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Abstract

In spite of the conspicuous use of the Internet as a delivery channel, there is a relative dearth of empirical studies that provide a quantitative analysis of the impact of the Internet on banks´ financial performance. This paper attempts to fill this gap by identifying and estimating the impact of the adoption of a transactional web site on financial performance using a sample of 72 commercial banks operating in Spain over the period 1994-2002. The impact on banks´ performance of transactional web adoption takes time to appear. The adoption of the Internet as a delivery channel involves a gradual reduction in overhead expenses (particularly, staff, marketing and IT). This effect is statistically significant after one and a half years after adoption. The cost reduction translates into an improvement in banks´ profitability, which becomes significant after one and a half years in terms of ROA and after three years in terms of ROE. The paper also concludes that the Internet is being used as a complement to, rather than a substitute for, physical branches.

Keywords: commercial banks, Internet banking, profitability, cost and income structure.

JEL Codes: G21, O32, O33.

1 Introduction

At the time of writing this paper, expectations on the impact of information technologies in general and the Internet in particular on retail banking are more realistic and far from the revolutionary views existing at the end of the 90´s or the turn of this century [see as an example of these views Feng (2001)]. The consensus is that the Internet simply adds another delivery channel to the existing channels (ATMs, branches, telephone). Nonetheless, despite the success of the multichannel model, few empirical studies are available regarding the impact of the Internet on the financial performance of multichannel banks worldwide and particularly in Europe. Frame and White (2004) describe some of the most recent studies in the US and "*urge fellow finance economists to expend some effort toiling in this untilled field*" (p. 137).

This paper attempts to fill this gap by focusing on the benefits of the transactional web site from the point of view of the commercial bank and not on an analysis of the determinants of the Internet adoption decision by the bank [Furst et al. (2000)] or the retail consumer [Bauer and Hein (2006)]. To the extent that banks operating in Spain share the same characteristics such as their universal character with continental European banks, our results could be extrapolated to the broader European banking system.

Banks operating in Spain have not been an exception in the adoption of transactional web sites. Moreover, their adoption strategy has been in line with the current world wide trend towards a multi-channel ("clicks and mortar") approach. Adoption started in the late 1990´s and by 2002, 55 percent of the commercial banks were using the Internet as a distribution channel for money transfers, brokerage and securities trading transactions and deposits. For the purposes of this paper, multichannel banks are those that use traditional distribution channels (i.e. branches and ATMs) as well as telephone and Internet regardless of the intensity of usage in terms of services provided or volume of operations contracted over the Internet. Hence, the primarily Internet banks are also included in our sample because they use, although to a lesser degree, more traditional delivery channels.[1]

The purpose of this paper is twofold: First, to identify and estimate the impact of the adoption of transactional web sites on the performance of commercial banks operating in Spain. To this end, we explore the impact on profitability and operational performance ratios of the adoption of the Internet as a distribution channel, using a sample of 72 commercial banks over the period 1994-2002. Moreover, we examine whether the Internet is a complement to or a substitute for physical banking branches.

The paper uses information from the regulatory database of Banco de España. It also draws from a voluntary survey carried out by Banco de España on Internet adoption of all depository institutions operating in Spain. We have also used information from the individual banks´ web sites. The database includes 72 commercial banks, accounting for nearly all bank deposits during this time. The data corresponds to two samples: Banks without transactional web sites, though they may have informational web sites *(traditional banks),* and banks with transactional web sites *(multichannel banks).*

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[1] **1.** They do have at least one-full-service physical office. The results are robust to the exclusion of these primarily Internet banks.

Our results suggest that the impact of Internet on banks´ performance takes time to appear. The adoption of the Internet as a delivery channel has a positive impact on profitability (ROA and ROE) and overhead expenditures (in particular, staff, marketing and IT costs) as compared with traditional banks. The impact of Internet adoption is not immediate but gradual. In the case of overhead expenses the impact turns out to be significant one and a half years after adoption reaching a maximum thirty months after adoption. The paper also concludes that the Internet is used as a complement to, rather than a substitute for, transacting by physical branches. A note of caution must be introduced given the preliminary character of the findings of this study that does not take into consideration either the intensity of the use of Internet as a delivery channel.

This article is divided in six parts in addition to this introduction. The second part describes the characteristics of the multichannel banks in Spain. Part three reviews the financial literature on the performance of Internet banks. The fourth part analyzes the economic rationale of Internet banking. Part five describes the data and the results of a comparative analysis of some financial ratios for the two samples of banks –traditional and multichannel–. Part six presents the regression framework and the results of the multivariate analysis. Finally, section seven summarizes the article and presents the conclusions.

2 Spanish banks and Internet adoption

The rapid development of the technology infrastructure, in particular the growth in the number of personal computers, the increased quality of Internet connections, the more widespread use of the Internet in both homes and businesses, and the significant reduction in both the fixed and variable costs of the Internet connections in Spain, have made it possible for the Internet to play a more central role in banks´ business strategy [Delgado and Nieto (2004)]. Spanish banks benefited particularly from the adoption of the Internet because of their universal character. As with many European banks –unlike US banks prior to enactment of the Gramm-Leach-Bliley Act of 1999–, Spanish banks have enjoyed the advantages of "broad banking" [Barth, Brumbaug and Wilcox (2000)]. Banks have been allowed to offer all sorts of financial products and engage in a wide variety of financial business (including securities trading and mutual funds management). Carbó and Rodríguez (2005) find that cost and profit global scope economies improve significantly when including mutual funds along with other earning assets, showing certain cross-selling and portfolio diversification benefits in the Spanish banks.

In Spain, the number of fully incorporated commercial banks was 89 as of December 2002.[2] All of which are under the supervision of Banco de España, that carried out a voluntary survey among all deposit institutions operating in Spain with the objective of determining the nature of the institutions' Internet-based financial activities.[3] The period covered by the survey was 2000-2002. The data obtained from the replies to the questionnaire reveal that the only financial products delivered over the Internet by commercial banks were money transfers, brokerage (stocks and mutual funds), deposits and mortgage loans. Multichannel banks offer economic incentives to their clients to shift their operations from the traditional distribution channels to the Internet.[4] These economic incentives are mainly more competitive interest rates on deposits and loans, and lower commission fees for their banking services. The uneven quality of the data submitted seems to reveal the limitations of multichannel banks´ accounting records as a means of differentiating operations by different distribution channels.

By 2002, nearly 55% commercial banks had incorporated the Internet as a delivery channel in Spain.[5] These data compare favourably with the Internet banking adoption in the US where the estimated adoption rate was approximately 50% by end-year 2000 [Carlson, Furst, Lang and Nolle (2000)]. Nonetheless, despite the growing importance of the Internet distribution channel, the branch network remains the most important delivery channel for retail banking in Spain. According to the European Central Bank (2005), the Spanish is one of the most "over branched" banking systems in Europe, although commercial banks have being reducing the number of branches in recent years. In comparison with other

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[2] **2.** This number excludes the savings banks (47), credit cooperatives (90) as well as branches of foreign banks (56). The number of banking groups was 30 at December, 2002. Spanish banking groups do not have a holding company structure since the parent company is always a bank. In 2002, the share of the five largest banks in total assets was 44%, as compared to the 55% average for the European Union (this figure does not include the recent accession countries).

[3] **3.** Since 1962 various legal provisions have conferred on the Banco de España the power to supervise credit institutions and their consolidated groups. Currently, the basic definition of the powers of the Banco de España in relation to banking supervision is to be found in Law 26/1988 of 29 July 1988 on the discipline and intervention of credit institutions (LDI), and in Law 13/1994 of 1 June 1994 on the Autonomy of the Banco de España (LABE).

[4] **4.** Only five banks declared not to offer any economic incentive to attract clients to use the Internet channel.

[5] **5.** Although a larger percentage of commercial banks (76%) had web sites at least for informational purposes.

European countries, Spanish banks´ branches have few employees. Branches have minimal administrative duties and they are almost solely used as a distribution channel. According to Standard & Poors (2004), new branches may have as few as three employees per branch.

In Spain, transactional web site adoption rates seem to depend on commercial banks´ size. This conclusion is in line with the findings of Furst, Lang, and Nolle (2002) for US banks and Hasan, Zazzara and Ciciretti (2005) for Italian banks. In 2002, all large banks and all but one medium size bank had a transactional web site. Smaller banks with assets of less than €9 billion had an adoption rate of only 50% (Figure 1). The rate of adoption of the Internet delivery channel by foreign bank subsidiaries is only marginally lower than that of Spanish banks. Finally, early adopters of the Internet delivery channel offered on-line brokerage and trading at the time of adoption.

3 Literature on the financial performance of multichannel bank

Studies on the impact of Internet adoption on banks´ performance, although scarce, are available for the US, European and Australian banking markets. Carlson et al. (2000) and Furst et al. (2002) investigated whether there is a link between offering Internet banking and bank's profitability. To this end, Furst et al. (2002) regressed ROE against a set of control variables for banks that adopted Internet as of Q3 1999. These authors conclude that Internet banking was too small a factor to have affected bank profitability at that time. This conclusion was in line with the previous findings of Egland et al. (1998) who found no evidence of major differences in performance of Internet banks in the US. However, the authors express two caveats: Firstly, this result may not hold for all the banks and, secondly, they are open tochange over time as the banks become more intensive in their use of the Internet. Sullivan (2000) also found no systematic evidence that multichannel banks in the 10th Federal Reserve District were either helped or harmed by having transactional web sites. These findings are in line with those of Sathye (2005) for the credit unions in Australia for the years 1997 to 2001. This author shows that Internet banking has not proved to be a performance-enhancing tool in the context of major credit unions in Australia. DeYoung et al. (2006) invoke the theoretical concepts of product and process innovation and develop numerous testable conjectures about the financial and strategic implications of Internet banking for US community banks that adopted Internet prior to 1999, comparing their financial performance over 1999-2001 to the performance of traditional community banks. Their results show that multichannel banks are somewhat more profitable, chiefly via increased non-interest income from deposit service charges. Other studies have examined the financial performance of primarily Internet banks that rely heavily, although not exclusively (e.g. telephone, ATM), on the Internet as a delivery channel. DeYoung (2005) identifies and estimates the magnitude of technology based scale effects of a dozen of primarily Internet banks in the US over the 1997-2001 period. This author finds evidence of technology-based scale economies while the evidence on experience effects is rather weak. The empirical analysis demonstrates that profitability gaps with traditional banks of similar size and age shrink as primarily Internet banks get larger.

In Europe, the majority of the studies have focused on the performance of primarily Internet banks: those that most heavily, although not exclusively, rely on Internet as a delivery channel. Delgado and Nieto (2004) studied the performance of these institutions in Spain and concluded that their negative aggregate profitability until 2002 was due to higher financial costs and lower fee income, which seemed to reflect the fierce competition among Internet banks and between them and traditional banks in Spain. Delgado, Hernando and Nieto (2006) identify and estimate the magnitude of technology based scale and technology based learning economies of fifteen European primarily Internet banks. They conclude that these banks show strong evidence of technology based scale economies and their primary source seems to be the ability of primarily Internet banks to control operational expenses even more efficiently than the new traditional banks.

Although primarily Internet banks have focused the attention of most authors in Europe, the analysis of the performance of multichannel commercial banks (as opposed to traditional banks) has been the objective of Hasan, Zazzara and Ciciretti (2005). These authors conclude that banks operating in Italy show a positive relationship between Internet adoption and profitability (ROA, ROE) over the 1993-2001 period.

In sum, the evidence of the impact of the adoption of Internet as a delivery channel on financial performance is mixed. Nevertheless, the latest studies seem to find a positive relationship with profitability in the US and Italy. It could be argued that as the intensity in the usage of Internet increases, the financial performance of multichannel banks is likely to improve. To complement this evidence, this paper analyzes the impact of the transactional web adoption on commercial banks profitability in Spain at different time horizons. We also analyze the sources of the profitability gap and, more precisely, intermediation margin, securities brokerage fees, overhead, staff, IT and marketing expenses over the same time period. Last but not least, this paper examines whether the Internet is a complement or a substitute to physical banking channels.

4 The economic rationale of Internet banking

Technology has changed the traditional retail banking business model by making it possible for banks to break their traditional value creation chain so as to allow the production and distribution of financial services to be separated into different businesses. Thus, for example, primarily Internet banks distribute insurance and securities as well as banking products, but not all the products they distribute are produced by their group [Delgado and Nieto (2004)].

However, the main economic argument for adopting the Internet as a delivery channel is based on the expected reduction in overhead expenses made possible by reducing and ultimately eliminating physical branches and their associated costs (e.g. staff and rent). This is particularly relevant in the Spanish banking system, which is one of the most "overbranched" in Europe. As shown by DeYoung (2005) and Delgado, Hernando and Nieto (2006), the Internet delivery channel may generate scale economies in excess of those available to traditional distribution channels. The unit costs of Internet banking fall more rapidly than those of traditional banks as output increases as a result of balance sheet growth. In this context, DeYoung, Lang and Nolle (2006) refer to the Internet banking as a "process innovation that functions mainly as a substitute for physical branches for delivering banking services". In the case of the Spanish banks, there is some anecdotal evidence that shows that the Internet distribution channel has lower unit transaction costs than the two other distribution channels (branch and telephone) for a given type of transaction (money transfer, mortgage loan, brokerage or demand deposits).[6]

Although DeYoung (2005) and Delgado, Hernando and Nieto (2006) find evidence of the impact of Internet in reducing banks´ unit costs on both sides of the Atlantic, no academic work has demonstrated as yet that Internet banks have systematically lower fixed costs.

To the extent that the Internet complements rather than substitutes the branch delivery channel, DeYoung, Lang and Nolle (2006) defend the view that "the Internet is best viewed as a product innovation because it makes valuable new services and new combination of services available". Online brokerage has become a more mainstream activity for retail banks and one of the main drivers used by European banks for acquiring new on-line customers and converting existing off-line to online customers. Cost effectiveness seems to explain this fact to a large extent [McKinsey (2001)]. Online brokerage activities are conducted directly by the customer, and hence the costs and benefits of conducting that business affect the bank's profitability. On-line brokers have undergone the most profound transformation due to the drastic cuts in brokerage unit costs brought about by the Internet. This in turn has allowed banks´ customers to access much more information cheaply and respond more rapidly. Indeed, with very few exceptions, the large European banks with on-line presence offered trading services on their web sites in 2000 [Moody´s (2000)].

This experience contrasts with the US, where online brokerage took off quite successfully, but via nonbank securities dealer firms; banks, for which the Gramm-Leach-Bliley Act of 1999 widens securities underwriting and dealing powers, nevertheless have to conduct those activities outside the bank, in a separate securities entity. So banks offering online brokerage are actually routing customers to a legally separate company within the holding company, and as a consequence the payoff does not really impact the bank.

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[6] The estimates were made by Accenture with a sample of five banks, all of which used, although not exclusively, the Internet as a delivery channel in 2002. The transaction costs include the cost of IT, staff and rent.

The Internet has also considerably changed banks depositors´ behaviour. In Spain, depositors are offered higher interest rates that reflect the fierce competition among banks that have adopted the Internet. As a result of this intense competition and the ease of transferring funds between deposit accounts, core deposits (current and savings accounts, and time deposits) that use the Internet channel have become more volatile. The high volatility of core deposits may increase dependence on more costly financing stemming from mutual funds, asset securitization and/or the interbank market.

5 Data and financial analysis of Spanish multichannel banks

5.1 The data

The paper uses half yearly (annualized) data from the regulatory data base of Banco de España from the first half of 1994 through the first half of 2002. It also draws on a voluntary survey carried out by Banco de España on Internet adoption of all deposit institutions operating in Spain. In addition, we used information from individual banks web sites.

The database includes 72 separately chartered individual (non-consolidated) banks operating in Spain in 2002 (of which 57 are part of a banking group). The study excludes 17 very small banks that either do not take deposits or are much specialised institutions part of a financial group. Bank mergers have been taken into consideration in the data collection process. We focus on two samples of banks: Banks without a transactional web site, which may or may not have an informational web site *(traditional banks)* and banks with transactional web sites *(multichannel banks)* (Table 1).

The combined data set is an unbalanced panel of 1153 observations of 72 banks, over a nine year period starting in 1994. The data panel is unbalanced because four banks started operations after the first half of 1994. In 2002, the average number of years since adoption of the Internet as a delivery channel was three and a half years.

5.2 Financial analysis of the data

The analysis of the two groups of banks *(traditional and multichannel)* is based on several financial performance ratios. These financial ratios measure business activity as a percentage of total assets (loans, deposits, off-balance sheet and trading portfolio activity); operational performance as a percentage of average total assets (general expenses and more specifically staff, information technology and marketing costs) and profitability (return on equity –ROE–, return on assets –ROA–, intermediation margin, other income and securities brokerage commissions). See Annex for definitions of variables.

Table 2 shows means and medians of the financial ratios as well as the statistical significance of the differences in these ratios between *traditional banks* and *multichannel banks.* The performance of *multichannel banks* is better in terms of ROE, although there are not clear differences in terms of ROA. This may be explained by differences in financial leverage. *Multichannel banks* generate more typical banking business (lending, deposit taking and securities trading –banks´ own portfolio–). They have also a larger branch and ATM network. This seems to imply that, so far, the Internet channel has not substituted the more traditional delivery channels. In spite of the higher overall profitability, the intermediation margin of *Multichannel banks* is lower as they operate in more competitive market segments. This result is statistically significant in terms of average and median. *Multichannel banks* do also engage in more off balance sheet activity which, in turn, seems to explain their higher other net income. However, these results are statistically significant only in terms of median. In addition to the higher commission income (other income net), the overall higher profitability of *multichannel banks* also seems to be explained by the somewhat lower general expenses and, more specifically, staff costs, all of which, in spite of having a larger branch and ATM network that handles a lower volume of total assets per branch and per ATM. The *Multichannel banks* show higher IT expenses. These differences are statistically significant both in terms of average and median, while the differences in marketing expenses are not significant.

The univariate results shown above provide only a preliminary picture of the impact of Internet adoption on the performance of multichannel banks in Spain. That impact is best represented by the estimated coefficients in the multivariate analysis below since the regressions control for other effects.

6 Regression analysis

The multivariate analysis explores the impact of the Internet adoption as a business model based on different performance variables. More precisely, this multivariate analysis consists of a set of regressions in which some performance variables are regressed over dummies denoting the introduction of Internet as a delivery channel and a set of control variables. This set of regressions is run for the whole sample of banks and includes dummy variables related to the period of introduction of a transactional web site. The coefficient associated with these dummies will indicate the possible association between Internet adoption by banks and their overall performance.

The equation considered is the following:

$$PERFORMANCE_{i,t} = \alpha + \sum_{J=1}^{6} \beta_J * MULTICHANNEL_{i,t}^{J} + \sum_{K} \delta_K * X_{it-1}^{K} + \sum_{t=1}^{17} \theta_t * timedum_t + \mu_i + \varepsilon_{i,t} \tag{1}$$

where subscripts *i* and *t* index banks and time in semesters, respectively.

PERFORMANCE can be any of the following performance ratios. As profitability ratios, we consider return on equity (*ROE*), return on assets (*ROA*), intermediation margin (*MINT*), other income (*OTHER_INCOME*) and securities brokerage commission income (*COMINC*) over total average assets. As operational performance ratios, we have considered: general expenses over total average assets (*GEXP*), and more specifically, staff (*STAFF*), information technology (*IT*) and marketing (*MARK*) costs over total average assets.[7]

$MULTICHANNEL^J$ are dummy variables defined in terms of the time of adoption of a transactional website. Thus, $MULTICHANNEL^1$ is a dummy variable that equals 1 if the bank introduced a transactional web site in the previous six months. Similarly, $MULTICHANNEL^2$, $MULTICHANNEL^3$, $MULTICHANNEL^4$ and $MULTICHANNEL^5$, are dummy variables that equals 1 if the bank introduced a transactional web site 12, 18, 24 or 30 months ago, respectively. Finally, $MULTICHANNEL^6$ is a dummy variable that equals 1 if the bank is operating a transactional web site for at least three years.

In fact, these dummies are a simple transformation of an alternative dummy variable, *INTERNET,* which equals 1 if the bank has a transactional website and 0 otherwise. Hence, for a bank *i*:

$$MULTICHANNEL_{i,t}^{1} = INTERNET_{i,t-1} - INTERNET_{i,t-2} \tag{2}$$

$$MULTICHANNEL_{i,t}^{2} = INTERNET_{i,t-2} - INTERNET_{i,t-3} \tag{3}$$

$$MULTICHANNEL_{i,t}^{3} = INTERNET_{i,t-3} - INTERNET_{i,t-4} \tag{4}$$

$$MULTICHANNEL_{i,t}^{4} = INTERNET_{i,t-4} - INTERNET_{i,t-5} \tag{5}$$

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[7] More detailed definitions are provided in the Annex.

$$MULTICHANNEL^5_{i,t} = INTERNET_{i,t-5} - INTERNET_{i,t-6} \quad (6)$$

$$MULTICHANNEL^6_{i,t} = INTERNET_{i,t-6} \quad (7)$$

The coefficients of these dummies will reflect the time profile of the impact of Internet adoption on performance.

These regressions include a number of variables to control for differences in asset size, business and organizational structure, as well as for the impact of the business cycle. In particular, the control variables (*X*) included are the following: off-balance sheet accounts to total assets (*OFF_BS*), loans to total assets (*LOANS*), deposits to total assets (*DEPOSITS*), securities trading portfolio to total assets (*TRADEPORT*), the log of the number of branches[8] (*BRANCHES*) and the share of non-performing loans over total loans (*NPLOANS*). These variables are included with a six months lag (i.e. they are measured at the beginning of the period) in order to avoid potential endogeneity. Finally, the regression also includes a set of dummy variables **(** $\sum_{t=1}^{t=17} timedum_t$ **)** for each sample half year to control for the impact of macroeconomic developments (such as business cycle effects) over the sample period.

In order to analyze whether Internet web sites are substitutes for physical branches, we also estimate a similar model for the variable *BRANCHES.*[9]

$$BRANCHES_{i,t} = \alpha + \sum_{J=1}^{6} \beta_J * MULTICHANNEL^J_{i,t} + \sum_K \delta_K * X^K_{it-1} + \sum_{t=1}^{17} \theta_t * timedum_t + \mu_i + \varepsilon_{i,t} \quad (8)$$

Models (1) and (8) are first estimated using a GLS-RE estimation technique. This approach includes, in addition to the usual random disturbance term (ε), a bank-specific disturbance component (μ) that accounts for unexplained variation in the dependent variable that it is specific to bank *i* during the sample period. Nevertheless, in order to control for the possible endogeneity of internet adoption (and, consequently, of our *MULTICHANNEL* dummies) with respect to some of the performance variables, we also use a two-step instrumental variable (IV) approach, following the method used by DeYoung et al. (2006) in a similar setting. In the first step, we estimate a probit model with random effects for the Internet adoption decision. This model includes on the right-hand side a set of variables that potentially affect Internet adoption and are arguably exogenous to the performance variables. This set includes the share of loans to households over total loans *(HOUSEHOLD),* the share of branches in locations with more than 100,000 inhabitants *(URBAN),* a dummy variable *(FINANCIAL_GROUP)* that equals 1 for banks that belong to a banking group, a dummy variable *(LARGE)* that equals 1 if total assets are above € 9 billion and 0 otherwise and a dummy variable *(LISTED),* that equals 1 for banks listed on the stock exchange.[10] Instruments for the *MULTICHANNEL* dummies can be obtained, from equations (2) to (7), using the resulting fitted values for the *INTERNET* dummy in the probit model. In the second step, equations (1) and (8) are estimated using these instruments for the *MULTICHANNEL* dummies.

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8. The variable BRANCHES is chosen over Automated Teller Machines (ATMs) for two main reasons: (a) both are highly correlated (r = 0.94) and (b) ATMs are mainly cash handling outlets in Spain.

9. Obviously, lagged BRANCHES is not included in the set of control variables (X).

10. The estimated coefficients for HOUSEHOLD, FINANCIAL_GROUP, LISTED and LARGE are positive and significant whereas that for URBAN is not significant. The simple correlation between INTERNET and the fitted value of the random effects probit model is 0.6997.

6.1 Results

Regression results on the impact of the adoption of a transactional web site are shown in tables 3 and 4.[11] Table 3 reports the results for the GLS-RE method whereas table 4 reports the IV estimates. In what follows, we refer mainly to the results in table 4, which represent the core results of our analysis. The adoption of the Internet as a delivery channel has a positive impact on *Multichannel banks´* profitability measured both in terms of *ROA* and *ROE*. This impact (8.5 percentage points (pp) in terms of *ROE* and approximately 2 pp in terms of *ROA*) is clearly significant three years after adoption. Nevertheless, the results also provide some indication that profitability gains appear somewhat earlier –around eighteen months after adoption–.[12] Strong competition among multichannel banks as well as these and the traditional banks is not significantly reflected in the intermediation margin *(MINT).*[13] Similarly, the results suggest that multichannel banks do not obtain significantly higher brokerage commission income *(COMINC).*[14]

The regression results are in line with those obtained in the descriptive analysis in terms of the cost structure. *Multichannel banks* show statistically significant lower general expenses *(GEXP)* than traditional banks after eighteen months of adoption. The impact of Internet adoption on overhead expenses is gradual. It becomes significant one and a half years after adoption, and reaches a maximum in absolute value (1.4 pp) thirty months after launching the transactional web site. The positive impact of Internet adoption on general expenses is at least partly explained by lower staff costs, which is statistically significant after a year and a half in both estimation methods. The reduction in staff costs is approximately 0.45 pp in the second year of adoption and it increases up to 0.8 pp afterwards. The introduction of a new technology seems to go hand in hand with higher IT expenditures during the first year, although this impact is only found in the GLS-RE estimation. In fact, IT expenditures actually decrease in the second year of adoption in both sets of estimates. Also, the introduction of a new delivery channel seems to involve a transitory increase in marketing expenditures. Again, this effect is not found in the IV estimates, according to which there is a statistically significant reduction in marketing expenditures after 12 months. The reduction of staff costs, IT and marketing expenditures in the IV estimates indicates that multichannel banks present statistically significant evidence of efficiency improvements (i.e. reduction in general expenses per unit of output).

The dummy variables related to the period of introduction of a transactional web site are, in general, not significant in the branches equation, which suggests that the Internet is used as a complementary means of transacting rather than a substitute for the traditional distribution channels (branches or ATMs). In fact, the IV estimates show a significant increase in the number of branches in the first six months after adoption that seem to confirm that the Internet is complementary rather than a substitute for physical branches.

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[11] As a robustness check, equations (1) and (2) have also been estimated with a sample that excludes primarily Internet banks, all of which are also recently established banks. The results obtained excluding those four banks are qualitatively similar to those reported in Tables 3 and 4. The impact on marketing expenses of the introduction of a transactional web site is weaker once those banks are excluded.

[12] MULTICHANNEL^3 and MULTICHANNEL^4 are close to be statistically significant in the ROE equation whereas MULTICHANNEL^3 is significant and MULTICHANNEL^4 and MULTICHANNEL^5 are almost significant in the ROA equation.

[13] The intermediation margin displays a slight decrease (around 0.2%) but it is not significant.

[14] Nevertheless, a slight increase in brokerage commission income is obtained in the GLS-RE estimation.

7 Conclusions

Spanish banks´ strategy has been in line with the current world wide trends according to which the multichannel ("clicks and mortar") banks will prevail, at least in the medium term. Adoptions started in the second part of the 90´s and by the turn of the century more than half of the banks operating in Spain had transactional web sites.

In Spain, the adoption rates and distribution by size are comparable to those in banks in the US. In 2002, all large and all but one medium size banks have adopted a multichannel strategy. However, adoption of the Internet as a delivery channel was lower in the case of the small banks (barely reaching 50 percent). Early adopters of the Internet delivery channel offered on-line brokerage and trading at the time of adoption (all large multichannel commercial banks offered on-line brokerage and trading, and all but one medium-sized bank offered this service).

In spite of the conspicuous use of this new delivery channel, there are few studies worldwide (and none in Spain) on the impact of the Internet on banks´ performance. The purpose of this paper has been twofold: First, to identify and estimate the impact of the Internet on banks´ operational performance; and, second, to examine whether the Internet is a complement or a substitute to physical branches. To this end, this paper presents the results of the multivariate analysis based on an unbalanced panel of 1153 semiannual observations from 1994-2002. The main conclusions of this analysis are as follows:

- The Internet delivery channel seems to serve as complementary means of transacting with customers rather than a substitute for physical branches. Despite the large investment in the Internet as distribution channel, the branch network remains an important channel for retail banking products in Spain.

- The impact on performance of adoption of the Internet as a delivery channel takes time to appear.

- The adoption of a transactional web site has a positive impact on profitability. This impact, that becomes significant three years after adoption, is observed both in terms of *ROE* and *ROA*. There is some weaker evidence of an earlier impact on performance, particularly in terms of ROA.

- The profitability gains associated with the adoption of a transactional web site are mainly explained by a significant reduction in overhead expenses. This effect is gradual, becoming significant eighteen months after adoption and reaching a maximum generally two and a half years after adoption. The reduction of staff costs, IT and marketing expenditures in the IV estimates seems to show that multichannel banks present statistically significant evidence of efficiency gains (i.e. reduction in general expenses per unit of output). Banks would further profit from these cost reductions to the extent that the Internet delivery channel functions as a substitute for traditional distribution channels.

- Multichannel banks do not seem to generate higher brokerage commission income, which indicates that online broker activity is not contributing to higher profitability of the multichannel banks as yet.

The above results in terms of profitability are in line with those obtained by DeYoung, Lang and Nolle (2006) in the US and Hasan, Zazzara and Ciciretti (2005) in Italy. Our analysis shows that this effect varies over time and explains, in terms of cost and income structure, the main drivers of better performance. Nonetheless, all these results should be taken with caution as they do not take into consideration the intensity in the use of the Internet as a delivery channel. Moreover, any further deepening of the analysis of the impact on performance of the adoption of Internet banking would benefit from accounting systems that discriminate financial variables per delivery channel and business line.

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Annex: Definition of Variables

Loans: Total loans and credits over total assets at the end of period.

Off-balance sheet *(OFF_BS):* Contingent assets and liabilities over total assets at the end of period.

Deposits: Current accounts and term deposits over total assets at the end of period.

Trade portfolio *(TRADE_PORT):* Banks´ own trading portfolio over total assets at the end of period.

Non performing loans *(NPL):* Non performing loans (doubtful and overdued) over total assets at the end of period.

Branches: Logarithm of the total number of branches at the end of period.

ROA: Gross profits over average assets of beginning and end period.

ROE: Gross profits over average equity of beginning and end period.

Mint: Net interest margin over average assets of beginning and end period.

Other income: Net commission income plus net profits (losses) of sales of the bank´s own trade portfolio over average assets of beginning and end period.

Cominc: Brokerage commissions over average assets of beginning and end period.

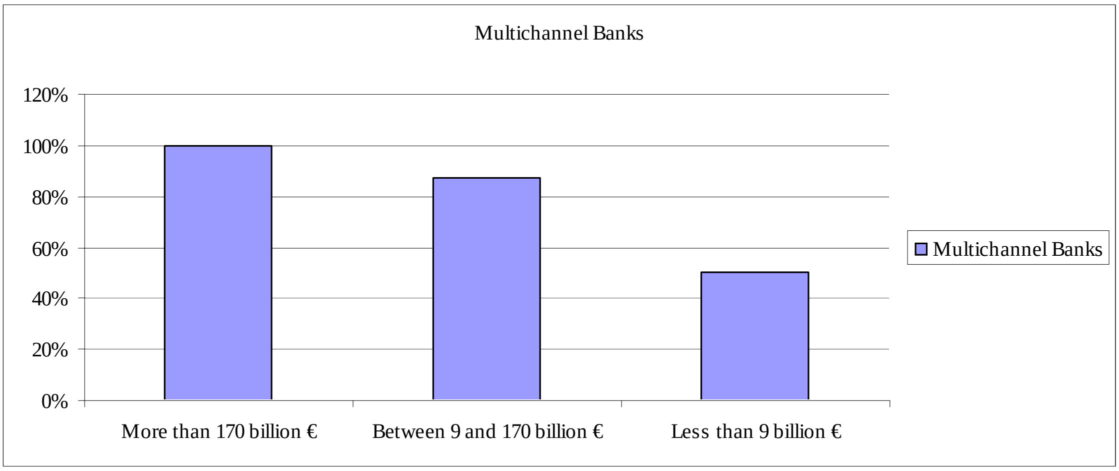
Gexp: Total overhead expenditures over average assets of beginning and end period.

Staff: Personnel expenditures over average assets of beginning and end period.

IT: Expenditures on Information Technology (i.e. software research and development expenses, amortisation of purchased software, data processing) over average assets of beginning and end period.

Mark: Expenditures on marketing over average assets of beginning and end period.

Figure 1: Multichannel banks by asset size in Spain*. 2002



Source: Banco de España.

Percentage of banks that had a transactional web site in 2002.

Table 1. Internet adoption by Spanish commercial banks. 2002.

	All banks	Banks without web[a]	Banks with informational web[a]	Banks with transactional web (multichannel banks)[a]
Total sample	72	17	55	40
Size				
Large	2	0	2	2
Quoted	2	0	2	2
Medium	8	0	8	7
Quoted	6	0	6	6
Small	62	17	45	31
Quoted	9	0	9	8
Part of Finantial Group				
Independent	15	3	12	8
Part of Finantial Group[b]	57	14	43	32
Ownership				
Spanish Institution	47	10	37	28
Subsidiaries Foreign Bank	25	7	18	12

Source: Banco de España

[a] The traditional banks do not have transactional web site and may or may not have informational web site. The multichannel banks do have transactional web site and may or may not have informational web site. In practice, all banks that have transactional webs do also have informational web sites.

[b] Part of financial group includes parent banks and banks that are subsidiaries.

Table 2. Comparison of financial ratios between traditional and multichannel banks[a]

	Traditional banks (without transactional web)		Multichannel banks (with transactional web)		Test on Means[b] (p-value)	Test on Medians[c] (p-value)
	Mean	Median	Mean	Median		
Business activity (% of total assets)						
Loans / TA	37.13	36.83	53.98	54.58	0.00	0.00
Deposits / TA	33.10	31.91	44.99	46.73	0.00	0.00
Off balance Sheet / TA	22.71	15.75	24.51	24.93	0.40	0.00
Trading Portfolio / TA	1.08	0.00	1.53	0.01	0.11	0.00
Profitability						
ROA	1.25	0.84	0.51	0.88	0.04	0.49
ROE	10.91	8.23	14.67	17.05	0.00	0.00
Intermediation Margin / TAA	3.17	2.79	2.63	2.49	0.00	0.05
Other Income (net) / TAA	1.11	0.81	1.24	1.07	0.27	0.00
Securities brokerage comissions/TAA	0.15	0.01	0.13	0.03	0.67	0.00
Operational performance (% of total average assets)						
General Expenses / TAA	3.01	2.77	3.06	2.46	0.84	0.00
Staff Costs / TAA	1.60	1.58	1.53	1.47	0.40	0.00
IT costs / TAA	0.27	0.19	0.35	0.22	0.03	0.00
Marketing Expenses / TAA	0.16	0.04	0.23	0.04	0.41	0.00
Size						
Total Assets (TA)[d]	3502222	584093.5	19100000	3081678	0.00	0.00
Branches	111.24	10.50	494.95	162.00	0.00	0.00
ATMs	85.92	2.00	548.54	128.50	0.00	0.00

[a] Statistics computed on the basis of 1153 observations corresponding to 72 banks over the period 1994-2002.

[b] The difference of means tests are generated from regressions that pool the data from the two groups of banks being compared. These regressions are specified as: $X_{it}=a+b^{*}D_{it}+e_{it}$, where X_{it} is the variable being tested, D_{it} is a dummy equal to 1 for banks in the second of the two pooled samples (i.e.multichannel banks), and e_{it} is a random disturbance term with zero mean. The statistical difference of b from zero provides the test of statistical significance for the difference of means.

[c] The difference of median tests are non-parametric two-sample tests for the null hypothesis that the two samples of banks being compared were drawn from populations with the same median.

[d] Total Assets in thousand euros

Table 3. The impact of Internet adoption by Spanish commercial banks (1994-2002)

Estimation method: Generalised Least Squares with random effects

	ROE	ROA	MINT	COMINC	OTHER_INCOME	GEXP	STAFF	IT	MARK	BRANCHES
MULTICHANNEL^{1}	-0.950	-0.930	0.042	0.074	0.061	0.615***	0.046	0.125***	0.314***	0.059
	0.64	*0.15*	*0.63*	*0.17*	*0.74*	*0.04*	*0.68*	*0.00*	*0.00*	*0.45*
MULTICHANNEL^{2}	-0.547	0.284	-0.010	0.092*	0.099	-0.133	-0.117	0.036	0.061	0.038
	0.80	*0.67*	*0.91*	*0.10*	*0.61*	*0.67*	*0.33*	*0.41*	*0.41*	*0.64*
MULTICHANNEL^{3}	-0.261	0.606	0.003	0.040	0.002	-0.532	-0.300***	0.024	-0.002	0.041
	0.91	*0.40*	*0.97*	*0.51*	*0.99*	*0.11*	*0.02*	*0.61*	*0.98*	*0.64*
MULTICHANNEL^{4}	3.652	1.076	0.057	0.034	-0.109	-0.709***	-0.317**	-0.064	-0.047	0.053
	0.13	*0.16*	*0.58*	*0.59*	*0.62*	*0.05*	*0.02*	*0.20*	*0.57*	*0.57*
MULTICHANNEL^{5}	2.339	0.752	0.062	0.084	-0.095	-0.543	-0.340**	-0.051	0.043	0.132
	0.37	*0.37*	*0.58*	*0.22*	*0.69*	*0.16*	*0.02*	*0.34*	*0.64*	*0.19*
MULTICHANNEL^{6}	4.086*	0.608	0.030	0.122**	-0.080	-0.808***	-0.508***	-0.082*	0.006	0.166*
	0.07	*0.40*	*0.76*	*0.04*	*0.70*	*0.02*	*0.00*	*0.08*	*0.94*	*0.06*
OFF_BS	0.019	0.011*	0.003***	0.000	0.010***	0.003	0.002	0.001***	-0.001	0.002**
	0.40	*0.09*	*0.00*	*0.41*	*0.00*	*0.28*	*0.13*	*0.01*	*0.46*	*0.01*
LOANS	0.051	0.027**	0.01***	-0.001	-0.003	-0.021***	-0.015***	-0.003***	-0.003*	-0.002
	0.25	*0.04*	*0.00*	*0.23*	*0.47*	*0.00*	*0.00*	*0.00*	*0.07*	*0.25*
DEPOSITS	-0.090**	-0.014	0.003	0.002**	0.004	0.016***	0.010***	0.003***	0.001	0.007***
	0.03	*0.25*	*0.14*	*0.05*	*0.24*	*0.01*	*0.00*	*0.00*	*0.34*	*0.00*
TRADEPORT	-0.198	-0.015	-0.030***	-0.010***	0.020	-0.013	-0.011	-0.003	-0.003	0.008
	0.14	*0.73*	*0.00*	*0.00*	*0.11*	*0.50*	*0.14*	*0.32*	*0.51*	*0.13*
NPLOANS	-1.166**	-0.189	0.042**	-0.022*	-0.165***	0.073	0.044	-0.002	-0.011	0.023
	0.02	*0.20*	*0.05*	*0.08*	*0.00*	*0.29*	*0.10*	*0.82*	*0.49*	*0.23*
BRANCHES	2.283***	-0.063	0.045	-0.029*	0.022	0.051	0.118***	-0.015	-0.04**	
	0.00	*0.73*	*0.20*	*0.09*	*0.70*	*0.58*	*0.00*	*0.20*	*0.04*	
Observations	723	723	723	723	723	723	723	723	723	727
R-squared	0.132	0.022	0.405	0.002	0.162	0.016	0.008	0.071	0.083	0.134
RMSE	10.47	3.415	0.45	0.28	0.961	1.566	0.589	0.221	0.373	0.403

P-value reported in italics

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. The impact of Internet adoption by Spanish commercial banks (1994-2002)

Estimation method: Instrumental variable

	ROE	ROA	MINT	COMINC	OTHER_INCOME	GEXP	STAFF	IT	MARK	BRANCHES
MULTICHANNEL^{1}	3.539	1.379	-0.013	0.070	0.104	-0.090	-0.005	-0.030	-0.037	0.334***
	0.34	*0.17*	*0.94*	*0.52*	*0.78*	*0.78*	*0.98*	*0.51*	*0.32*	*0.02*
MULTICHANNEL^{2}	3.821	0.687	-0.181	0.051	0.030	-0.350	-0.182	-0.033	-0.084**	-0.008
	0.32	*0.51*	*0.27*	*0.65*	*0.94*	*0.30*	*0.35*	*0.47*	*0.03*	*0.96*
MULTICHANNEL^{3}	6.447	2.028*	-0.034	-0.018	-0.244	-0.869**	-0.439**	-0.125***	-0.121***	0.092
	0.11	*0.06*	*0.84*	*0.88*	*0.54*	*0.01*	*0.03*	*0.01*	*0.00*	*0.54*
MULTICHANNEL^{4}	7.104	1.669	-0.140	0.023	-0.179	-0.719*	-0.457**	-0.057	-0.050	0.068
	0.12	*0.18*	*0.48*	*0.87*	*0.70*	*0.07*	*0.05*	*0.30*	*0.27*	*0.69*
MULTICHANNEL^{5}	1.569	1.921	-0.224	0.073	-0.260	-1.355***	-0.775***	-0.143***	-0.098**	0.050
	0.73	*0.12*	*0.25*	*0.59*	*0.57*	*0.00*	*0.00*	*0.01*	*0.03*	*0.77*
MULTICHANNEL^{6}	8.495***	2.09**	-0.197	0.122	-0.102	-1.083***	-0.654***	-0.174***	-0.084***	0.198
	0.01	*0.01*	*0.15*	*0.20*	*0.75*	*0.00*	*0.00*	*0.00*	*0.01*	*0.10*
OFF_BS	0.000	-0.002	0.003***	0.000	0.009***	0.006***	0.003**	0.002***	0.000*	0.002*
	0.99	*0.72*	*0.00*	*0.49*	*0.00*	*0.00*	*0.01*	*0.00*	*0.09*	*0.05*
LOANS	0.047	0.009	0.013***	-0.001	-0.003	-0.029***	-0.019***	-0.002***	-0.001*	0.000
	0.29	*0.30*	*0.00*	*0.50*	*0.54*	*0.00*	*0.00*	*0.00*	*0.06*	*0.99*
DEPOSITS	-0.063	-0.011	0.013***	0.002*	0.004	0.030***	0.018***	0.003***	0.002***	0.007***
	0.14	*0.20*	*0.00*	*0.07*	*0.35*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
TRADEPORT	-0.244*	-0.059	-0.024***	-0.010***	0.018	-0.010	-0.010	-0.001	0.001	0.009*
	0.05	*0.06*	*0.00*	*0.01*	*0.16*	*0.34*	*0.11*	*0.47*	*0.56*	*0.05*
NPLOANS	-1.470***	-0.282***	0.032*	-0.024*	-0.180***	0.087**	0.040*	0.008	0.002	0.035**
	0.00	*0.01*	*0.10*	*0.07*	*0.00*	*0.03*	*0.08*	*0.14*	*0.73*	*0.05*
BRANCHES	1.608**	-0.282**	0.002	-0.036*	-0.010	0.120	0.101**	0.012	0.001	
	0.02	*0.01*	*0.96*	*0.09*	*0.89*	*0.10*	*0.02*	*0.12*	*0.86*	
Observations	675	675	675	675	675	675	675	675	675	677
R-squared	0.144	0.073	0.538	0.003	0.153	0.009	0.008	0.065	0.001	0.217
RMSE	9.756	2.669	0.416	0.287	0.974	0.843	0.489	0.118	0.097	0.359

P-value reported in italics

* significant at 10%; ** significant at 5%; *** significant at 1%

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