.009	0.525
CAP	304	0.12	0.089	0.005	0.834
GRW	304	0.113	0.319	-0.58	3.336
SIZ	304	23.974	2.352	19.375	28.686
AGE	304	3.879	1.052	1.386	5.273
GDP	304	2.856	4.325	-5.800	11.200
INF	304	1.725	2.057	-0.500	8.400
SMC	304	126.597	31.582	65.97	207.95
MSP	304	7.325	4.219	1.800	16.300
BSD	304	2.202	0.255	1.757	2.852
INB	304	78.812	7.944	57.000	87.000
INB 16 24	304	68.875	5.598	57.000	78.000
INB 25 34	304	90.312	4.126	79.000	95.000
INB 35 44	304	88.062	6.139	69.000	93.000
INB 45 54	304	83.562	10.184	58.000	96.000
INB 55 74	304	67.938	14.817	35.000	84.000

Source(s): Authors' own work

78.812, reflecting Sweden's advanced digital infrastructure. The adoption of INB shows the lowest variance among the age group of 25–34, while the highest variance is among the oldest age group, 55–74, which varies between 35 and 84%.

Figures 1 and 2 further compare the trends in INB adoption against the average ROA of the banks. In the sample period, INB increased steadily in Sweden, which is known for its digital advancement. In Figure 1, ROA first declines sharply with the 2008 financial crisis, while digital adoption keeps increasing. Starting in 2013, profitability improved but did not always follow the increasing trend of digital adoption. This gap means that while INB usage may have advantages, other economic factors and bank characteristics also affect profitability. Figure 2 demonstrates the adoption of INB by different age groups.

4.2 Correlation

The correlation matrix in Table 3 shows several interesting features. For example, the correlation between bank size (SIZ) and ROA is slightly negative, which means that just being large does not have to result in better performance. The highest correlation with profitability (ROA) is shown for capital ratio (CAP), which means that higher-capitalized banks can be more profitable. Macroeconomic and industry-specific variables like GDP, INF, MSP and BSD are also moderately correlated with each other and the bank-level factors, indicating the multiple causes of profitability.

Notably, the measures of INB adoption by age (INB 16–24, INB 25–34, INB 35–44, INB 45–54 and INB 55–74) are highly correlated with each other since the overall INB adoption is increasing with all demographics. While high correlations are usually considered to indicate multicollinearity issues, Internet adoption for different age groups is individually included in the model. Thus, it will not create a problem of multicollinearity. The correlations between other variables are below the critical value of 0.8, indicating no severe issue of multicollinearity (Gujarati and Porter, 2009; Kennedy, 2008).

4.3 Regression analysis

Table 4 presents the regression results regarding the effect of INB adoption on the profitability of Swedish banks using three estimation methods: OLS, FE and GMM, while Figure 3 shows

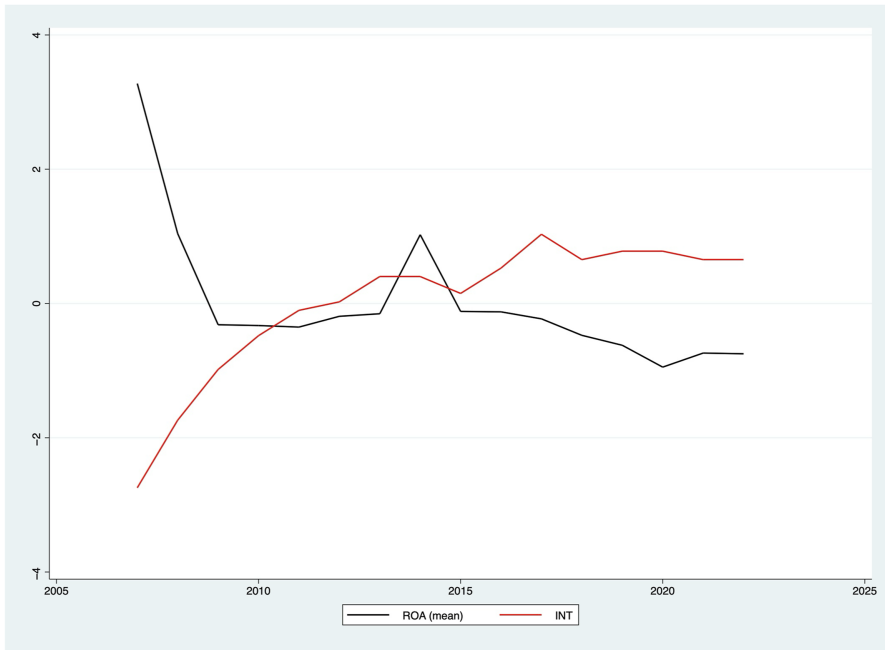


Figure 1. Adoption of internet banking in relation to banks profitability. **Source(s):** Authors' own work

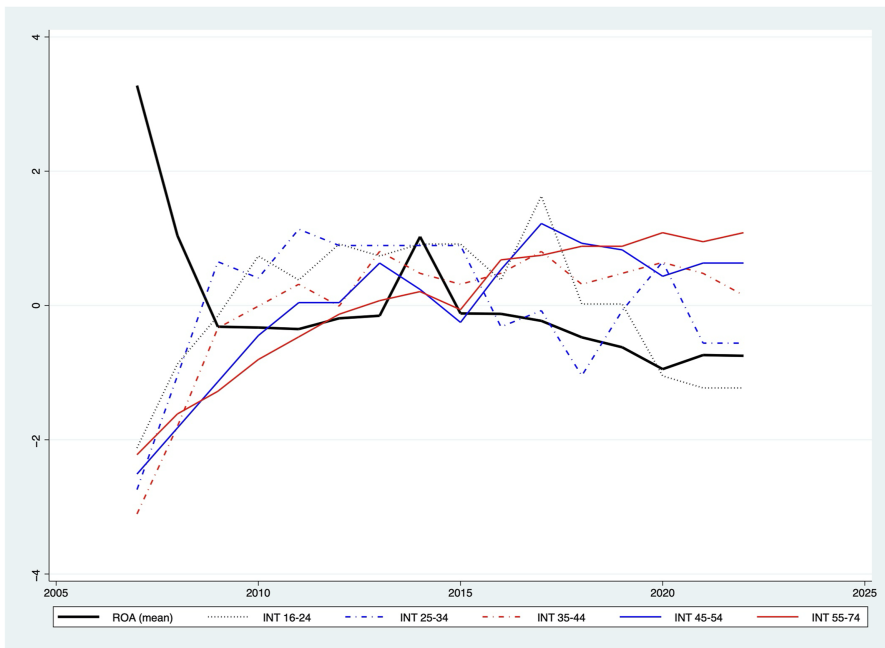


Figure 2. Adoption of internet banking in relation to banks profitability across different age-groups. **Source(s):** Authors' own work

Table 3. Matrix of correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) ROA	1.000															
(2) CAP	0.682***	1.000														
(3) GRW	0.275***	0.058	1.000													
(4) SIZ	-0.220***	-0.568***	-0.006	1.000												
(5) AGE	-0.314***	-0.053	-0.160***	-0.186***	1.000											
(6) GDP	0.026	0.043	-0.018	0.026	0.023	1.000										
(7) INF	-0.013	0.004	0.034	0.057	0.035	0.017	1.000									
(8) SMC	-0.082	-0.015	-0.018	0.145**	0.113**	0.418***	0.024	1.000								
(9) MSP	0.078	0.086	-0.001	0.026	0.024	0.145**	0.191***	0.463***	1.000							
(10) BSD	-0.093	-0.039	-0.090	0.097	0.079	-0.080	-0.007	0.204***	-0.118**	1.000						
(11) INB	-0.178***	-0.101	-0.065	0.167***	0.129**	0.093	-0.001	0.578***	-0.179***	0.641***	1.000					
(12) INB 16 24	-0.073	-0.068	-0.070	0.005	0.008	0.058	-0.460***	-0.218***	-0.637***	0.518***	0.465***	1.000				
(13) INB 25 34	-0.132**	-0.112	-0.052	0.034	0.023	-0.186***	-0.420***	-0.035	-0.637***	0.178***	0.505***	0.683***	1.000			
(14) INB 35 44	-0.188***	-0.117**	-0.073	0.139**	0.106	0.053	-0.182***	0.447***	-0.404***	0.576***	0.947***	0.608***	0.717***	1.000		
(15) INB 45 54	-0.169***	-0.099	-0.058	0.162***	0.125**	0.128**	0.042	0.543***	-0.190***	0.642***	0.982***	0.470***	0.426***	0.917***	1.000	
(16) INB 55 74	-0.163***	-0.082	-0.052	0.183***	0.141**	0.107	0.147**	0.696***	0.044	0.588***	0.957***	0.219***	0.280***	0.827***	0.941***	1.000

Note(s): *** $p < 0.01$, ** $p < 0.05$

Source(s): Authors' own work

Table 4. The effect of Internet banking on banks profitability

	OLS	FE	GMM
L.ROA			0.360***
CAP	0.340***	0.432***	0.144
GRW	0.025***	0.019	0.018**
SIZ	0.003***	-0.012*	-0.003
AGE	-0.007***	-0.028*	-0.005
GDP	0.000	-0.000	0.000
INF	-0.000	0.000	-0.000
SMC	-0.000	0.000	-0.000
MSP	0.000	0.000	0.000
BSD	0.001	-0.001	-0.002
INB	-0.000	0.001***	0.001*
Cons	-0.050*	0.308**	0.046
R-square	0.60	0.74	
F value	45.78	210.17	
F (sig)	0.000	0.000	
Wald χ^2 (11)			519.61
Hansen test (p-value)			1.000
AB test AR (1) (p-value)			0.173
AB test AR (2) (p-value)			0.369
n	304	304	285

Note(s): *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source(s): Authors' own work



Figure 3. The coefficients of variables across the three analyze models. **Source(s):** Authors' own work

the corresponding coefficients for each variable. The GMM results indicate a positive but marginally significant relationship ($p < 0.10$) between INB adoption and bank profitability. This provides tentative support for [Hypothesis 1](#). The FE model produces stronger statistical significance. Still, it does not account for the persistence of profitability over time and is therefore interpreted as a robustness check rather than the primary estimator.

Among the control variables, capital adequacy (CAP) is positively related to ROA in both OLS and FE. Still, its significance is reduced in the GMM specification, probably because of the dynamic nature of the model and the larger number of instruments. Growth (GRW) has a substantial positive impact on OLS profitability. At the same time, size (SIZ) and age (AGE) have mixed effects across specifications, which may be attributable to the fact that these variables affect banks' performances differently. In particular, the GMM model includes the lagged dependent variable (L.ROA), which is strongly significant, indicating that bank profitability is persistent over time.

Macroeconomic and industry-specific factors like GDP, inflation (INF), SMC, MSP and BSD have generally small or insignificant coefficients, which means that in the short run, at least, within the sample period, profitability may be relatively insensitive to these broader indicators.

Therefore, our findings suggest that INB adoption may enhance bank profitability, though the evidence is statistically weaker under the preferred GMM model. The difference between the OLS model and the more sophisticated FE and GMM models also suggests that controlling for unobserved heterogeneity and the persistence of profitability is essential.

[Table 5](#) shows the results of FE and Generalized Method of Moments (GMM) regarding the effects of INB adoption across various age cohorts on bank profitability. FE and GMM are preferred here, as these models provide the best solution to the primary methodological problems. FE addresses time-invariant bank-specific heterogeneity and GMM uses a lagged dependent variable and instrumental variables to tackle endogeneity. In combination, they provide a more accurate and timelier picture of how age-specific INB adoption affects banks' profitability.

The results show that some age groups are more influential than others in affecting profitability. For instance, the middle-aged and older groups (e.g. INB45–54, INB55–74) have positive and significant coefficients in both FE and GMM models, which means that INB usage within these groups is more in sync with higher returns on assets. On the other hand, the younger cohorts (e.g. INB16–24) either fail to reach statistical significance or have weaker effects. Hence, in this sample, it can be inferred that the older age groups may be more critical in enhancing banks' profitability through INB adoption. This is against our second hypothesis, which had predicted a positive relationship between the adoption of INB among younger age groups and banks' profitability. Therefore, the second hypothesis of our study is not supported by these empirical results.

The control variables behave as expected for the most part. Capital adequacy (CAP) and growth (GRW) are positively related and statistically significant with bank profitability. This is consistent with the expectation that relatively well-capitalized and growing banks will likely enjoy higher returns. Size (SIZ) and age (AGE) have incongruent signs and levels of significance, which means that large or older firms may have certain advantages. The macroeconomic factors are either significant or not significant at all. While the overall economic environment is essential, bank-specific factors are more critical in explaining profitability differences.

5. Discussion

The findings of this study reveal a complex link between the adoption of INB and the profitability of banks in Sweden. Our findings indicate that INB adoption may improve bank profitability; however, the statistical support is relatively weak under the preferred GMM specification. This highlights the need for further research using more detailed or granular data, ideally at the bank or customer level, to validate and extend these results.

Table 5. The effect of Internet banking on banks profitability across different age groups

	FE	GMM	FE	GMM	FE	GMM	FE	GMM	FE	GMM
L.ROA		0.337***		0.343***		0.316***		0.450***		0.462***
CAP	0.435***	0.093	0.435***	0.070	0.434***	0.109**	0.433***	0.068	0.430***	0.016**
GRW	0.018*	0.022	0.019*	0.024*	0.018*	0.021	0.019	0.021***	0.019	0.026
SIZ	-0.012*	-0.001	-0.012*	-0.001	-0.012*	-0.000	-0.012*	-0.003	-0.013*	-0.008
AGE	-0.024	-0.003	-0.024	-0.004	-0.026	-0.004	-0.027*	-0.003	-0.029*	-0.006*
GDP	-0.000*	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000
INF	0.001**	0.000	0.001**	-0.000	0.001**	-0.000	0.001	-0.000	0.000	0.000
SMD	0.000**	0.000	0.000*	0.000	0.000	-0.000	0.000	-0.000	0.000	0.000
MSP	0.000	0.000	0.000	-0.000	0.000	0.000	0.000	0.000	0.000	-0.000
BSD	0.000	-0.001	0.007	0.003	0.002	0.001	-0.000	-0.002	-0.000	0.000
INB 16-24	0.001**	0.000								
INB 25-34			0.000	0.000						
INB 35-44					0.001**	0.000				
INB 45-54							0.000**	0.000**		
INB 55-74									0.000**	0.000*
Cons	0.273*	-0.003	0.267*	0.013	0.277*	-0.003	0.313**	0.057	0.345**	0.206
R-square	0.74		0.74		0.74		0.74		0.74	
F value	203.73		207.21		211.92		217.73		218.44	
F (sig)	0.000		0.000		0.000		0.000		0.000	
Wald χ^2 (11)		374.85		585.39		313.05		469.00		1412.92
Hansen test (p-value)		1.000		1.000		1.000		1.000		1.000
AB test AR (1) (p-value)		0.174		0.161		0.200		0.126		0.116
AB test AR (2) (p-value)		0.456		0.633		0.460		0.790		0.577
n	304	285	304	285	304	285	304	285	304	285

Note(s): *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source(s): Authors' own work

The results also reveal that the impact of INB on bank profitability varies across different customer segments. Our findings challenge the assumption that younger individuals—typically more technologically adept—are the primary drivers of digital banking success. Instead, the results indicate that middle-aged and older groups, particularly those aged 45–54 and 55–74, are more strongly associated with increased bank profitability. While younger individuals may adopt digital platforms more quickly, this enthusiasm does not appear to translate into higher profitability for banks. Younger users may engage readily with digital banking tools. Still, they are less likely to be involved in high-value transactions—such as mortgages, investment products or business loans—that substantially impact profitability. In contrast, mature individuals are often at the peak of their earning potential or approaching retirement, with greater disposable income available for deposits, investments, or credit-based services. Thus, INB adoption among these older age groups may directly influence revenue generation through service fees, interest margins and relationship-based banking.

The findings provide insights into how demographic elements intersect with INB usage to influence financial results. While the coefficients for INB adoption—both in total and across age groups—are small in magnitude, the consistent positive direction and statistical significance across models suggest that digitalization still plays a meaningful, if incremental, role in enhancing bank profitability. These minor effects may accumulate over time or be more pronounced when adopted at scale across multiple customer segments. In the following sections, these findings’ theoretical and practical implications will be further discussed, and suggestions for future research will be provided.

5.1 Theoretical contribution

The findings of this study add to the growing body of research on digital banking and fintech. They question the idea that technology adoption and financial success can be generalized universally. While previous research suggests that younger individuals are more likely to bring results for service providers due to their familiarity with platforms in most consumer markets (e.g. Czaja and Sharit, 1998; Kolodinsky *et al.*, 2004; Treiblmaier *et al.*, 2006), this study reveals a more intricate scenario within the banking industry. Younger individuals may embrace banking tools readily but might not yet be involved in substantial transactions like mortgages or business loans that significantly impact a bank’s profitability. On the other hand, older individuals are often at their peak earning stage or nearing retirement age, with higher disposable income for investments. The use of technology could potentially influence revenue from fees and services and impact the growth of deposits or lending activity for users in various stages of life and contexts, according to enhanced models of technology adoption currently in place.

Moreover, our findings highlight the significance of time-invariant and time-dependent variables in determining banks’ profitability. The GMM model in this study demonstrates that previous successes or failures influence profitability and tend to continue in a similar direction. According to frameworks such as the resource-based view (Barney, 1986; Hamel and Prahalad, 1996) and dynamic capabilities perspectives (Loasby, 1998; Teece *et al.*, 1997), it is suggested that banks accumulate skills over time to adjust to changes and enhance their edge. Banks that effectively integrated INB channels could use their knowledge to consistently improve their services to build customer trust and streamline operations. This accumulated edge becomes particularly powerful when tailored to match customers’ behaviors. The underlying idea is that digital transformation goes beyond adopting technology; it’s a process influenced by demographic factors. Banks that grasp this dynamic can effectively utilize platforms to achieve enduring improvements in performance levels.

The research also contributes to discussions regarding market segmentation within the financial services sector by addressing the limitations of segmentation theories that mainly focus on demographic factors like age and income levels without accounting for the diverse digital behaviors among different age groups. Our results indicate the necessity for

frameworks to not just distinguish between individuals who are tech savvy from those who are less familiar with technology, but also to recognize the varied user characteristics within each age group.

5.2 Practical implications

The findings of this study go beyond theory and have real-world implications. For banks and their managers to maximize the benefits of embracing INB services effectively, it doesn't just mean attracting online users in general. Focusing on increasing the number of online users exclusively for better returns would be an easy solution. The findings of this study propose a more strategic approach. It suggests that banks could see profitability by targeting customer segments that promise significant gains. In practice, this would involve tailoring products and services to appeal to middle-aged and older customers through offering customized solutions, like simplified mortgage applications or specialized retirement planning tools that cater to their needs. Customers who tend to make transactions or hold account balances are more likely to bring in higher fee income and opportunities for cross-selling products and services than younger customers who may not have as much accumulated wealth or engage with high-value financial products.

Furthermore, the persistence of banks' profitability discovered in this study highlights the significance of setting up a solid foundation from the start. Financial institutions that have succeeded with their platforms can utilize these capabilities to stay in the competition. This could involve utilizing customer data analysis to enhance user experiences, retain customers, or even create digital products that cater to emerging market demands. This indicates that digital evolution should be seen as a process of enhancement rather than a one-time shift to online channels. To keep up with advancements and stay ahead of the curve, managers might have to allocate resources towards staff training, enhancing cybersecurity defenses and acquiring data analytics solutions in the banking industry.

Government officials could also learn lessons from these findings in nations like Sweden, with significant Internet usage and tech proficiency among citizens. Recognizing the importance of middle-aged and elderly individuals for banks' profitability could shape governmental policies for promoting financial inclusivity and enhancing digital literacy initiatives. For instance, encouraging middle-aged and older adults to utilize digital platforms may yield wider economic advantages, such as increasing savings rates and facilitating better credit accessibility, while ensuring that young customers stay interested in INB services.

5.3 Limitations and future research

While this research has made significant theoretical and practical contributions, it also has some limitations that should be noted. Firstly, the analysis is limited to banks within the Swedish context. Although Sweden is an ideal setting for exploring INB due to its strong digital literacy and technological infrastructure, the country's unique traits may restrict the applicability of the results to other contexts. Other nations with varying Internet penetration rates, different regulations in place and diverse cultural perspectives on banking could show differing trends in usage and financial success. Future studies could explore this by researching other developed countries or growing economies to see if these demographic impacts are consistent across different contexts.

The other limitation of this study comes from its applied measure of profitability, i.e., ROA. While ROA is typically used to evaluate how effectively a bank leverages its assets to generate income, it does not always capture the entirety of performance dimensions. Additional indicators like ROE, net interest margin (NIM) and the cost-to-income ratio offer insights into different aspects of financial performance. Exploring profitability from these angles could help determine if specific age groups play a role in generating fee-based income or interest revenue, while also reducing costs through INB settings. Researchers could also explore other metrics, like customer satisfaction levels and brand reputation, to better grasp the overall impact of INB.

Another limitation stems from the temporal frequency of our data. While quarterly data could potentially enhance the robustness of our results and address sample size constraints, such data are not systematically available for the Swedish banking sector during our study period. Specifically, INB adoption rates are only surveyed annually by Statistics Sweden, and several banks in our sample only report comprehensive financial data on an annual basis. Future research with access to higher-frequency data could provide additional insights into the short-term dynamics between INB adoption and bank profitability. For instance, quarterly observations might reveal seasonal patterns in INB usage or allow for more nuanced analysis of how quickly banks can translate increased digital adoption into improved financial performance. Researchers in markets with more frequent data collection could test whether our findings regarding age-specific adoption effects hold at shorter time intervals.

The INB service adoption measure used in this study reflects market-level adoption patterns rather than bank-specific digital usage rates. This may create a degree of abstraction when linking digitalization to individual bank outcomes. However, these variables capture the broader digital environment that affects all banks and can influence strategic responses such as marketing investments, digital transformation and product delivery. Future research with access to bank-specific digital usage data could further refine these relationships. Another limitation of the measure used in this study is that it does not differentiate between the channels through which INB services are received, such as desktop or mobile banking app usage.

Moreover, our INB analysis also considers the proportion of people in age groups who use INB but does not account for how deeply they engage with it. The level of involvement with services can vary significantly among people of the same age range. Some individuals may monitor their accounts regularly to handle bill payments online and use tools such as budget planners and investment platforms. In contrast, others might only log in from time to time. Future research could include more detailed data, such as how often transactions occur or the typical transaction amount, to see if more involvement leads to increased profits. This information could also shed light on whether specific age groups are inclined towards participating in financial tasks through online platforms and how this affects a bank's success.

Using FE and GMM models helps us tackle unobserved heterogeneity and endogeneity; however, it's worth noting that no method is flawless, as there are limitations to consider. GMM estimations require instruments; if these instruments are weak or correlated with the error term, the estimates may become biased. To ensure validity and check for correlation, we have carried out standard tests, like the Hansen and Arellano–Bond tests (AB); yet, future studies could explore different estimation methods or enhance the instrument set to bolster causal interpretations. Moreover, the apparent relationship between middle-aged and older individuals' use of INB services and banks' profitability might be influenced by hidden factors associated with adopting technology and financial choices. For instance, older adults open to banking services may possess financial knowledge, greater economic stability, or a more hands-on approach to managing their finances than peers who do not embrace digital solutions. This bias in selection could magnify the perceived relationship between adoption and financial gains. Future studies may also trace how customers switch to INB services to provide a more accurate understanding of the impacts of embracing digital technologies.

6. Conclusion

In conclusion, this study shows that INB adoption positively impacts bank profitability in Sweden. Still, the effect is not the same for all age groups. The research design includes FE and GMM models to analyze the data, and the results show that while the overall use of INB has a positive impact on returns on assets, the benefits are especially evident among the middle-aged and older generations. These findings are at odds with the conventional wisdom that younger, more digitally savvy customers are the engine of profitability in INB and, instead, imply that the financial consequences of the digital channels are very different for different age cohorts.

Theoretically, the study contributes to understanding digital transformation in banking by extending the traditional models of technology adoption and financial performance with demographic factors. It also stresses the importance of considering the role of heterogeneity and dynamic effects in assessing the impacts of digitalization. In practice, the findings are important for bank managers and policymakers. By distinguishing the most effective target groups for digital initiatives, banks can improve the effectiveness of their digital spending for performance and policymakers may promote measures that would increase the take-up of digital products among different age categories.

As a limitation, the study only covers Swedish commercial banks and focuses mainly on the ROA as a measure of profitability. However, these constraints provide the opportunity for future research. Extending the analysis to other performance indicators and cross-country comparisons would add value to the current understanding of the link between digital adoption and bank profitability. Another limitation of our data is that we cannot separate desktop INB from mobile banking app usage. However, the variable captures active recent INB usage and reflects the broader digital engagement environment in which Swedish banks operate. In conclusion, as the digital environment develops, the results of our research stress the importance of continuous investigation and adaptive planning to unleash the full potential of digital banking.

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