Web Adoption by Irish Credit Unions: Performance Implications.

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Abstract

The purpose of this paper is to examine website adoption and its resultant effects on credit union performance in Ireland over the period 2002 to 2010. While there has been a steady increase in web adoption over the period a sizeable proportion (53%) of credit unions did not have a web-based facility in 2010. To gauge web functionality the researchers accessed all websites in 2010/2011 and it transpired that most sites were classified as informational with limited transactional options. Panel data techniques are then used to capture the dynamic nature of website diffusion and to investigate the effect of website adoption on cost and performance. The empirical analysis reveals that credit unions that have web-based functionality have a reduced spread between the loan and pay-out rate with this primarily caused by reduced loan rates. This reduced spread, although small, is found to both persist and increase over time.

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Web Adoption by Irish Credit Unions: Performance Implications.

1: Introduction

Irish credit unions are member-owned, voluntary, self-help, democratic, cooperative financial institutions that provide financial services to their members. The first credit union in Ireland was established in 1958; by 2011 there were 403 credit unions with assets under management of €14.1 billion and 2.8 million members (63 percent of the population). Indeed, credit union membership penetration in Ireland is higher than in any other country in the world. Despite this McKillop et al. (2006) have categorized the Irish credit union movement as being in the transitional development stage, well behind such mature movements as those in the US, Canada and Australia. Classification as a transition movement rests in part with a technological environment which has as yet failed to fully capture the benefits which may accrue to members through the sophisticated utilisation of information and communications technology (ICT).

Technological progress is often cited as the main, if not the most important, driver of change in the financial services industry. Worldwide, ICT utilization has been linked with the advancement and success of financial intermediaries. For example, by enabling customers to access services through automated distribution channels without having to physically visit premises increases customer flexibility and reduces costs. The recent history of technology advancement in the Irish credit union movement has, however, been demonstrated in somewhat of a poor light. In the late 1990s a work programme was established to take responsibility for ATM projects and to knit together 33 different ICT systems into one integrated system to support the spread of ATM services. The ultimate objective of this initiative was to enable electronic fund transfer and essentially create a centralized banking system for all credit unions. This project became known as ISIS and was financed by a levy on each credit union payable in two tranches. It was anticipated that the new ICT system would be in place by 2000. However, by 2000 the project's anticipated cost had increased dramatically and a number of the largest credit unions withdrew from the initiative with the ISIS project ultimately abandoned in 2001 as costs spiraled to €100 million.

Set against this failure to establish an integrated ICT system has been the general improvement in ICT infrastructure in Ireland. This improvement has encouraged the general

population to become much more computer literate and demanding of their financial provider. ICT has altered the ways in which customers access services. Increasingly financial services and products are obtained through automated distribution channels such as the internet and smart phones. It is also true that for the financial provider ICT can yield cost savings in the management of information (collection, storage, processing and transmission), and through substituting paper-based and labour-intensive procedures with automated processes. Given this context it should therefore be of no surprise to learn that credit unions at an individual level have pursued their own ICT development programmes with various levels of sophistication and degrees of success.

The purpose of this paper is to examine the costs and performance implications of ICT development as proxied by web-based functionality. The analysis is undertaken for the period 2002 to 2010. It is based on financial statement and balance sheet data plus surveys of the web-based functionality of each credit union. The survey data highlights that 215 credit unions (53%) do not even have a web presence. For those that do have a website it tends to be informational in form offering details on products and services, opening hours and links to social media sites with only limited evidence of transactional functionality. Panel data techniques are then used to capture the dynamic nature of website diffusion and to investigate the effect of website adoption on cost and performance. This reveals that credit unions that have web-based functionality have a reduced spread between the loan and pay-out rate with this primarily caused by reduced loan rates.[1] This reduced spread, although small, is found to both persist and increase over time.

This paper is the first to examine a facet of technology adoption for a credit union movement other than the US[2]. The paper is also timely as Irish credit unions are now entering a period of substantive structural change which will in part be based around technological improvements. One of the conditions of the EU/IMF/ECB financial support package for Ireland is the requirement that credit unions are restructured. A Credit Union Re-Structuring Board was established in 2012 to facilitate amalgamations and the creation of strong 'anchor'

[1] In the context of this paper we define the pay-out as interest on deposits plus dividends on members' shares. Members' shares dominate with deposits amounting to only 6% of members' shares in 2010.

[2] US studies concentrated on different facets of the technology adoption process, for example Ono and Stango (2005), and Borzekowski and Cohen (2005) examine decisions to outsource technology; Dow (2007) and Damar and Hunnicutt (2010) study the determinants of technology adoption; while Dandapani et al. (2008) and Pana et al. (2013) investigate changes in benefits to credit union members after adoption.

credit unions capable of developing more sophisticated and more sustainable business models. €250 million has been allocated for this process some of which will be used to enable 'anchor' credit unions upgrade their ICT systems. This study which highlights that the adoption of a website, even with limited functionality, can provide cost reductions and performance enhancement points to the potential of additional benefits accruing from more sophisticated levels of technological advance.

The rest of this paper is structured as follows. Section 2 reviews the literature on technology adoption by financial institutions and the cost and performance implications of such adoption. Section 3 details the panel methodology used to assess performance differences before and after web adoption. Section 4 presents trends in web adoption by credit unions over the period 2002 to 2010 and the results of a survey of all websites undertaken in 2010/2011. This section also profiles the outcome variables and the control variables employed in the panel models used in the empirical estimations. In Section 5 the empirical findings are presented while Section 6 summarizes and concludes.

2: Literature Review

2.1 Factors important in determining internet banking adoption

Technological advances have had a dramatic impact on the structure, operations and economics of the financial services industry. Technological progress is often cited as the main, if not the most important, driver of change in the banking industry. Naturally, developments in information collection, storage, processing, transmission and distribution technologies have a major impact on many aspects of banking activity. ICT developments affect financial services in two main ways. First, they contribute to reducing costs associated with the management of information (collection, storage, processing and transmission), mainly by substituting paper-based and labour-intensive procedures with automated processes. Second, they alter the ways in which customers have access to services and products with the trend increasingly moving towards the automation of distribution channels through the internet and smart phones. Engagement with ICT has also led in many cases to improvements in bank profitability primarily via increased revenues from service charges, or through lower processing costs (Hernando and Nieto, 2007; De Young et al., 2007).

2.1 Banking Studies

Patterns of internet banking adoption by banks have received significant attention in the academic literature[3]. Furst et al. (2000) find that US banks that incurred high fixed costs relative to net operating revenues and were located in an urban area were more likely adopters of internet banking. Courchane et al. (2002) note that bank size, industry concentration and bank location were significant determinants in the adoption of internet banking. Nickerson and Sullivan (2003) suggest that US banks are more likely to adopt internet banking where uncertainty over the level of demand is low. Sullivan and Wang (2005) find that the adoption of internet banking was slower in US states where average income is low, where there is a scarcity of internet access, where financial institutions are older, and where average bank size is smaller. Fuentes et al. (2006) show that although bank-specific characteristics are important determinants of banks' adoption decisions, competition also plays a prominent role[4]. Arnaboldi and Claeys (2010) find that EU banks with a heavy cost structure and a large market share in client deposits and non-interest activities are more likely to introduce internet banking.

Alongside this literature on the factors driving adoption is a literature which explores the impact on performance once adoption has occurred. DeYoung (2005) finds that the variable cost of producing a basic internet banking transaction is very low for US banks and that offering internet banking services can enhance the profitability of small banks. DeYoung et al. (2007) compare community banks which adopted transactional banking websites in the late-1990s to branching-only community banks. The analysis found that internet adoption improved US community bank profitability with this achieved through increased revenues from deposit service charges. Hernando and Nieto (2007) find that for Spanish banks online banking was associated with lower overhead costs (particularly, staff, marketing and ICT) and higher profitability which emerged about one and a half years after adoption[5]. Arnaboldi and Claeys (2010) find that for EU banks the initial investment in technology is higher than

[3] Other ICT adoption patterns examined in banking include: ATMs (Hannan and McDowell, 1984; 1986; 1990; Saloner and Shepard, 1995); Automated Clearinghouse Settlement Systems (Gowrisankaran and Stavins, 2004); Credit Scoring Technologies (Akhavein et al., 2005); Real Time Gross Settlement Systems (Bech and Hobijn, 2006); and Debit Cards and Electronic Giro Transactions (Bolt et al., 2008).

[4] The extent of competition is related to the geographical overlap of banks in different markets and their relative market share in terms of deposits. In particular, banks adopt earlier in markets where their competitors have already adopted.

[5] Hernando and Nieto (2007) also conclude that the internet was used as a complement to, rather than a substitute for, physical branches.

any subsequent cost saving, and that internet banks fail to create synergies with other banking activities.[6]

2.2 Credit Union Studies

The literature on technology adoption by credit unions is exclusively focused on the US credit union sector. Ono and Stango (2005) examine the factors that influence the decision to outsource information technology services. The decision to outsource is associated with asset size, and the diversity of the credit union's product offerings. Borzekowski and Cohen (2005) find that the propensity to outsource is increasing in the number of other credit unions in the same geographic location that also elect to outsource. Dow (2007) examines the adoption of web and computer based banking and find that larger credit unions are more likely to adopt new technologies earlier than their smaller counterparts. Callahan and Associates (2007) suggest that technology is still very much at the forefront of US credit unions' attempts to retain and increase membership, enhance competitiveness, improve efficiency and improve member services. Dandapani et al. (2008) find that offering web access increases operating expenses but adopters still maintain the same average profitability as that of non-adopters. They also find some evidence of increased asset growth in credit unions that offered web accounts. Damar and Hunnicutt (2010) study the determinants of internet banking adoption within a consumer decision making framework. They conclude that organizational form as well as size may be critical in the adoption of new technology. Pana et al. (2013) investigate the changes in benefits to credit union members via the interest-rate spread around the adoptions of internet-based services and show that adopters offer a less favorable interest-rate spread to their members than non-adopters[7].

[6] Although not addressed in this paper it should be noted that increased efficiency and performance is only one benefit an institution might realize from web adoption. For instance, ATMs were seen as a way of increasing an institution's market (see Hannan and McDowell 1984, 1990). A similar argument has been made for internet banking (see Petersen and Rajan 2002).

[7] Pana et al. (2013) also find evidence that early adopters have a lower degree of market power in dealing with their members than late adopters and offer interest-rate spreads comparable to those of non-adopters over a three-year period following the adoption year.

3: Methodology

In assessing the impact of adopting a new technology on a credit union's performance it is important to consider the appropriate comparison of before and after performance variables to obtain accurate causal inferences. A credit union that chooses to adopt a new web technology is likely to be characterized differently from those that do not adopt. These differences, if they influence a credit union's response to adoption, may invalidate causal comparisons, even after controlling for the differences that can be observed. The key issue for estimation is whether adoption is randomly assigned; that is can we assume the decision to adopt a new technology is independent of all other factors?[8]

The problem of evaluation of some treatment exposure (in this case website adoption) on outcomes has a long history in the statistics literature and is centred on the Rubin Causal Model, which compares potential outcomes used for causal inference. Potential outcomes are pairs of outcomes defined for the same unit given different levels of exposure to the treatment, where only the outcome corresponding to the level of treatment received is observed. This approach allows for general heterogeneity in the effects of treatment and a definition of the causal inference problem without the need for a statistical model.

An important feature of this approach is how treatment assignment is related to the potential outcome, which in observable data creates some estimation challenges. This problem is well understood when the assumption of `unconfoundness' can be applied.[9] This assumption adjusts treatment (adopters of the web technology) and control (non-adopters of the web technology) groups for differences in observed covariates, which removes all biases in the comparison of these two groups. To mimic such an approach using non-experimental financial data, as in this study, an attempt is made to find equivalent groupings in which everything apart for the variable of interest (and other controllable variables) are assumed to be the same[10].

[8] In the econometrics literature this problem is one of endogeneity or self-selection and has been traditionally investigated using fixed effects models and instrumental variable techniques.

[9] Unconfoundedness implies that there are sufficient controls – usually pre-treatment covariates and outcomes – so that, conditional on these controls, treatment assignment is essentially randomized.

[10] The unconfoundness assumption is not directly testable, although a number of indirect tests have been proposed in the literature. The first set of these tests is predicated on precise identification of an ineligible control group. In the context of our investigation this might be credit unions which cannot adopt website

In our panel dataset, which has repeated observations on individual credit unions over time two-way effects estimation can be derived from a counterfactual framework where un-confoundedness holds conditional on unobserved heterogeneity and the history of a set of covariates (the operational and structural characteristics of a credit union) thought to influence the outcome variable (the cost and performance of the credit union). After controlling for the operational and structural characteristics that are thought to influence cost and performance, the unobserved heterogeneity that is likely to remain would relate to technological ability, which is the ability of credit union staff and management to learn, adapt, and effectively utilise the new website technology to improve the performance of the credit union.

The baseline panel model employed in the investigation has the following form:

$$Outcome_{it} = \beta_0 + \beta_T D^T_{i,t-1} + Controls_{i,t-1} + DI_{it} + \alpha_i + \theta_t + \varepsilon_{it} \qquad (1)$$

The outcomes refer to a selection of cost and performance variables (*such as, return on assets, the interest rate spread, the loan rate, the pay-out rate, the cost to income ratio, capital expenditure, labour expenditure*). The specification includes an indicator variable for each panel which controls for unobservable individual credit union effects, α_i, (that do not vary over time) and a set of time dummies, θ_t, to control for group level time effects. The control matrix includes variables that are thought to affect the outcome (*such as, asset size, asset growth, delinquency rate, capital strength, county penetration*). Lagged values are used to help mitigate the possible endogeneity issue of contemporaneous feedback relationships with the performance and cost outcomes variables.

$D^T_{i,t-1}$, is a lagged dummy variable taking the value 1 if the credit union had a live website in that year, and zero otherwise. A lagged variable is used as the decision to adopt may not be strictly exogenous with for example funding to enable adoption dependent on the past performance of the credit union.[11]

technology – such credit unions do not exist. The second test is based on the use of lagged outcome variables (see Imbens and Wooldridge, 2009). We have implemented this test on all relevant outcome variables and find no evidence of an indirect violation of the unconfoundedness assumption.

[11] In using a lagged value we are assuming that the decision to adopt is weakly exogenous or pre-determined. That is $D^T_{i,t}$ is independent of all subsequent structural disturbances, $\varepsilon_{it+s}, s \geq 0$. Variables that are

Although time-constant variables, such as a dummy variables for common bond type and credit union location, cannot be included by themselves in a fixed effects model, they can be interacted with variables that change over time and, in particular, with year dummy variables. This controls for how the effect of the common bond and location impacts on performance and cost changes over time. The term, DI_{it}, is a vector of interaction terms of the dummy variables with the time dummies.

To test the robustness of our findings we reworked model (1) and incorporated an in-sample adoption dummy as an alternative approach. In this instance the in-sample adoption dummy takes the value of one for those credit unions which have adopted a website after 2002, the start of the sample period. This effectively re-categorises those credit unions which had adopted a website in 2002 to be in the control group and thus allows a more robust assessment of the impact of adoption to be estimated.

Early adopters may be inexperienced and new technologies may have poor customer acceptance, as such performance may be poor at the initial stages of adoption and the influence of a new technology may take time to manifest (Sullivan, 2000). To assess whether the effects of adoption persist over a longer period we again estimate model (1) but in this instance we use moving averages for two and three years for each of the outcome variables.

A limitation of a fixed effect estimator is that any unobserved time-varying variable, such as past outcomes, cannot be subsumed in the time-invariant omitted variable α_i. In Section 3 it was argued that it may be reasonable to assume that the history of the outcome variable has an influence on how adoption impacts upon the current outcome. Consequently in equation (2) a dynamic model is specified and is used to investigate if the statistical impact of website adoption persists in the presence of the history of these outcomes.

$$Outcome_{it} = \beta_0 + Outcome_{it-h} + \beta_T D_{i,t-1}^{T} + Controls_{i,t-1} + DI_{it} + \alpha_i + \theta_t + \varepsilon_{it} \qquad (2)$$

$Outcome_{it-h}$ is a vector of lagged values of the cost and performance variables for multiple periods.

predetermined in a model can be treated, at least asymptotically, as if they were exogenous in the sense that consistent estimators can be derived when they appear as regressors (Greene, 2008).

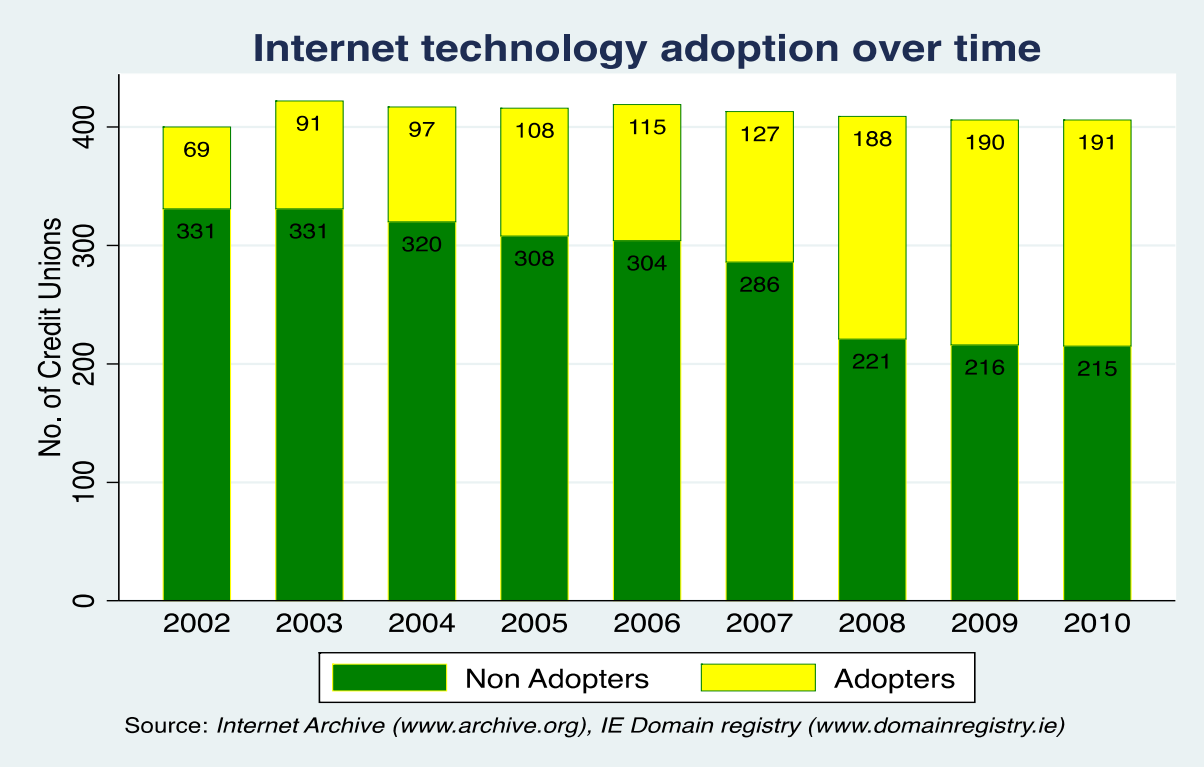
4: Data Analysis

In Section 4.1 information is presented on trends in web adoption over the period 2002 to 2010 plus summary findings from a survey of credit union websites in 2010/2011. In Section 4.2 we profile outcome variables (performance and cost variables) before and after website adoption by the credit union. Section 4.3 profiles the control variables employed in the panel models over the estimation period, 2002 - 2010.

4.1 Credit unions with a web-based presence 2002 to 2010

To empirically investigate adoption over time, data on the history of a credit union's website was acquired using the Internet Archive online facility and data from the IE domain registry. Figure 1 shows the trend in website adoption within the Irish credit union movement over the period for which we have financial data, 2002-2010.

Figure 1



There has been a steady increase in web adoption over the period although in 2010 53% of credit unions still did not have a web-based facility. Credit unions in Ireland can be distinguished in terms of their common bond as either occupational or community credit unions. In 2010 there were 45 occupational credit unions with the remainder (358) community based. In 2002, 20% of occupational credit unions had a web presence with this rising to 50% in 2010 (comparable figures for community credit unions were 16% and 47%).

Credit unions are also designated as rural or urban with an equal number of credit unions in each category. In 2002, 23% of urban credit unions had a web presence by 2010 this had risen to 57% (comparable figures for rural credit unions were 7% and 40%)[12].

It is usual to differentiate web functionality into three categories. At the first (lowest) level, an *informational* website displays general information on interest rates, and contact details. At the second (intermediate) level, an *interactive* website allows members to request information on share and loan balances, to request statements and also accepts applications for membership, loans or share accounts. Finally, at the third (highest) level, a *transactional* website also allows members to complete transactions such as paying bills, make loan payments or deposits, and transfer funds between accounts.

To gauge web functionality the researchers accessed all websites in 2010/2011. All websites could be classified, at a minimum, as *informational* sites offering details on products and services, opening hours and links to social media sites. Most sites also had some *interactive* elements such as enabling loan and share balance requests and accepting applications for loan and share accounts. Thereafter differences in web functionality appeared relatively modest with even the very largest credit unions offering relatively minor *transaction* functionality. For such sites there was some evidence of internal transactions such as account transfers, as well as external transactions, although less so, such as recurring bill payments and transfers to third party accounts. In Table 1 we present a summary of the services offered by means of the website and we also document the other technology based services provided by credit unions.

[12] The difference between adoption in rural and urban credit unions may be in part influenced by fibre optic coverage. In 2004, the Irish Government sponsored infrastructure project 'Fibre Optic Metropolitan Area Networks' was introduced aimed at permitting open access to private enterprise of 'always on' broadband. Phase I of this project saw the installation of fibre optic networks in 27 provincial towns with Phase II, commencing in 2010, tasked with adding a further 66 towns.

Table 1 Credit Union Web Functionality (2010/2011)

SERVICES OFFERED	
Year	2010/2011
Live web sites	191
Membership Application	115
Online Account Access	131
Online Loan Application	109
Loan Application download	44
Loan Calculator	140
Annual Report Online	36
Online General Enquiry	98
Privacy statement	100
Directors Login	15
Salary Deduction	76
Electronic Fund Transfer*	102
OTHER TECHNOLOGY ADOPTIONS	
Phone Banking	11
Phone a Loan	88
ATM-local*	26
ATM- Nationwide*	10

*While many credit unions indicate they have an electronic fund transfer facility the majority do not use the facility. Where it is used it usually takes the form of` a direct debit facility into or out of the credit union. Local ATMs restricted to withdrawals from the credit union branch only. Nationwide ATM use the banking network so withdrawals can be made at other banking ATMs.

The relatively unsophisticated nature of web-based provision relates to two factors. The first is that Irish credit unions have been unable to create a sophisticated integrated technology solution across credit unions and secondly credit unions are constrained by legislation and the regulatory authorities in the range of services that they provide. Irish credit unions for the most part are relatively simple savings and loans institutions. For example our audit of credit union service provision suggests that financial technologies such as phone banking and ATMs have adoption rates of considerably less than 10%. Therefore in the ensuing empirical

analysis we do not differentiate in terms of website functionality rather we simply divide credit unions into two categories those with a website and those without.

4.2 Performance and cost metrics

In the models detailed in Section 3, the dependent variable is described as an outcome variable. We consider a range of outcomes as website adoption may affect both performance and cost variables. The performance metrics considered are *return on assets; the interest rate spread* (the difference between the cost to members of borrowing and the pay-out to members on their deposits and shares); *the loan rate* and *pay-out ratio* are also investigated separately to decompose any overall effect in the interest rate spread. The cost variables considered are the *cost to income ratio*; with cost further assessed using *labour expenditure* and *capital expenditure*. See Appendix 1 for full definitions of the outcome variables.

In choosing this range of outcome variables we draw from two schools of thought in the measurement of credit union performance: 1) institutional efficiency, and 2) improved abnormal net gains. These two schools of thought are summarized by Rubin et al. (2013). The former school of thought has resulted in a variety of parametric and non-parametric efficiency studies where the outcome variable tends to be cost related; one such example is that by Glass et al. (2010) which uses a cost function to explore performance determinants for Irish credit unions. The latter school of thought builds on theoretical discussion of the credit union's objective function (see Smith, 1984, 1986). Bauer (2008) adopts a member benefit objective function in dissecting abnormal performance – members with large deposits/shares want high interest rates/dividends while members with large loans want lower loan rates. Such objectives lead to a natural squeeze on margins. In the context of our study we use *the interest rate spread*, and its constituent parts *the loan rate* and the *pay-out* ratio as outcome variables.[13]

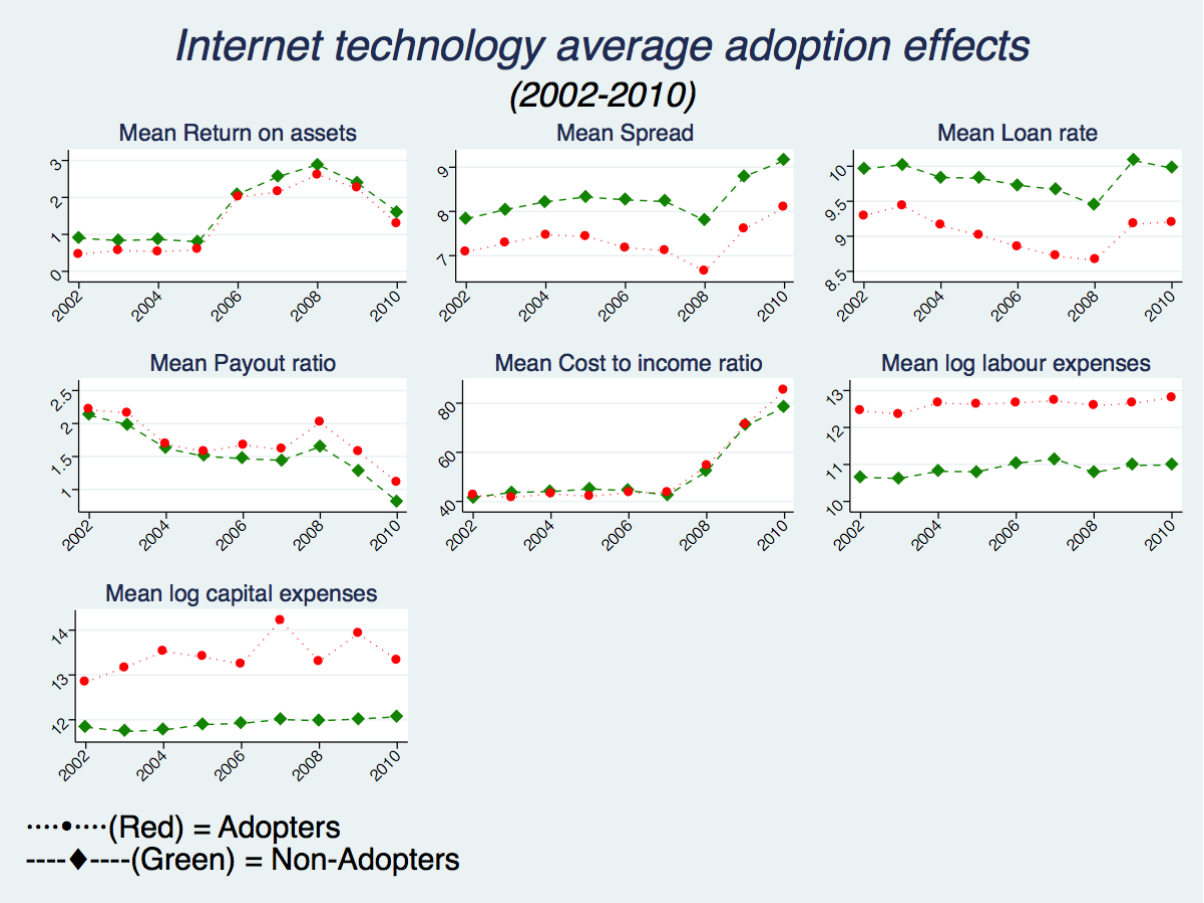
Figure 2 presents a preliminary visualization of the performance and cost metrics grouped by whether the credit union has adopted a website or not. The graphical analysis reveals some distinct difference with web adopters experiencing lower spreads on average (driven it seems

[13] It is interesting to note that both schools of thought tend to yield similar results. For instance Bauer, Miles and Nishikawa, 2009 use the abnormal net gains approach in a study of US credit union mergers, but report that their results are the same as those of other researchers who used Data Envelopment Analysis.

by lower average loans rates), a marginally higher pay-out ratio and higher average labour and capital expenditures. The latter finding is consistent with the initial encroachment on costs of the adoption of a new technology; initially an increase in labour and capital expenses may coincide with adoption and preparation for adoption[14]. The former finding suggests that credit unions are passing any benefit accrued from this new technology to their membership. The graphical analysis suggests that both saving members and borrowing members benefit but that the majority of the benefit accrues to borrowers. That said, care must be taken when drawing any causal inference on the effect of adoption from these graphs as to do so infers that the non-adopters and adopters have no other differences other than treatment (adoption of a website).

[14] See DeYoung et al. (2007) for empirical evidence of increases in labour expenses due to the adoption of internet technologies.

Figure 2



4.3 Control Variables

A number of credit union characteristics are used in a conditioning covariate set to control for observable differences in the performance and cost metrics between website adopters and non-adopters. It is important to include factors that are thought to distinguish how a credit union will engage with web technology. Risk metrics are included namely a *capital ratio* and a *delinquency ratio;* the size of the credit union and its growth performance are included through incorporating *asset size* and *asset growth;* the adoption rate is likely to be increasing in the number of prior adopters, with adopters who are geographically close probably particularly important, to capture this a *penetration rate per county over time* is included.[15] See Appendix 1 for full definitions of the control variables.

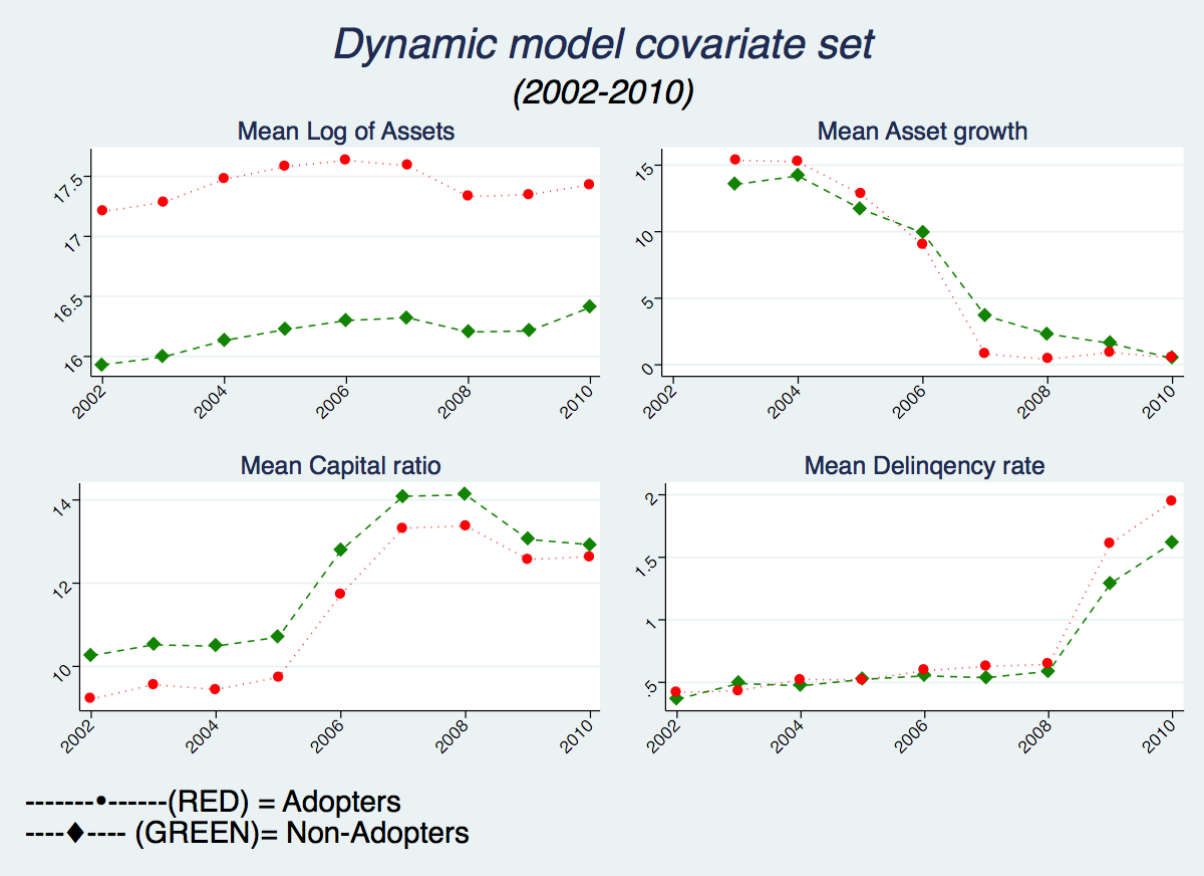
[15]The network effects literature suggests that demand for a product can be related to the number of adopters of compatible products (Gowrisankaran and Stavins, 2004).

Organizational structure such as the distinction between credit unions structured around an occupational common bond and those based on a community bond may be important. Occupational credit unions are more like to adopt a website as their members tend to be mostly in employment, are on average better educated and consequently likely to be technologically literate[16]. Whether the credit union is urban or rural may also prove important. Urban credit unions are more likely to adopt due to superior connectivity in urban areas. Unfortunately time-constant variables, such as common bond type and location, cannot be included by themselves in fixed effects models such as those detailed in Section 3 (Methodology). They can, however, be interacted with variables that change over time and, in particular, with year dummy variables. This controls for how the effect of the common bond and location on the outcome variable changes over time and quantifies how the common bond and location effect in each year differs from that in a base year. The term, DI_{it}, in equation (1) and (2) is a vector of interaction terms of dummy variables for bond type and location with time dummies.

Figure 3 depicts the operational control variables again grouped by whether the credit union adopts a website or not. The analysis shows that credit unions that adopt a website are typically bigger in size, and have lower capital ratios with perhaps surprisingly the suggestion that since 2008 delinquency rates are higher for those credit unions that have adopted a web-based presence. Higher delinquency rates may relate to weakened customer loyalty due to the impersonal nature of technology based distribution channels.

[16] Bauer and Hein (2006) argue "*the more one earns, the more likely that a computer has been purchased, reducing the marginal cost of internet banking*". Lee et al. (2008) argue that the less affluent may be less likely to be user of e-banking technologies.

Figure 3



5 Empirical Findings

Table 2 presents the estimation results for the baseline panel model defined in equation (1). From Table 2 it can be seen that after controlling for a number of credit union characteristics, the adoption effect is statistically significant at the 1% level in both the interest rate spread and loan rate models. It is not significant in the equations where return on assets, pay-out rate, cost to income ratio, labour expenditure and capital expenditure are the dependent variables. The coefficient estimates on the web adoption effect in the interest rate spread and loan rate models are negative. The implication of the negative findings is that the benefits from new web technology adoption is being passed to members in the form of a reduced spread between the pay-out rate paid to members and the loan rate charged to members with the reduction in spread being essentially due to a loan rate reduction. The latter is supported by the insignificance of the adoption effect in the pay-out rate specification. That credit unions are passing benefits to members in the form of a reduced rate on loans probably relates to the fact that a majority of Irish credit unions have been significantly under lent in

recent years and competitive loan rates may help to increase lending levels, see Report of the Irish Commission on Credit Unions (2012).

Dow (2007), who examines the adoption of web and computer based banking, finds that larger more technologically sophisticated credit unions are more likely to adopt new technologies earlier than their smaller counterparts. In Table 1 we highlighted limited technological sophistication in all but a small number of credit unions. It is these credit unions that can be expected to have a greater capacity to innovate in terms of technology adoption.

To test the robustness of our findings we reworked model (1) and incorporated an in-sample adoption dummy as an alternative approach. In this instance the in-sample adoption dummy takes the value of one for those credit unions which have adopted a website after 2002, the start of the sample period. This is a much stricter definition which controls for the influence of early adopters (probably the more technologically sophisticated credit unions) and can be expected to lower the value of the estimate of the adoption effect (see Lewbel, 2007). It effectively re-categorises those credit unions which had adopted a website in 2002 to be in the control group and consequently permits a more robust assessment of the impact of adoption to be estimated. The empirical findings are presented in Table 3 and as in the previous analysis the new website indicator is again negative and statistically significant at the 1% level in the loan rate and interest rate spread equations ultimately indicating that credit union members enjoy a reduced loan rate as a consequence of web adoption.

In that new technology may have poor initial customer acceptance and consequently the influence of a new technology may take time to manifest we re-estimate model (1) using moving averages for two and three years for each of the outcome variables, see Table 4. An encouraging result is the persistence of the adoption effect on both loan rates and spreads over the two and three year window. In fact there appears to be a slight increase in the estimated coefficients as the time period extends, for example the one year spread effect is -0.338 (see Table 3) while the two and three year effects are respectively -0.373 and -0.393 (see Table 4). The increase in average effect over time may be indicative of some form of learning economies when adopting a new technology, see for example, DeYoung (2005); Delgado et al. (2007). In Table 4 there also appears to be evidence of an effect on the cost to income ratio on a three-year moving average basis.

In Section 3 it was argued that it may be reasonable to assume that the history of the outcome variable has an influence on how adoption impacts upon the current outcome, motivating model (2). In Table 5 the empirical estimation of a dynamic model for the outcome variables which have proved resilient to estimation (the spread and the loan rate) is documented. A lag model structured on three time periods was found to best capture the dynamic nature of both loan rates and spreads. The Arellano and Bond (1991) panel data test for autocorrelation in the residual is reported and highlights the absence of any autocorrelation in the error matrix. Once the dynamic nature of the outcome variable is considered there is no longer any significant relationship found for website adoption in the spread model. However, the specification with loan rate as the outcome continues to exhibit a negative significant adoption effect at the 5% level, although the effect is somewhat reduced.

Our finding of a positive outcome from web adoption does find support in the academic literature. DeYoung (2005) highlights that offering internet banking services improves the profitability of small US banks. DeYoung et al. (2007) find that US community banks which adopt a transactional banking website are more profitable that branching-only community banks. Overall, the various estimations in our study suggest that the web adoption effect on the loan rate ranges from a value of -0.107 (Table 5) to -0.325 (Table 3). For the average credit union loan of €3,025 this suggests an annual interest cost reduction of between €3.24 and €9.83 due to web adoption[17]. At the lower level this is not a sizeable saving, however it should be recognized that many of those who conduct business through a credit union are of modest means and any cost saving is likely to be welcomed. Additionally, web functionality has been demonstrated to be relatively limited and consequently a finding of cost benefits in adoption holds out an expectation that more sophisticated technology adoption can lead to further improvements in the welfare of members.

6: Concluding Comments

In this analysis we detail the diffusion of web adoption by credit unions over the period 2002 to 2010 and highlight that even at the end of this period 53% of credit unions do not have a web presence. Websites, where they exist, could be classified at a minimum as informational

[17] Our financial database has annual information on loan numbers and loan amounts for each credit union. For 2010 we calculate the average credit union loan to be €3,025.

sites offering details on products and services, opening hours and links to social media sites. Most sites also had some interactive elements such as enabling loan and share balance requests and accepting applications for loan and share accounts. Thereafter differences in web functionality appeared relatively modest with even the very largest credit unions offering relatively minor transaction functionality.

Panel data techniques were used to identify the effect of website adoption on the cost and performance of credit unions. A result which consistently emerges across the various specifications is that the adoption of a web presence resulted in a reduction in the loan rate and the spread with this reduction driven by a fall in the loan rate. It was also noted that the spread and loan rate adoption effects persists over both a two and three-year period and tend to increase with duration. Although the reduction in loan cost due to web adoption is small its existence does highlight that the adoption of a web presence, albeit with limited functionality, translates into cost benefits for borrowing members.

The data upon which this study is based does not permit assessment of which aspects of web technology are important in driving the loan cost reductions. This is an aspect which we will pursue in follow up work. Nevertheless we feel this paper is of importance as Irish credit unions are now entering a period of substantive structural change which will in part be based around technological improvements. The Credit Union Re-Structuring Board, established in 2012, has been allocated €250 million to facilitate restructuring and to enable 'anchor' credit unions upgrade their ICT systems. This study which highlights that the adoption of a website, even with limited functionality, can provide cost reductions and performance enhancement points to the potential of additional benefits accruing from more sophisticated levels of technological advance.

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Table 2: Two Way Individual Effects Model

Regressors	ROA	Spread	Loan Rate	Pay-out Rate	Cost-to-Income	Labour Expenditure	Capital Expenditure
Website$_{t-1}$	-0.009	-0.333***	-0.275***	0.057	0.218	0.004	0.112
	(0.115)	(0.116)	(0.094)	(0.068)	(1.866)	(0.039)	(0.155)
Asset growth	0.001	-0.001	-0.007	-0.006	-1.039***	0.004	0.014
	(0.007)	(0.006)	(0.005)	(0.004)	(0.117)	(0.003)	(0.016)
Log of Assets $_{t-1}$	-0.047	-0.063	0.257	0.320	-27.591***	0.628**	-0.144
	(0.424)	(0.356)	(0.343)	(0.223)	(5.766)	(0.275)	(0.900)
Capital ratio $_{t-1}$	0.146***	-0.016	0.024*	0.040***	0.333	0.011	-0.058
	(0.029)	(0.018)	(0.013)	(0.015)	(0.262)	(0.008)	(0.062)
Delinquency rate $_{t-1}$	0.063*	0.143***	0.145***	0.001	-1.324**	-0.043	0.041
	(0.038)	(0.029)	(0.028)	(0.018)	(0.568)	(0.057)	(0.046)
Loans to assets $_{t-1}$	0.007	-0.005	0.009*	0.013***	0.525***	0.002	-0.002
	(0.006)	(0.006)	(0.005)	(0.003)	(0.091)	(0.003)	(0.008)
Cost to income $_{t-1}$	-0.014***	0.007***	-0.004***	-0.012***		0.000	-0.007
	(0.003)	(0.002)	(0.002)	(0.002)		(0.002)	(0.008)
County penetration rate	0.928*	0.340	0.375	0.035	2.899	0.134	-0.008
	(0.474)	(0.284)	(0.236)	(0.208)	(5.230)	(0.174)	(0.176)
Observations	3,044	3,044	3,044	3,044	3,044	3,044	3,044
Wald	899.8	751.8	532.3	893.0	1237	1270	678.2
Rho	0.649	0.751	0.837	0.608	0.840	0.908	0.583
$Corr(\alpha_i, X_{it})$	0.0892	0.133	-0.375	-0.267	-0.868	0.501	-0.101

Rho estimates the variation in the model, which can be attributed to the unobserved individual effect. Bootstrapped standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 3: Two Way Individual Effects Model (In Sample Adoption Indicator)

Regressors	ROA	Spread	Loan Rate	Pay-out Rate	Cost-to-Income	Labour Expenditure	Capital Expenditure
Website$_{t-1}$	-0.069	-0.338***	-0.325***	0.013	0.946	0.001	0.114
	(0.134)	(0.123)	(0.092)	(0.064)	(1.973)	(0.034)	(0.170)
Asset growth	0.000	-0.001	-0.007	-0.006	-1.036***	0.004	0.014
	(0.007)	(0.006)	(0.005)	(0.004)	(0.114)	(0.004)	(0.017)
Log of Assets $_{t-1}$	-0.060	-0.058	0.251	0.310	-27.433***	0.627**	-0.146
	(0.397)	(0.375)	(0.324)	(0.235)	(5.525)	(0.271)	(0.973)
Capital ratio $_{t-1}$	0.145***	-0.015	0.025**	0.040**	0.335	0.011	-0.058
	(0.030)	(0.017)	(0.012)	(0.015)	(0.241)	(0.008)	(0.067)
Delinquency rate $_{t-1}$	0.064*	0.143***	0.145***	0.002	-1.328**	-0.043	0.041
	(0.038)	(0.030)	(0.027)	(0.019)	(0.563)	(0.059)	(0.044)
Loans to assets $_{t-1}$	0.007	-0.005	0.009*	0.014***	0.525***	0.002	-0.002
	(0.006)	(0.006)	(0.005)	(0.003)	(0.094)	(0.003)	(0.007)
Cost to income $_{t-1}$	-0.014***	0.007***	-0.004***	-0.012***		0.000	-0.007
	(0.003)	(0.002)	(0.002)	(0.002)		(0.002)	(0.008)
County penetration rate	0.962**	0.332	0.394*	0.062	2.493	0.136	-0.005
	(0.453)	(0.296)	(0.219)	(0.207)	(4.945)	(0.173)	(0.176)
Observations	3,044	3,044	3,044	3,044	3,044	3,044	3,044
Wald	993.1	827.1	665.4	896.9	1458	1201	637.4
Rho	0.648	0.757	0.842	0.602	0.839	0.908	0.584
$Corr(\alpha_i, X_{it})$	0.0902	0.0891	-0.416	-0.238	-0.867	0.502	-0.110

Rho estimates the variation in the model, which can be attributed to the unobserved individual effect. Bootstrapped standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 4: Persistence of Adoption Effects

Regressors	ROA 2 year MA	ROA 3 year MA	Spread 2 year MA	Spread 3 year MA	Loan Rate 2 Year MA	Loan Rate 3 Year MA	Pay-out rate 2year MA	Pay-out rate 3 Year MA	Cost-to-Income 2year MA	Cost-to-Income 3 Year MA	Labour Expenditure 2 Year MA	Labour Expenditure 3 Year MA	Capital Expenditure 2 Year MA	Capital Expenditure 3 Year MA
$Website_{t-1}$	-0.073	-0.245*	-0.373***	-0.393***	-0.316***	-0.394***	0.057	-0.001	0.456	1.830*	0.002	-0.012	0.040	0.097
	(0.121)	(0.139)	(0.102)	(0.106)	(0.083)	(0.097)	(0.064)	(0.061)	(0.929)	(1.065)	(0.028)	(0.022)	(0.084)	(0.128)
Asset growth	0.011*	0.009	0.006	0.008	0.001	0.002	-0.005	-0.006*	-0.499***	-0.278***	0.001	0.003	-0.009	-0.018
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.060)	(0.046)	(0.002)	(0.002)	(0.010)	(0.019)
$Ln(Assets_{t-1})$	0.124	-0.126	-0.090	-0.018	0.341	0.311	0.431*	0.328	-12.239***	-6.786*	0.547**	0.411*	-0.683	-0.865
	(0.419)	(0.417)	(0.353)	(0.353)	(0.301)	(0.324)	(0.222)	(0.241)	(3.142)	(3.669)	(0.262)	(0.231)	(1.461)	(1.494)
Capital ratio $_{t-1}$	0.142***	0.108***	-0.002	-0.000	0.036***	0.022*	0.038***	0.022**	0.277**	0.273*	-0.001	-0.001	-0.032	-0.053
	(0.028)	(0.026)	(0.014)	(0.014)	(0.012)	(0.012)	(0.011)	(0.010)	(0.129)	(0.160)	(0.007)	(0.007)	(0.037)	(0.056)
Delinquency rate $_{t-1}$	0.071**	0.064**	0.157***	0.111***	0.173***	0.144***	0.015	0.033**	-0.955***	-0.809**	-0.040	-0.024	0.024	0.093
	(0.033)	(0.032)	(0.029)	(0.024)	(0.021)	(0.022)	(0.019)	(0.016)	(0.346)	(0.341)	(0.028)	(0.016)	(0.034)	(0.104)
Loans to assets $_{t-1}$	0.006	0.004	-0.028***	-0.019***	-0.017***	-0.006	0.011***	0.012***	0.250***	0.233***	0.005**	0.005**	-0.002	0.001
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.048)	(0.052)	(0.002)	(0.002)	(0.007)	(0.005)
Cost to income $_{t-1}$	-0.005**	-0.007**	0.002	0.001	-0.005***	-0.006***	-0.008***	-0.007***	0.558***	0.326***	0.003**	0.004***	-0.002	-0.013
	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.032)	(0.029)	(0.001)	(0.001)	(0.005)	(0.015)
County penetration rate	1.109***	1.082**	0.610*	0.388	0.294	0.307	-0.315	-0.081	1.557	-1.858	0.136	0.103	-0.260	-0.626
	(0.369)	(0.425)	(0.318)	(0.290)	(0.225)	(0.214)	(2.596)	(3.442)	(2.596)	(3.442)	(0.119)	(0.119)	(0.331)	(0.532)
Observations	3,044	2,608	3,044	2,608	3,044	2,608	3,044	2,608	3,044	2,608	3,044	2,608	3,044	2,608
Wald	1119	817.1	650.1	355.5	495.3	356.3	926.8	537.7	4063	1543	1658	1342	575.7	581.2
Rho	0.751	0.809	0.821	0.877	0.881	0.913	0.757	0.798	0.811	0.709	0.957	0.979	0.854	0.874
$Corr(\alpha_i, X_{it})$	0.0226	0.0940	-0.00158	0.0114	-0.472	-0.485	-0.414	-0.299	-0.667	-0.349	0.554	0.610	-0.474	-0.537

Rho estimates the variation in the model, which can be attributed to the unobserved individual effect. Bootstrapped standard errors in parentheses*** p<0.01, ** p<0.05, * p<0

Table 5: Dynamic Models

	Spread	Loan Rate
Y_{t-1}	0.589***	0.759***
	(0.024)	(0.031)
Y_{t-2}	0.200***	0.109***
	(0.035)	(0.036)
Y_{t-3}	0.081***	0.060**
	(0.030)	(0.031)
$Website_{t-1}$	-0.088	-0.107**
	(0.059)	(0.042)
Asset Growth	-0.012**	-0.009**
	(0.005)	(0.004)
Log of $Assets_{t-1}$	-0.175***	-0.087***
	(0.024)	(0.016)
Capital $ratio_{t-1}$	-0.002	0.002
	(0.007)	(0.005)
Delinquency $rate_{t-1}$	0.041	-0.013
	(0.029)	(0.028)
Loans to $assets_{t-1}$	0.002	0.006***
	(0.002)	(0.001)
Cost to $income_{t-1}$	0.006***	0.000
	(0.002)	(0.001)
County penetration rate	-0.204*	0.024
	(0.114)	(0.087)
Observations	2,185	2,185
AB1	0.399	0.118
p-value	0.690	0.906
AB2	-2.212	-1.607
p-value	0.0270	0.108
AB3	-2.712	-1.422
p-value	0.00669	0.155

AB# is the (Arellano & Bond, 1991) panel data test for autocorrelation in the residual for # lags. The constant term and year dummies are suppressed from each output.
Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.
This dynamic model was also estimated using all other outcome variables and results are available upon request.

Appendix 1
Definition of Outcome and Conditioning Variables

Variable	Definition
Adoption indicator	
Website	A binary variable taking the value one if the credit union has a live website nine months before the year end, zero otherwise
Outcome Variables	
Return on Assets	The ratio undistributed surplus to total assets of the credit union, expressed in percentage terms.
Spread	The difference between loan rate and pay-out rate, expressed in percentage terms
Loan rate	The ratio of interest on members loans to total loans of the credit union, expressed in percentage terms
Pay-out rate	The ratio of interest paid on members' deposits and dividends paid on members' shares to the sum of members' deposits and members' shares, measured in percentage terms.
Cost-to-Income	The ratio of total expenditure less losses on investment to the total income of the credit union, expressed in percentage terms.
Labour expenditure	The ratio of salary expenditure plus treasurer's honorarium plus pension expenses to total expenditure less losses on investments, expressed in percentage terms.
Capital expenditure	The ratio of operating expenditure plus depreciation to total expenditure less losses on investments, expressed in percentage terms.
Conditioning Variables	
Asset growth	The logarithmic difference in total assets on an annual basis
Log of assets	Logarithm of the total assets of the credit union
Capital ratio	The ratio of statutory and other reserves to total assets of the credit union, expressed in percentage terms
Delinquency rate	The ratio of bad debts written off to total loans of the credit union, expressed in percentage terms.
County penetration rate	The ratio of credit unions in a county with a live website to the total number of credit unions in that county, expressed in percentage terms.