Market Structure and the Diffusion of E-Commerce: Evidence from the Retail Banking Industry*

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June 30, 2009

Abstract

This paper studies the effect of market structure on the diffusion of e-commerce technologies. These include self-serve electronic check-in/-out kiosks, online retail outlets, online customer-service centers, and e-banking, which reduce costs for firms relative to their old, non-electronic (offline) technology. The full benefits for firms of these technologies, however, accrue only once consumers begin to perform a significant share of their transactions using electronic options. Since learning costs are involved in the adoption of the new technology, firms may try to encourage consumers to switch to the electronic option by manipulating the relative quality of the two options. We argue that their ability to do so is a function of market structure. In more competitive markets, reducing the relative attractiveness of the offline option involves the risk of losing customers (or potential customers) to competitors, whereas this is less of a concern for a more dominant firm. We study this issue in the context of the retail banking industry. Using household survey data on banking habits, as well as data on branch-locations, we find that households respond to branch closures by adopting and using e-banking more intensively. We show that a bank's ability to close branches, and therefore gain from this consumer response, depends on market structure.

JEL classification: D14, D4, G21, L1

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1 Introduction

This paper studies the diffusion of new cost-reducing technologies. As the final stage of the research and development process, this diffusion represents an important contribution to productivity growth. We are interested in innovations in e-commerce, such as self-serve electronic check-in/-out kiosks, online retail outlets, and online customer service centers that reduce the cost for firms of servicing customers relative to their old, non-electronic technology. Our analysis focuses on the diffusion of a specific e-commerce technology, namely, the online channel in the retail banking industry. Online banking (or e-banking) represents a cost-reducing technology, since it is less costly for banks if consumers perform day-to-day transactions online rather than at the teller.[1]

We are particularly interested in the role that market structure plays in affecting this diffusion. The relationship between market concentration and the diffusion of a new process innovation (a technology that reduces the cost of production) has been studied extensively.[2] That literature focuses on the trade-off that firms face between the incentive to delay adoption, since the cost of adoption is expected to fall over time, and the incentive to adopt early to prevent or delay adoption by competitors in the case of strategic rivalry. The evidence is somewhat mixed, but generally, competition is found to speed up diffusion, since it gives rise to a pre-emptive motive for technology adoption.

In the literature, it is assumed that once firms adopt the new technology, any increase in returns is immediately realized. There are instances, however, where the realization of the full benefits of a new technology depends on the extent to which consumers use it in the place of the old technology. This is particularly true for innovations in e-commerce. Airlines and retail outlets may invest in the installation of electronic kiosks, but the benefits from adoption are realized only once consumers start checking in/out electronically. The same holds for e-banking. Despite the fact that banks have adopted these mechanisms, their

[1]Using internal data from twenty of the top U.S. banks, Boston Consulting Group (2003) concludes that banks could double their profits if customers switched from offline to online bill payment. Also, DeYoung, Lang, and Nolle (2007) report a positive correlation between community bank profitability and early adoption of an operational website.

[2]See Reinganum (1981a), Reinganum (1981b), and Fudenberg and Tirole (1985) for theoretical analyzes of the effect of market concentration on the speed of adoption. Kamien and Schwartz (1982) survey the early empirical work on this relationship. See Forman and Goldfarb (2006) for a review of the literature on the adoption and diffusion of information and communication technologies. Also see early work by Hannan and McDowell (1984), Levin, Levin, and Meisel (1987), and Karshenas and Stoneman (1993). More recently this question has been studied by Hamilton and McManus (2005), Schmidt-Dengler (2006), Gowrisankaran and Stavins (2004) (for technologies featuring network externalities), and Seim and Viard (2006).

full benefits can be realized only if consumers decide to perform their banking transactions electronically rather than at traditional "bricks-and-mortar" branches. This situation also exists for online customer-service centers and for online retail outlets.

The fact that diffusion is consumer-driven implies a different role for market structure in affecting firm incentives and the resulting diffusion of new e-commerce technologies. In markets where firms operate both the e-commerce technology (we will refer to this as the online option) and the old, non-electronic technology (the offline option), they may have an incentive to manipulate the relative attractiveness of the two options to encourage consumers to adopt the less costly one. Evidence suggests that manipulating offline price and the local availability of offline outlets can affect the use of e-commerce by consumers (see Goolsbee (2000), Ellison and Ellison (2006), and Prince (2007)). Whether or not firms are able to engage in this type of behavior depends on local market structure. There is evidence that local competition plays a role in affecting firms' decisions regarding quality.[3] Therefore, reducing the attractiveness of traditional retail stores by closing offline outlets, reducing staff, or decreasing operating hours involves a greater risk of losing customers (or potential customers) when the local market is more competitive. In the case of e-commerce technologies, instead of the pre-emptive technology adoption motive, increased competition generates a business-stealing effect, which slows the penetration of the cost-reducing technology.

To our knowledge, this role for market structure has not been studied. There has, however, been some work on the effect that the diffusion of e-commerce has on market structure. For instance, Goldmanis, Hortaçsu, Syverson, and Emre (2008) look at the effect of the introduction of e-commerce on market reorganization in a number of industries. They find that in the automobile dealership and bookstore industries, small stores exited local markets where the use of e-commerce channels grew most rapidly. The underlying assumption in their analysis, however, is that the diffusion of e-commerce is an exogenous process. This may not be an appropriate assumption in markets where firms operate both online and offline channels.

To study this issue, we focus on the retail banking industry and the diffusion of e-banking. We are interested in the trade-off that banks face between (i) making branch banking relatively less attractive to encourage consumers to switch to e-banking – the *technology-*

[3]Cohen and Mazzeo (2007) analyze the effect of market structure on bank branching decisions and find that networks are larger in more competitive markets. Hoxby (2000) finds that metropolitan areas with more school districts have higher-quality public schools, i.e. greater levels of student achievement. Mazzeo (2003) finds that more competitive airline routes feature better on-time performance.

penetration incentive –, and (ii) maintaining quality for fear of losing consumers to rivals – the *business-stealing* incentive –, and the role that competition plays in influencing this trade-off. We set up a model of branch-network competition that formalizes the trade-off banks face between the technology-penetration and business-stealing incentives. Our hypothesis is that, since the business-stealing incentive should be less important for banks that face less attractive rivals, competition is expected to increase the quality of branch networks offered by banks and therefore decreases the usage rate of electronic transactions. Our predictions are in contrast to those in the literature that have examined the relationship between market concentration and the diffusion of a new process innovation. As mentioned, much of the literature has found that adoption is typically faster in more competitive markets.

Our empirical analysis focuses on the Canadian retail banking industry, which features a small number of large banks that have traditionally provided an extensive network of branches for their clients. Since 1998, however, the average bank's branch network has shrunk by 23 per cent, and the total number of branches fell by 29 per cent. Over the same period, Canadians became some of the world's heaviest users of electronic payments. In December 1997, the Royal Bank of Canada became the first Canadian bank to offer some banking services online and, soon after, the major Canadian banks all had operational websites. By 2006 the amount of transactions performed electronically exceeded 300 million. To study the substitution between online and offline banking channels and the role that branch quality and market structure play in this substitution, we combine two unique data sets. The Canadian Financial Monitor (CFM, Ipsos-Reid) contains information on the usage of different banking channels from 1999 to 2006, a period immediately following the introduction of e-banking in Canada, along with detailed information on the demographic characteristics of respondents. To measure the quality of the branch network, we use location data from the Financial Services Canada directory (Micromedia ProQuest). The directory provides information on branch locations in all local markets for all of the years in our sample, as well as years prior to the introduction of e-banking. With this information, we construct measures of branch density to reflect the quality of the offline option, since there is persuasive evidence that consumers care strongly about the extent of a bank's network of branches (Kiser (2004), Cohen and Mazzeo (2007) and Grzelonska (2005)).[4]

[4]As mentioned above, firms can use other mechanisms to degrade the quality of their offline option, such as decreasing the number of staff or reducing operating hours. In the case of retail banking, manipulating the number of branches in operation affects wait times and travel distances, while these other quality measures affect only wait times. Relative prices could also affect some banking markets, but not at the local level, since the Canadian retail banking industry features a small number of very large national institutions that

Our empirical work supports the prediction that banks can rationalize their networks in order to encourage adoption and that it is easier to do so in less competitive markets and for more dominant banks. Our analysis involves three results: 1) We first study, using a household-level analysis, the degree of substitutability between e-banking and branch banking for households. More specifically, we consider the effect of changes in the presence of a branch in a household's local neighborhood on its adoption and use of e-banking. We show that branch closures cause increased adoption and usage. 2) Next we study diffusion of e-banking at the market level. We establish that initial market structure plays an important role in influencing the diffusion of e-banking. 3) Finally, we investigate whether one mechanism via which this diffusion is encouraged is branch-network reorganization. We show that there were more closures in the period following the introduction of e-banking in markets that were initially more concentrated and that featured more dominant banks.

The paper proceeds as follows. Section 2 provides an overview of the Canadian banking industry, including a discussion of the degree of branch rationalization seen in Canada since 1998 and the changing banking behavior of Canadians. Section 3 presents a model of branch-network competition that generates predictions about the relationship between competition and branch network size. Section 4 describes the data and Section 5 outlines our empirical approach and presents our results. Section 6 offers conclusions and outlines future work. An Appendix contains tables describing the data and reports results.

2 The Canadian banking market

The Canadian retail banking industry features a small number of very large, federally regulated national institutions that dominate most local markets.[5] The industry is best described as a stable oligopoly Bordo (1995), with almost no exit and little entry, at least on the retail side.[6] The major banks provide similar products and services and are not dissimilar in terms of standard measures of productivity and efficiency Allen and Engert (2007). There has been one substantial merger during our sample period. In 2000, Toronto-Dominion Bank

dominate most local markets. Although day-to-day banking is done locally, posted banking fees of each individual bank are standardized across regions.

[5]The top five banks are: Royal Bank Financial Group, Bank of Montreal, Canadian Imperial Bank of Commerce, TD Canada Trust, and Bank of Nova Scotia.

[6]There has been a large inflow of foreign banks into the Canadian market, but mostly on the corporate side of banking. A few foreign banks have made inroads in the retail market, including ING Canada, a virtual bank. By 2006, neither ING nor any of the other virtual banks had a strong presence in the Canadian market. ING's share of deposits, for example, was about 1.5 per cent in 2006.

and Canada Trust merged to become TD Canada Trust.

The industry is characterized by several key facts: (i) 85 per cent of banking assets are held by the five largest banks; (ii) at least one of these banks operates in 98 per cent of the census divisions, and at least two in 81 per cent;[7] (iii) the remainder of the Canadian banking industry features a large number of foreign and domestically owned small banks, as well as provincially regulated credit unions; and (iv) there is considerable variation in the level of competition in the census divisions. Figure 1 presents the distribution of Herfindahl-Hirschman Indices (HHI), measured using the distribution of branches rather than deposits, across census divisions for 1998.[8] There is a large mass slightly over 2000, as well as a substantial mass beyond that, indicating a high degree of concentration in some markets.

The structure of the Canadian banking industry has led to national pricing strategies. Regardless of where they live, Canadians face the same prices. For example, a standard checking account at a Canadian bank in 2006 cost approximately $4 per month, irrespective of location. This gives clients access to all of a bank's delivery channels, although some banks charge a handling fee for branch transactions.

Over the past decade, the largest Canadian banks have profoundly changed their way of offering retail banking services. Between 1998 and 2006, the top eight Canadian banks have, on average, reduced the number of retail branches they operate by 23 per cent, despite a 37 per cent increase in deposits. In contrast, in the period 1982-1997, the top six Canadian banks closed only 2.3 per cent of their branches. This suggests that the period before e-banking was characterized by a relatively stable, steady-state level of branches. By 1998 the major Canadian banks had invested in the necessary infrastructure to offer e-banking services. Given that these banks paid the fixed cost of technology adoption, it became cheaper for banks to have households move their transactions from offline to online, lowering the marginal cost of a transaction.

Summary statistics regarding branch network reorganization are reported in Table 1 for all markets. On average, the change from 1998 to 2006 in the average number of own branches per square kilometer is -23.2 per cent. The average change in total branch density is -29.5 per cent. For both the average number of own branches and the total number of branches, the rate of rationalization is higher the more concentrated the market (ranked according to HHI

[7] We define a market as a census division. A census division is similar to a county in the United States and there are 288 of them.

[8] Because of data restrictions, we define the HHI of a market using the number of branches owned by each bank rather than by deposits. As one would expect, however, the number of branches and the value of deposits are highly correlated, with a correlation coefficient of 0.9 when computed at the provincial level.

in 1998). This pattern provides a preview of our empirical results regarding the relationship between closures and market concentration.

From 1999 to 2006, Canadians quickly became among the world's most frequent users of electronic payments. The number of transactions performed electronically increased from 47 million per year to more than 300 million from 2000 to 2006, while the share of consumers who did at least some online banking increased from 17 per cent in 1999 to 58 per cent in 2006.

Table 2 documents Canadian banking habits.[9] We include the rate of household access to the Internet from work and from home. Web access is necessary for e-banking and is a key variable in our analysis. Web access at work increased from 34 per cent to 44.2 per cent between 1999 and 2002, but remained stable afterwards. Home web access, on the other hand, steadily increased from 35.3 per cent to more than 70 per cent in 2006.

With respect to bank services, the majority of households continue to visit a teller at least once a month, although this number has fallen as more households adopt e-banking. The fraction of phone-bankers has remained relatively constant throughout the sample; as of 2005, there are more e-bankers than phone-bankers. The fraction of households that have adopted e-banking has risen substantially, from 17.3 per cent in 1999 to nearly 60 per cent in 2006.

The share of e-transactions has followed a similar pattern over the sample period, increasing from 4.4 per cent to 22.9 per cent, while the shares of branch (teller and ABM at a branch) and phone transactions have fallen. Interestingly, the average number of transactions per month has not changed significantly over the sample period. The evidence that Canadians used to pay a large fraction of their bills in a branch and now pay these bills online suggests that e-banking is substituting for offline banking, and not that the two technologies are complementary.[10] Table 2 also includes the coefficient of variation for the share of the different banking channels. The amount of heterogeneity across households and markets in e-banking and home banking (online and phone) is much higher than for branch banking, suggesting that there exists a lot of heterogeneity across households and regions in the usage

[9] These data are from the CFM survey described in further detail in section 4.

[10] The majority of e-banking is for day-to-day purposes – bill payment and transfers (roughly 77 per cent, compared to just 4 per cent for e-banking for investment activities) – tasks that have typically been conducted in a branch. For readers more familiar with the U.S. banking experience, paying bills by check is not prevalent in Canada. This is why "pay bill by mail" is not included as a bill payment option in the survey. An interesting research question would be to examine the reasons behind the substantial differences in check-use in Canada and the United States.

rate of the newer technologies.

3 Model

In this section we develop a model of branch-network competition which characterizes the trade-off banks face between *technology penetration* and *business stealing*. We determine the equilibrium branch network firms choose to build when this choice affects both consumers' decisions about whether to adopt the new technology, and their decision about which bank network to subscribe to.

All-else equal, a bigger branch network attracts a bigger share of consumers and so banks have an incentive to increase their network (*business stealing* effect). At the same time, however, consumers also decide whether or not to bank online. A smaller network encourages more adoption on the part of consumers and so this gives banks an incentive to decrease the size of their network (*technology penetration* effect).

Our objective is to analyze the effect that concentration has on these conflicting incentives to close branches. We therefore focus our attention on the closure rate, as opposed to the size of the branch network. We define the closure rate as the percentage change in the size of the branch network following the diffusion of the internet. This gives us a sense of the closure pattern over time once e-banking has been introduced and as it becomes easier for consumers to do more of their banking online.

We show that the number of branches is inversely related to the number of e-bankers in the population so that in order to study the effect of concentration on the diffusion of e-banking, it suffices to look at the effect of concentration on branch closures. We then show that the closure rate is negative suggesting that over time, as consumers are able to bank online more easily (as the internet is diffused), banks reduce the size of their branch networks. Finally, we analyze the role of concentration and show that concentration speeds up the reduction in the size of the branch network.

3.1 Setup

We consider a circular city of unit diameter where two banks compete by building up a network of branches. For simplicity we assume that each bank j simultaneously chooses n_j branches that are located according to the principle of maximum differentiation. That is, the distance between branches is equal to $\frac{1}{n_1+n_2}$. Note that the exact location of branches is irrelevant for our analysis since we assume that banks are not competing in prices at the local level.[11]

There is a fixed cost associated with the building of a branch. We assume that one of the banks has a cost advantage in building up its network and we parameterize this advantage by supposing that its building cost is $F - \epsilon$ per branch, while for its rival it is F. Changes in ϵ represent changes in the degree of concentration. As ϵ increases the building costs for one of the banks fall relative to those of its rival, and the bank with the lower cost of building will construct a bigger network of branches giving it a dominant position and making the market more concentrated. Note that this implies that our measure of concentration does not refer to the number of banks, but to the nature of the distribution of market shares and the degree of dominance.

Consumers are uniformly distributed around the circle and decide which bank to patronize and whether or not to use e-banking technologies. We suppose that even if they choose to use e-banking, a share, (1-δ), of their transactions must be performed at the branch. Further, we assume that over time δ increases exogenously, meaning that consumers are more easily able to perform a larger share of their transactions online. This could be, for instance, because computing speed has increased over time allowing banks to include more sophisticated options on their sites for consumers, or because home-internet access has increased so that more consumers do their e-banking at home rather than at work or in internet cafes.[12] The utility of both options for a consumer located at distance $x \sim U\left[0, \frac{1}{2(n_1+n_2)}\right]$ from the closest branch is given by:

$$U(x) = \begin{cases} S - tx & \text{branch-banking} \\ S - \delta E - (1-\delta)tx & \text{e-banking,} \end{cases}$$

where S is the utility from performing banking transactions, E is the cost of performing transactions online, and t is the transportation cost. Therefore, if $\frac{E}{t} < \frac{1}{2(n_1+n_2)}$ all consumers within distances between $\frac{E}{t}$ and $\frac{1}{2(n_1+n_2)}$ will choose to use e-banking.

Letting μ_e and μ_b be the mark-ups on electronic and branch transactions respectively,

[11]This assumption reflects the structure of the Canadian banking market. See section 2 for a discussion.
[12]In our empirical work we proxy for δ with the rate of home-internet adoption.

we can write the profit of bank j from building n_j branches as:

$$\Pi_j = n_j 2\left(\mu_b \frac{E}{t} + \bar{\mu}\left(\frac{1}{2(n_1+n_2)} - \frac{E}{t}\right)\right) - F_j n_j,$$

where $\bar{\mu} = \delta\mu_e + (1-\delta)\mu_b$.[13] We define $G_j = \dot{\mu}\frac{2E}{t} + F_j$, where $\dot{\mu} = \delta(\mu_e - \mu_b)$, as the effective marginal cost of operating n_j branches. This is justified by the fact that by adding a new branch to its network a bank not only increases its operating cost by F_j, but also decreases the proportion of consumers who perform e-banking. Since $\dot{\mu} > 0$, this component is an indirect cost for bank j. This allows us to rewrite Π_j as:

$$\Pi_j = \bar{\mu}\frac{n_j}{n_1+n_2} - n_j G_j.$$

We look for a Nash equilibrium in $\{n_1, n_2\}$.[14] From the first order conditions for the two banks we can clearly see the *technology penetration* and *business stealing* effect:

$$-\dot{\mu}\frac{2E}{t} - F_j + \bar{\mu}\frac{n_k}{(n_1+n_2)^2} = 0, \ (k \neq j).$$

The first two terms represent the *technology penetration* effect and are negative. When bank j closes a branch its profits increase as a fraction $\frac{2E}{t}$ of consumers move out of branch banking into more profitable e-banking. It also saves on the fixed cost F. The third term represents the *business stealing* effect and is positive. When bank j closes a branch it loses a fraction $\frac{n_k}{(n_1+n_2)}$ of the customers that formerly went to this branch to its rival. The business stealing incentive is decreasing in n_j. Importantly, since banks are asymmetric in the cost of operating their network, the business stealing incentive will be smaller for the one with the larger network size (i.e. $\epsilon < 0$). In other words, the bank with the cost advantage will have relatively more incentive to shrink its network size because it does not fear losing customers as much as the smaller bank.

Solving yields the following pair of network sizes:

$$n_1^* = \frac{\bar{\mu}G_2}{(G_1+G_2)^2}, \ n_2^* = \frac{\bar{\mu}G_1}{(G_1+G_2)^2}, \tag{1}$$

[13] In banking, pricing may not in fact involve transaction-specific pricing, but rather fixed fees. In this case the channel-specific mark-ups that we have assumed are not necessarily appropriate. However, it is easy to rewrite the problem as one of cost minimization in which there are different marginal costs for the bank of performing transactions online or in branches. The results would be entirely unchanged.

[14] For simplicity we treat n_j as a continuous variable and abstract from the integer problem.

and so the total number of branches is given by:

$$N^* = n_1^* + n_2^* = \frac{\bar{\mu}}{2F - \epsilon + \dot{\mu}\frac{4E}{t}}. \tag{2}$$

The following assumption imposes two restrictions on the parameters. The first ensures that the equilibrium proportion of e-banking users is in the interior. The second guarantees that in equilibrium the number of branches is smaller with e-banking than without. Notice that this second condition is not always satisfied because e-banking raises the marginal revenue of a transaction, which can be enough to increase the size of networks if the transaction cost is sufficiently small.

Assumption 1. *The parameters of the model are such that in equilibrium,*

1. *the proportion of e-bankers at each branch is less than 1. That is:*

$$\frac{E}{t} < \frac{1}{2N^*} \Leftrightarrow \mu_b \frac{E}{t} < F - \epsilon/2 + \frac{E}{t}(\mu_e - \mu_b), \tag{3}$$

2. *the number of branches when $\delta = 0$ is bigger than the number of branches for any other δ, ie. $N^*(\delta = 0) > N^*(\delta \neq 0)$:*

$$\frac{\mu_b}{2F - \epsilon} > \frac{\bar{\mu}}{2F - \epsilon + \dot{\mu}\frac{4E}{t}} \Leftrightarrow \mu_b \frac{2E}{t} > F - \epsilon/2. \tag{4}$$

3.2 Analysis

Our model generates a number of predictions for which, further on in the paper, we will seek to provide empirical support. We present the predictions in series of propositions.

Proposition 1. *The total number of e-bankers is inversely related to the number of branches.*

From above, we arrive at the total number of e-bankers is given by:

$$O^* = 2N^* \times \left(\frac{1}{2N^*} - \frac{E}{t}\right).$$

Differentiating this with respect to N^* yields:

$$\frac{\partial \ln O^*}{\partial N^*} = -2\left(\frac{E}{t}\right) < 0. \tag{5}$$

This result is a reflection of the fact that online and offline transactions are substitutes. The result implies that to learn about how concentration affects the diffusion of e-banking, it suffices to understand the effect of concentration on branch closures.

From equation (2) it it is clear that the level of e-banking usage is always decreasing in ϵ since the size of networks is strictly decreasing in F. However, this is not the right comparative static to study. Essentially this is a cross-sectional result that says that in more concentrated markets there will be fewer branches and more e-banking. Rather, we are interested in the adjustment of markets once e-banking has been introduced and as the internet is diffused.

We turn our attention, therefore, to our variable of interest, the **closure rate**. As mentioned at the start of this section, we define the closure rate to be the percentage change in the size of the branch network following the diffusion of the internet. In the framework of the model we interpret the diffusion of the internet as a change in the share of transactions consumers are able to perform online, which we have parameterized by δ. The following proposition characterizes the closure rate.

Proposition 2. *Under the conditions stated in Assumption 1, the closure rate is negative.*

Using equation (2) we can write the closure rate as:

$$\frac{\partial \ln N^*}{\partial \delta} = (\mu_e - \mu_b)\left(\frac{1}{\bar{\mu}} - \frac{\frac{4E}{t}}{2F - \epsilon + \dot{\mu}\frac{4E}{t}}\right) < 0. \tag{6}$$

In general, as long as the transaction costs for consumers are large (ie. E/t is large), firms have an incentive to close branches when δ increases.

This prediction is consistent with Goldmanis, Hortaçsu, Syverson, and Emre (2008), who show that the introduction of e-commerce led to the closure of bricks-and-mortar outlets. In their environment, firms sell their services only through one channel and the introduction of e-commerce reduces consumers' search costs. Since firms compete in price, the reduction in search costs makes the market more competitive which pushes the least efficient of the bricks-and-mortar stores out of business. We point out that there is an additional factor influencing firms to rationalize in retail markets where firms offer their services through both the online and offline channels. In these markets, firms may have an incentive to distort the relative quality of the offline option to encourage the use of the cheaper channel. While both of these factors may be present in many retail markets, in local retail banking markets the technology penetration incentive is more important since (at least in the Canadian context) banks do not compete in prices at the local level and entry is blocked.

To understand how dominance affects the closure rate we need to understand how increasing ϵ affects the change in the size of branch network when δ increases. In other words, we want to characterize the following cross partial derivative:

$$\frac{\partial^2 \ln N^*}{\partial \delta \partial \epsilon} = \frac{-4(\mu_e - \mu_b)\frac{E}{t}}{\left(2F - \epsilon + \dot{\mu}\frac{4E}{t}\right)^2}. \tag{7}$$

The sign of this expression is clearly negative, implying the following proposition:

Proposition 3. *As the level of dominance increases, the closure rate increases.*

From Proposition 1 we know that e-banking diffusion and branch closures are inversely related, and so we can state the following corollary:

Corollary 1. *As the level of dominance increases, e-banking diffusion increases.*

As ϵ increases, the rate at which banks close retail branches increases. Intuitively this result is due to the fact that ϵ directly affects the *business stealing* incentives of the two banks. When the asymmetry is large, the more efficient firm has little fear of losing market share when closing branches since it is very costly for the small firm to increase n. Therefore, when ϵ becomes large, as δ increases the *technology penetration* incentive tends to dominate even more the *business stealing* incentive.[15]

3.3 Discussion

To summarize, the model has the following important predictions. First, as the share of transactions that consumers can perform online increases over time, the number of retail branches will decrease. Second, the rate at which this is occurring depends on market structure. In particular, the closure rate will be more pronounced in more concentrated markets –markets in which there is a greater asymmetry in the market shares of firms. Finally, since the rate of e-banking diffusion in inversely related to the number of retail

[15] Note that the presence of an asymmetry between banks is crucial to generate this results. If instead we analyze the effect of concentration by a change in the number of homogenous firms, the rate of closure is independent of the number of banks. However, the results generalize to the case with B asymmetric banks ranked by their marginal costs of operating a branch. In this case we can show that the closure rate is increasing in the size of the asymmetry and also in the number of "inefficient" firms in the market.

branches, the model also predicts that the rate of technology diffusion will be faster in more concentrated markets.

4 Data

To conduct our analysis, we combine two unique data sets. The first contains information about the use of different banking channels, along with detailed information on the demographic characteristics of respondents. The second contains the location of all branches in our sample period and is used to construct a measure of branch density with which we proxy branch-service quality. We describe these data sets below before turning to our empirical results.

4.1 Household data

We use detailed consumer-level data characterizing household decisions to adopt/use electronic payment technologies, as well as their banking relationships and demographic characteristics. This is done by combining census information with household financial data obtained from the Canadian Financial Monitor (CFM), a survey conducted by Ipsos-Reid (1999-2006).

On average, the CFM consists of approximately 12,000 Canadian households surveyed per year (staggered evenly by quarter), with a non-trivial number of households surveyed in more than one year and up to eight years.[16] The geographic distribution of households in the survey is similar to the total population across all census divisions, where each census division is labeled a market. Ipsos-Reid offers incentives, such as holding frequent lotteries with valuable prizes, for completing and returning valid diaries. One-third of diaries are typically returned in any given period. Participants are drawn from a much larger access panel and household diary panel, where socio-economic statistics are collected. Once a household is in the CFM survey they can stay for as long as they wish, even if they move locations. Ipsos-Reid handles attrition by replacing departing households with households that have similar socio-economic and geographic characteristics in their access and household diary panels. The survey is used by Canadian banks for market research and the Bank of

[16] There are a total of 76,204 households in the sample. Of these, we observe 24,113 just once, 15,600 twice, 11,238 three times, 8,676 four times, 6,645 five times, 4,764 six times, 3,360 seven times, and 1,808 eight times.

Canada for monitoring.

The CFM has ten sections. The first two focus on the household's banking habits and financial-delivery services. The survey asks respondents to list their main institution as well as other financial institutions where they do business. The respondents are asked to indicate the frequency of use for the different banking channels for each institution in the "last month." Options include: not used, 1, 2, 3-5, 6-10, 11+; therefore, the number of transactions is right-censored.

Survey responses provide us with a substantial amount of information regarding household characteristics. In our analysis, we focus on those characteristics that are most likely to be correlated with bank channel choice. Helpful in this choice are results previously documented by Stavins (2001), who showed, using the limited data available in the 1998 U.S. Survey of Consumer Finances, that younger households were more likely to make online bill payments, as were those with high income, higher education, and white-collar jobs. Summary statistics are presented in Table 3.

From Table 3 we notice immediately that the average duration of a banking relationship is relatively long; the median is 20+ years. The high proportion of households that have a banking relationship exceeding 20 years suggests that switching costs are relatively high. Focusing on those households that are seen repeatedly in the sample, we find that 3.1 per cent of them have switched from their main financial institution to either an institution previously recorded as secondary or to a new institution.[17]

To characterize our markets, we use 2001 and 2006 Canadian census data on population, age, income, and employment. We also use business data (average business sales per employee in a market in 2003), provided by InfoCanada, as an additional measure of market characteristics. Summary statistics on key variables are reported in Table 4. We use this information to control for local market characteristics that might affect reorganization decisions.

[17]More conservatively, we find that only 1.25 per cent of households record switching to an entirely new bank.

4.2 Branch data

Our measure of bank quality is the density of its branch network.[18] This is a realistic approximation, given the evidence provided in Kiser (2004) and Cohen and Mazzeo (2007). Branch-location information on all financial institutions in Canada has been scanned and transferred to electronic files from the Financial Services Canada directory produced by Micromedia ProQuest. The directory is cross-listed with branch information provided by the Canadian Payments Association, branch-closing dates are reported by the Financial Consumer Agency of Canada, branch closing and opening information is provided in the annual reports of Canada's largest banks (a process that started in 2002 because of the Federal Accountability Act), and location data are provided directly by some of the banks.[19]

We also use the distribution of retail branches to construct our measure of the degree of concentration by local market. We define the relative dominance of a bank by its share of retail branches in the market. Similarly, we use the Herfindahl-Hirschman Index corresponding to the distribution of branches to measure the competitiveness of local markets. This variable (rather than a concentration ratio) is particularly attractive in our context, since the number of banks active in each market does not vary significantly. All banks in our sample are national and most of them are present in all provinces. We then define the 1998 market structure as the pre-e-banking market structure.

5 Empirical analysis

In this section, we analyze the diffusion of e-banking technologies in Canada between 1999 and 2006 in relation to branch network rationalization and to the structure of local markets. Our objective is to provide a set of empirical facts supporting the predictions from our theoretical model. Our model predicts that over time as consumers are able perform a greater share of their transactions online, branch networks shrink (Proposition 2), and that the extent to which they shrink depends on local market competition (Proposition 3). Dominant banks

[18] By focusing on branch networks, we implicity ignore virtual banks, such as ING. Empirically this will not have a significant impact on our analysis, because less than 5 per cent of households in the survey report a virtual bank as their primary financial institution.

[19] We do not have access to data on all of the banks' ABM networks. This limits the analysis to branch-location choice. However, a substantial fraction of brand-name ABM machines (as opposed to white-label machines), are located in branches. Furthermore, according to our CFM survey, more than 60 per cent of ABM transactions are at the branch, a number that has been slowly increasing since 2001. This is likely because of the change in composition of ABMs from mainly brand labels to white labels.

are more easily able to shut down branches to encourage consumers to use the online channel. The model also predicts that branch closures influence the propensity of consumers to bank online (Proposition 1), so that to learn about how concentration affects the diffusion of e-banking it suffices to study the effects on closures.

We begin by studying the decisions by households to adopt and use e-banking, focusing on the response of households to changes in the presence of retail branches in their immediate neighborhood. This allows us to analyze the substitutability between online and offline banking services. Next we analyze the diffusion of e-banking at the market level. We present evidence establishing that initial market structure plays an important role in influencing the diffusion of e-banking. Finally, we confirm that the mechanism through which this diffusion is encouraged is branch-network reorganization by showing that in the period following the introduction of e-banking the closure rate was higher in markets that were initially more concentrated.

As mentioned in Section 3, we define concentration to mean dominance and take it to measure the shape of the distribution of market shares rather than the number of firms in a market. Equivalently, in our empirical analysis we measure local market concentration by the Herfindahl-Hirschman Index corresponding to the distribution of branches.

Result 1: Household e-banking usage and adoption

A key assumption behind the technology-penetration incentive faced by banks is that consumers' decisions to adopt and use e-banking depend on the structure of their bank's network of branches. When banks decide to rationalize their network, some consumers must incur a larger transportation cost to visit a branch, and some must wait longer in line to visit a teller or use an ABM. As a result, if e-banking is a substitute for branch banking, some consumers will change their day-to-day banking habits, opting more (or more often) for e-banking. The objective in this section therefore is to measure the extent to which online and offline services are substitutes by studying consumers' use and adoption of e-banking following changes in the presence of branches in their neighborhood.

We take advantage of the fact that the CFM survey identifies each household by its postal code to construct household-specific measures of branch density.[20] We define branch presence as an indicator variable equal to one if at least one branch of a household's primary bank is present in its neighborhood. We define neighborhoods to be circles with radius equal

[20]For a household banking at a branch the local market is the area surrounding their home.

to 0.5 km centered at the centroid of each household's postal code.[21]

We consider two specifications for this analysis. The first set of regressions estimates the relationship between the change in e-banking/teller usage and the change in branch presence. The second specification studies the adoption decisions of consumers. For this we use a linear Probit model to estimate the transition probability of adopting e-banking conditional on not having adopted in the past, as a function of the change in the presence of branches in households' neighborhood and demographic characteristics.[22]

Usage regression results

Table 6 presents regression results for the household-level analysis of the decision to use e-banking and teller services. We express our dependent variable in first-difference rather than in levels in order to control for the fact that a household's location might reflect its preference for proximity of retail services (i.e. distance to branch might be endogenous). We therefore use the panel structure of the data to identify the effect of branch presence on e-banking usage.[23] The following equation describes our main specification:

$$\Delta Y_{it} = \alpha_0 + \alpha_1 \Delta D_{it} + \alpha_2 \mathcal{I}\left(\Delta \text{Web}_{it} = 1\right) + \alpha_3 \mathcal{I}\left(\Delta \text{Web}_{it} = 0\right) + \beta X_{it} + \epsilon_{it}, \tag{8}$$

where ΔY_{it} is either the change in e-banking or teller usage intesnity, ΔD_{it} is the change in neighborhood branch presence, and $\mathcal{I}\left(\Delta \text{Web}_{it} = 1\right)$ and $\mathcal{I}\left(\Delta \text{Web}_{it} = 0\right)$ are indicator variables for consumers who recently purchased home internet access and consumers who had purchased internet access in the past and continue to purchase internet access, respectively. In addition, X_{it} includes a full set of demographic control variables and bank/year fixed effects.[24] Since Canadian banks are not allowed to price discriminate across regions and web

[21] We experimented with a number of definitions for the level of branch activity in a neighborhood. Our results hold for a variety of definitions, including the change in the number of branches per capita and indicator variables for exit. We also experimented with larger neighborhood definitions. Our results are similar, although less precisely estimated.

[22] We exclude from our analysis households that do not report the same postal code in consecutive years or that have changed banks in consecutive years. We also exclude the most dense 1 per cent of markets – where the density is greater than 23,000 households per square kilometer – because the neighborhood size in some very small neighborhoods is measured imprecisely.

[23] In this respect our identification strategy is different from Gentzkow (2007) who uses an exclusion restriction to evaluate the substitution between online and offline news.

[24] The controls are: age, education, change in household income, and a full set of bank and year effects (along with their interactions) to control for unobserved factors that are common to all customers of a given bank (e.g., national transaction costs, website quality, advertising, etc.).

interfaces are common, we are confident that our branch-density variables are not correlated with any form of price-discrimination strategy after controlling for bank and year fixed effects (and their interactions).

Columns (1) and (2) present the OLS and IV estimates, respectively, for household changes in e-banking habits. We find that a change in bank-branch presence inside of a household's local neighborhood is significantly correlated with a change in e-banking usage. That is, online usage is positively correlated with the closure of a local branch. The results in columns (3) and (4) are similar with respect to the effect of branch presence on teller usage. The share of banking done at a teller increases with the number of branches. As a response to branch closures, households in our data switch from teller banking to e-banking. These results offer support for our main hypothesis that e-banking and teller services are substitutes.

In addition to the effect of branch presence on e-banking usage, we also find strong correlations with internet access and age. We find that households who signed up for internet access between 1999 and 2006, $Dweb01$, were more likely to increase their usage of e-banking than those households that had access as of 1999 ($Dweb11$).

We use instrumental variables in equation (8) to control for the presence of omitted variables. It is unclear ex-ante in which direction the bias should go. For instance, it is possible that banks base their closure/opening decisions on unobserved (to the econometrician) neighborhood-level factors affecting the adoption/usage decisions of consumers. An observed increase in usage could reflect this anticipation effect, which would bias the estimate of α_1 upward. Another potential source of correlation is the fact that we are not controlling for other aspects of the quality of branch services. For instance, prior to closing a branch, a bank may first reduce opening hours or the number of tellers. This lowering of service quality by means other than branch closure may motivate consumers to start using e-banking even before the branch has actually been closed, which would bias the estimate downwards.

We construct our instruments using two sources of variation affecting ΔD_{it}. The first is due to the reorganization of branch networks that affected all markets. In particular we calculate the total change in the number of branches of the same bank between 1998 and year $t-1$ in a 2 km and 3 km radius around consumer i. These two variables are correlated with ΔD_{it} because banks are unlikely to close branches in the immediate neighborhood of i if they had already closed branches in nearby areas (and vice-versa if the change is positive). They also precede in time any changes in the unobserved attributes of branches in period t, and therefore should be excluded from the main regression.

The second source of variation that we use to instrument for ΔD_{it} is the 2000 merger between Toronto Dominium (TD) and Canada Trust (CT). The new entity (TD Canada Trust) progressively closed duplicate branches, mainly between 2001 and 2003. We take advantage of this reorganization of branch networks by constructing an indicator variable equal to one if both TD and CT branches were present in a 1 km neighborhood surrounding each branch prior to the merger (i.e., 1999), since these branches were more likely to be closed. We consider the reorganization due to the merger as "exogenous" since TD and CT are national firms, and the merger of two branches is not endogenous to local market conditions (see Hastings (2004) for a similar use involving a retail chain merger). We then interact this variable with the two instruments constructed as before using past local reorganization.

We therefore use four IVs in our specifications (we label the set of instruments "reorg-IVs"). At the bottom of Table 6 we report for each specification the result of a first-stage F-test for weak instruments, and the J-statistic for overidentification. Testing shows that our instruments are strongly correlated with ΔD_{it}, and we cannot reject the null hypothesis that our moment conditions are satisfied. Qualitatively the IV results are the same as the OLS ones, but the coefficients are about ten times larger.

This suggests that the omitted variables bias the coefficients downward, and does not support the hypothesis that the correlation between ϵ_{it} and ΔD_{it} is caused by banks anticipating future consumer usage decisions.[25] Instead, it appears that the closing of a local branch is positively correlated with omitted factors that increase the usage of e-banking (e.g. quality of services, hours of service, etc).

The magnitude of the IV estimates suggests a very large substitution between online and offline services. The exit of a branch in a 0.5 km neighborhood leads to an increase in the share of online transactions by 22 percent according to the IV estimates. We must interpret the size of the parameters with caution however, since the identification of α_1 in equation (8) is coming both from new adopters and existing users. For new adopters, the change in the usage of e-banking is discrete and large which explains the large coefficient in the IV specification.[26] Therefore we cannot directly interpret the estimate as a usage elasticity. Our goal however is simply to verify empirically that e-banking and branch services are

[25]For the anticipation effect to be important, we would need the presence of an unobserved variable affecting jointly the adoption/usage decisions of many households in the same neighborhood. Our results suggest that either households are sufficiently heterogeneous, or more likely, that these spatially correlated unobservable variables are very persistent over time and are differenced out by our specification.

[26]The average e-banking usage conditional on having adopted in the past is 34%, and the unconditional average is about 14%.

substitutes, and the results in Table 6 support this hypothesis.

Adoption probability results

We report results for the Probit regressions in Table 7. We estimate the transition probability that a particular household goes from not having adopted to having adopted e-banking as a function of the change in its immediate neighborhood branch presence. That is we estimate the following model:

$$\begin{aligned}&\Pr(Y_{it}=1|Y_{it-1}=0)=\\&\quad\Phi\left(-\epsilon_{it}<\alpha_0+\alpha_1\Delta D_{it}+\alpha_2\mathcal{I}\left(\Delta\text{Web}_{it}=1\right)+\alpha_3\mathcal{I}\left(\Delta\text{Web}_{it}=0\right)+\beta X_{it}\right).\end{aligned} \tag{9}$$

As before, we control for changes in web access, age, education, change in household income, and a full set of bank and year interaction effects. We use bank/year interactions to control for year-to-year changes in the relative price or quality of online services.

As with the banking habits regression, (8), we also report results where we instrument the branch presence variable using the set of reorg-IVs. As before the coefficient on $Dpresence1$ is almost ten times larger once we use the instrument set. In addition to reporting results on the full sample of households, we also present results estimated on a sub-sample of consumers whose local neighborhood contained both TD and CT branches prior to the merger. Analyzing this sub sample allows us to identify the effect of branch closure on adoption using only the variation due to the merger. We consider this variation as being exogenous, as mentioned earlier, since the merger between TD and CT resulted in branch closures independently of to the diffusion of e-banking at the individual level.

In all three instances the decision to adopt e-banking is positively correlated with changes in the presence of branches in a 0.5 km neighborhood. Consistent with the usage regressions, these results indicate that the effect of neighborhood branch closures is important in a household's decision to bank online.

To summarize, both the usage regressions and the adoption probability estimates provide a strong indication that e-banking and teller services are substitutes. At the household level, we conclude that the closure of a neighborhood branch increases the usage of e-banking services, and provides incentives for consumers to adopt the new technology.

Result 2: Aggregate e-banking diffusion and market structure

In this section, we study diffusion of e-banking at the market level. The objective is to relate the diffusion to the pre-e-banking market structure, measured by the Herfindahl-Hirschman Index in 1998. We estimate the effect of the initial level of market concentration on the change in banking usage and adoption rates, while controlling for Internet access and other key census variables, such as age, income, employment, and population. In line with the previous discussion, we define e-banking both in terms of the portion of transactions performed online and the proportion of households using e-banking. Since branch services represent the relatively more expensive channel for banks, we also report results related to the proportion of teller transactions. Note that these variables are aggregated using the households surveyed in each local market.

To conduct our analysis we define a market to be a census division (CD). Statistics Canada defines a CD as a collection of municipalities joined for the purpose of managing common public services, e.g., police service. We use 245 out of the possible 288 CDs since some markets are very small and relatively unpopulated. We eliminate those markets where the population density is less than one household per square kilometer. Table 8 provides a summary of key variables used in our census division regressions. Table 4 provides a summary of census characteristics.

Table 9 reports results using changes (between 1999 and 2006) in e-banking as the dependent variable. Table 10 reports similar results using the 2005-2006 levels, since 1999 corresponds to the very early stage of e-banking diffusion in most markets.[27] Both tables present the estimation results of the following specification:

$$Y_m = \theta \mathrm{H}_m + Z_m \beta + \epsilon_m, \tag{10}$$

where Y_m is a measure of e-banking diffusion (i.e. e-transactions, fraction of adopters, or teller usage), H_m is the concentration level in 1998, and Z_m is a vector of demographic variables including population, the fraction of people aged 20-34 residing in the market, average income, average level of employment, and Internet accessibility (measured by the proportion of households with Internet access). In order to minimize the importance of measurement error, in all specifications we consider only local markets for which we observe more than 25 households in the CFM data.

[27] For this specification, we group the last two years of the survey together to improve our measure of e-banking usage.

An important concern for the estimation of θ is the fact that the initial market structure is correlated with omitted factors affecting the diffusion of the new technology. In our context, it is clear that the degree of concentration and the number of banks in a local market are related to characteristics of demand for banking services that could affect the use of e-banking. We know, for instance, from the CFM survey, that consumers who perform a small number of day-to-day transactions are also less likely to adopt e-banking. If these omitted variables are important, we should expect the OLS estimate of θ to be biased downward.

To circumvent this problem, we use an instrumental variable, namely the share of Francophones in a local market. Francophones represent about 23 per cent of the Canadian population. Historically, most Francophone regions of the country were dominated by one credit union, Caisses Populaires Desjardins. Very early in the economic development of the province of Québec, this institution established large networks of retail branches which matches almost exactly the distribution of Catholic parishes.[28] To a large extent, the success of Desjardins is due the fact the other important banks were controlled by Anglophone managers, while it was almost exclusively Francophone controlled. Moreover, Desjardins was initially operated as a cooperative, and its decisions were less driven by profit maximization motives than the other banks. Today, it behaves similarly to other commercial banks, but still dominates most local markets in Québec and Francophone communities in New Brunswick. As a result, the share of Francophones in a market is highly correlated with our concentration measure. Importantly, using the household-level usage data introduced earlier, we cannot reject the hypothesis that Francophones behave in the same way as the rest of the population with respect to the decision to use and adopt e-banking once we condition on bank affiliation and other demographic characteristics.[29] A drawback of this variable, however, is that since Francophones are mainly located in the province of Québec, any omitted variable that affected only Québec residents' decisions to use e-banking would violate our exclusion restriction. We therefore treat the IV results with caution, and report both the OLS and IV estimates.

The results from Tables 9 and 10 offer similar conclusions regarding the relationship between e-banking diffusion and initial market concentration. All specifications lead us to conclude that the diffusion of e-banking was more important in markets that were more concentrated in 1998. The results from the IV regressions show that usage/adoption of

[28] Almost all Francophones in Québec were Catholic during this period.

[29] With an F-statistic greater than 84, the instrument easily passes a weak-instrument test (Stock, Yogo, and Wright (2002)). Results of the first-stage regression are available upon request.

e-banking is positively related with concentration, while the correlation with use of tellers is negative. The coefficients associated with H_m are also significantly smaller in the OLS specifications, suggesting a negative correlation between H_m and ϵ_m, as discussed above. Statistically, the Francophone instrument is somewhat weak, with an F-test between 5.2 and 6.9 when we focus on the smaller set of census divisions that have at least 25 households. In addition to initial market structure, the adoption and use of e-banking is strongly correlated with access to Internet at home, although not strongly correlated with web access at the office. This suggests that most people perform their e-banking at home.

Overall, these results confirm our initial claim that the diffusion of e-banking technologies has been faster and more pronounced in more concentrated markets. This is in line with the previous results concerning the household-level decision to adopt and use e-banking. Since e-banking and teller services are substitutes, dominant banks in concentrated markets have additional incentives to reduce the relative quality of branch services in order to realize the cost savings associated with e-banking. In the next subsection we study one particular measure of quality change, namely the density of retail networks.

Result 3: Reorganization of branch networks

In this section we study the reorganization of branch networks at the market level with two goals in mind. Having established that e-banking and teller services are substitutes, and that the diffusion of e-banking has been faster in concentrated markets, our first objective is to determine whether branch-network reorganization is a mechanism through which this diffusion is encouraged. More specifically, we analyze the change in the average number of branches per square kilometer from 1998 to 2006 at the census division level. In order to validate Result 2, our second goal is to show that branch-network reorganization is indeed related to e-banking in the aggregate. We show that there are more closures in markets with more adoption and usage of e-banking.

The change in the average retail network density proxies the change in the relative quality of branch services from the beginning of the diffusion of e-banking technologies (i.e., 1998) to the end of our sample. Our objective is to relate this variable to market structure, controlling for demand-side variables. In line with the model described in Section 3 we are interested in studying three aspects of local markets. First, looking at bank-level decisions, we are interested in testing whether dominant banks are more likely to shrink their branch network than weaker banks. We measure the dominance of a bank by its 1998 market share, and by the concentration of branches among competing banks within the same market (measured by the HH index of competing banks). Then, taking the market as a unit of observation, we study the effect of market concentration on aggregate reorganization. Finally, we look at the relationship between the amount of reorganization and the usage of e-banking services.[30]

Bank level results

Table 11 presents regression results for the change in the number of bank j's branches per square kilometer in market m ($\text{dbdens}_{jm} = \log\left(\text{branch}_{jm06}/\text{branch}_{jm98}\right)$) over the sample period on market-structure variables:

$$\text{dbdens}_{jm} = \alpha \text{Share}_{jm} + \theta H_{jm}^{-j} + Z_m \gamma + \epsilon_{jm}, \tag{11}$$

where Share_{jm} is bank j's initial share of market m and H_{jm}^{-j} is the initial level of concentration amongst j's rivals in the market. Z_m is a vector of demographic variables expressed in both levels and growth rates, including the fraction of people aged 20-34 residing in the market, average income, average level of employment, business activity, and Internet accessibility (measured by the proportion of municipalities with DSL access). We produce the following results: (i) A larger initial market share is associated with more branch closures. This suggests that the most dominant banks have the largest incentive to lower branch quality. (ii) The positive and significant coefficient on H^{-j} suggests large/dominant banks close more branches the less attractive their rivals are. The reason is as follows. Holding fixed bank j's share of branches, an increase in H^{-j} means either fewer competitors or the presence of one or more dominant rival banks. As such, this variable measures the attractiveness of competitors. Both results confirm that banks who were in a dominant position in 1998 are the ones who closed more branches between 1998 and 2006.

The estimates of the rest of the parameters are quite intuitive. Markets in which the overall population was growing experienced a larger increase in the number of branches, while the number of branches was decreasing in the fraction of 20-34 year olds. Similarly, the closing rate is more pronounced in markets with a better access to high-speed internet.

[30] To control for the effect of the merger between TD and Canada Trust, we assume that the merger took place at the beginning of our sample (i.e., 1998 instead of 2000), and reset the 1998 number of TD Canada Trust branches to the maximum of number belonging to either TD or CT. The correction method does not significantly affect our results.

Market-level results

Tables 12 and 13 present the results of a similar analysis, but aggregated over all banks active in each census division. We estimate the relationship between the change in the average number of branches per square kilometer in market m ($\text{dbdens}_m = \log\big(\text{Branch}_{m06}/\text{Branch}_{m98}\big)$) over the sample period and market-structure variables:

$$\text{dbdens}_m = \theta H_m + \lambda \Delta \text{Bank}_m + Z_m \gamma + X_m \beta + \epsilon_m, \tag{12}$$

where H_m is the initial (1998) level of concentration in market m, ΔBank_m is the change in the number of banks active in market m,[31] and Z_m are demographic variables. The variables in X_m correspond to variables related to the diffusion of e-banking. These include the proportion of municipalities with DSL (digital subscriber line) access, the change in the proportion of households with Internet access, and the change in usage/adoption of e-banking. We use each variable sequentially to examine the robustness of our results across different proxies.

We first report in Table 12 the effect of market concentration and demographics on branch closures. The results clearly show that more branches were closed in markets that were initially more concentrated. Notice that this does not contradict the previous results associated with the variable H^{-j}. Previously the effect of H^{-j} was conditional on the share of bank j, and was thus a proxy for the relative quality of competing banks. Here we interpret the effect of H in terms of a change in the overall concentration of branches on the branch reorganization process.

As in the market level diffusion regression, this interpretation could be misleading if H is correlated with unobserved factors affecting the decisions of banks to close branches. For instance, H could be correlated with factors related to the size of markets, which in turn might affect the aggregate decline in demand for banking services (e.g. demand in large markets that grew faster). To address this issue, the results in Table 12 first compare the estimates with and without controlling for demographic characteristics of the markets, namely the levels and changes in population, age, employment and income. The OLS estimate of θ drops slightly once we control for these variables, but the effect of H is still negative and significant. The third column reports IV estimates using the share of Francophones as an

[31] We control for the change in the number of competitors, since some local markets experienced entry during the sample. A negative coefficient associated with $dbank_m$ indicates that new entrants have a smaller network of branches than incumbent banks.

instrument. Again the effect of H is significant and negative.[32] Overall, we are confident that H measures the strength of competition in markets, and that more competitive markets experienced less branch closures.

Table 13 reports results on branch closures, controlling for effects related to e-banking. We control for high-speed Internet access in 2006, change in web access, change in e-banking (adoption and usage), and change in teller usage. We find that, even after controlling for these factors, the result linking market structure with branch closures does not change.[33] In addition, we find that most of the Internet access and e-banking-related variables are significantly related to closures. In particular, the coefficients on the change in e-banking and internet access are negative and significant, while change in teller usage is positive.[34] It should be noted that there is a simultaneity in the decisions of banks to close/open branches and the decision of consumers to use e-banking. At the market level we are unable to disentangle the effect of banks' incentives from exogenous changes in internet diffusion, because both effects go in the same direction. Therefore, these results simply establish a correlation between closures and e-banking. In contrast, in the household-level analysis we have demonstrated that a causal relationship exists between closures and e-banking.

This last result is similar to the one described in Goldmanis, Hortaçsu, Syverson, and Emre (2008). These authors conclude that an increase in e-commerce leads to exit of bricks-and-mortar establishments. Although the mechanism described in their paper is different from ours, both results suggest that online and offline retail channels are substitutes. In addition, our results suggest that e-commerce diffusion is not an exogenous process, since more concentrated markets experienced a larger rationalization of branches and a faster diffusion of electronic banking. In situations where online and offline retail services are jointly offered, our empirical results confirm that firms have an incentive to influence the diffusion of the less costly (for them) channel by reducing the quality of the other one.

[32]The F-test for the share of Francophones in a neighborhood being a weak instrument for market concentration is much larger in the case where we use all 245 census divisions than in tables 9 and 10, suggesting the instrument is strongly correlated with market concentration.

[33]Note that there are 85 markets in these regressions, since only these 85 markets have at least 25 households in the CFM survey sample both in 1999 and 2006.

[34]There may be measurement error in our e-banking variables since we are using a small number of households to compute them (i.e., as few 25 households). We have run this specification using change in Internet access as an instrument in an effort to deal with this potential problem. The results are unchanged.

6 Conclusion

In this paper, we analyze the relationship between market structure and the diffusion of electronic banking. In the day-to-day banking market, despite the fact that banks have adopted electronic-payment mechanisms, the realization of the full benefits from its introduction depends on the decisions of consumers to perform electronic transactions. Since banks operate both online and offline channels, they have an incentive to manipulate the relative quality of the channels to drive consumers into the cheaper one. This is true in general for innovations in e-commerce. This paper sheds light on how firms can affect the relative attractiveness of their offline and online channels to encourage consumer adoption of innovations in e-commerce. We show that firms can encourage online adoption by rationalizing their retail network, but that their ability to do so depends on the level of competition in local markets.

To summarize our empirical results, through several steps we find that the diffusion of e-banking is strongly correlated with market structure. First, we find that households respond to local branch closures by substituting out of branch banking and into e-banking. Second, we establish that initial market structure plays an important role in influencing the diffusion of e-banking. Finally, we demonstrate that this diffusion is encouraged by branch reorganization by showing that there were more closures following the introduction of e-banking in markets that were initially more concentrated and that featured more dominant banks.

Note that, although our analysis implies that the online and offline technologies are substitutes, banks cannot reduce their branch network to zero, since there are many services that cannot be performed online (for instance, cash withdrawals). In fact, as alluded to above, the data suggest that Canadians are not embracing Internet-only (virtual) banks – fewer than 5 per cent of those surveyed report banking with a virtual bank and ING, the leading virtual bank in Canada, had deposits representing less than 1.5 per cent of total deposits in Canada by the end of our sample period. This fact also allows us to rule out an alternative explanation of the pattern of diffusion that we have uncovered here, namely, that diffusion of e-banking is led by virtual banks, and traditional banks are responding to the inroads of virtual banks when they promote their online channel.

It is interesting to consider our results in the context of the experience with e-banking diffusion in the United States. Although the past thirty years have witnessed a gradual relaxing of restrictions on within- and across-state expansion of branch networks, the US banking market remains fragmented and there is significant competition at the local market level. This may help to explain why Americans have been much slower to adopt e-banking than Canadians. As of the end of 2004, only a quarter of American adults had adopted e-banking, compared to more than half of Canadians.[35]

In future work, we will extend the analysis to focus more on consumer behavior and the substitution between branch and e-banking. In particular, we might allow the cost of adopting e-banking to vary according to both household characteristics and the diffusion of Internet technologies more generally. This would allow us to measure the welfare costs associated with bank closures and the introduction of e-banking across households facing low and high adoption costs.

[35] Statistics on US adoption is available from the Pew Research Center: http:www.pewinternet.org/pdfs/PIP_Online_Banking_2005.pdf

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Appendix

A Figures and Tables

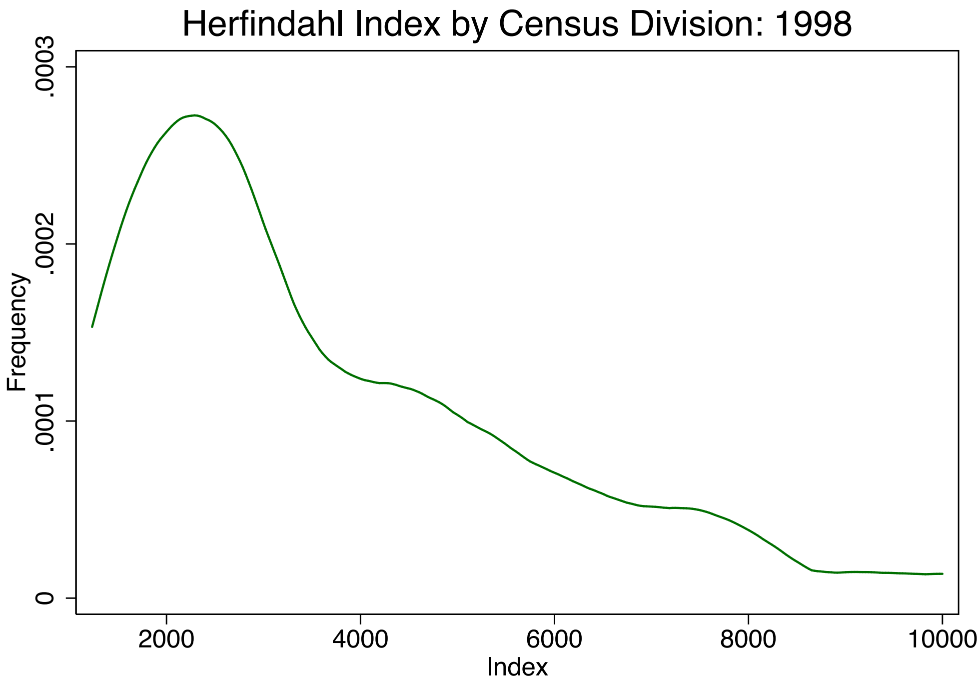

Figure 1: Kernel density of market concentration in 1998

Table 1: Summary of Branch Network Reorganization: 1998-2006

Variable	Total	Low	Medium	High
Change in branch density	-29.5%	-11.1%	-22.4%	-55.1%
Change in Avr. branch density	-23.2%	-11.3%	-14.9%	-43.4%

Note: We present the mean for four groupings: total as well as high, medium, and low levels of concentration in the census divisions. Sorting was by the HHI in 1998. Branch density is the total number of bank-branches per square kilometer; Avr. Branch density is the average number of branches a bank owns per square kilometer.

Table 2: Summary of Banking Channel Usage

	1999	2000	2001	2002	2003	2004	2005	2006
	Fraction of Users							
Web access (work)	34.0	38.6	41.5	44.2	44.6	45.7	46.5	46.9
Web access (home)	35.3	44.4	50.0	58.1	62.3	61.8	66.5	70.3
Teller	80.6	77.4	75.2	73.5	72.1	74.5	67.1	73.2
ABM	90.4	90.4	90.2	90.5	88.9	89.4	89.0	90.5
Phone	43.5	46.6	47.6	47.8	45.8	48.7	47.7	45.9
E-banking	17.3	25.8	33.2	40.6	44.5	45.7	53.0	57.6
	Average number of transactions							
All channels	13.5	12.7	12.6	12.8	12.4	12.4	12.5	12.8
	Share of total transactions							
Teller	30.5	27.8	27.0	25.2	25.1	25.9	23.2	24.3
	[0.99]	[1.12]	[1.13]	[1.20]	[1.22]	[1.20]	[1.34]	[1.27]
Branch	83.3	79.8	76.9	73.9	72.3	70.7	68.1	66.9
	[0.27]	[0.30]	[0.33]	[0.35]	[0.37]	[0.38]	[0.41]	[0.42]
Phone	12.2	13.0	13.0	12.7	11.9	12.5	11.0	10.2
	[1.59]	[1.52]	[1.48]	[1.49]	[1.61]	[1.52]	[1.69]	[1.79]
E-banking	4.4	7.2	10.1	13.4	15.7	16.8	20.9	22.9
	[3.06]	[2.28]	[1.98]	[1.62]	[1.47]	[1.44]	[1.25]	[1.15]

Note: Rates and shares are reported in percentage points. Numbers in square brackets are coefficients of variation. "Branch" includes teller and ABM transactions at a branch. "Web access" denotes the rate of household access to the internet from work and from home.

Table 3: Summary of Household Characteristics: 1999-2006

CHARACTERISTICS	Mean	Median	Std. Dev
Respondent: age†	46.7	46	14.9
Respondent: education	15.3	14	2.5
Age (oldest head)	51.9	51	15.1
Education (oldest head)	15.7	16	2.5
Household: income($)	61,568	57,500	35,581
Household: size	2.5	2	1.3
Duration: primary bank*	11.1	12	4.9
Transaction cost‡($)	5.67	2.5	7.4

Note:†The age variable refers to the age of the respondent in 1999. Respondents under the age of 18 in 1999 represent only 0.02 per cent of the sample and were dropped. *Duration is right-censored at 20 years. Therefore, we report the average duration for those reporting less than 20 years, which represents close to 50 per cent of the sample. ‡Transaction costs are almost entirely unreported in the panel prior to 2004. The reported figures are for households surveyed after 2003 and defined as service charges paid in the last month.

Table 4: Summary of Market Characteristics: 2001, 2004, 2006

	2001	2004	2006
Census:			
Population			
mean	106272		112132
median	38931		39817
sd.	253958		268366
Income			
mean individual	25459		30488
median individual	25062		29929
sd individual	4241		5489
Age			
mean share under 20	21.4%		20.0%
mean share 20-24	6.2%		6.1%
mean share 25-34	12.4%		11.8%
mean share 35-49	26.2%		24.1%
mean share 50-64	18.8%		22.1%
Employment			
mean	45.5%		47.7%
median	46.0%		48.1%
Share French			
mean	35.3%		35.1%
median	3.8%		3.7%
Business:			
Retail businesses / 10000 persons			
mean		16.3	
sd.		14.6	
Number of employees / business			
mean		10.8	
sd.		6.0	
Sales / employee (2001 CDN$)			
mean		1,540,022	
sd.		491,939	

Table 5: Variable Description

Dependent Variables:	D.PC use (dpcuse)	1999 to 2006 log change in the intensity of online banking
	D.PC adopt (dpcadopt)	1999 to 2006 log change in online banking adoption
	D.Teller use (dtelleruse)	1996 to 2006 log change in the intensity of teller banking
	PC use	Intensity of online banking
	PC adopt	Adoption of online banking
	Teller use	Intensity if teller banking
	dbdens_jm	1998 to 2006 log change in the number of branches of bank j per square kilometer in market m
	dbdens_m	1998 to 2006 log change in the number of branches per square kilometer in market m
Independent Variables:		
CD:		
	HH1998	Herfindhl-Hirschman index in 1998
	nb	Number of banks in a market
	share1998	Bank i's share of branches in market m in 1998
	HHi98	Market concentration of bank i's rivals in 1998
	dhomeweb	log change in home internet access
	dworkweb	log change in workplace internet access
	avgdsl	Dummy variable for CD that have DSL access in 2006
	dpop	2001 to 2006 log change in population
	dshare2034	2001 to 2006 log change in the share of the population aged 20 to 34
	davgemp	2001 to 2006 log change in average level of employment
	davgincome	2001 to 2006 log change in average income level
	avg_sales_empl	Average retail sales per employee in a market
Household:		
	Dpresence1	Defining $presence1$ as an indicator variable equal to 1 if there's a change in own-bank branch presence within a circle with a 0.5Km radius centered on each household i's postal code, $Dpresence1$ is the change in $presence$.
	Dnbh2	Change in own-bank branches in household i's 2.0km radial neighborhood
	Dnbh3	Change in own-bank branches in household i's 3.0km radial neighborhood
	Dweb01	Dummy variable for households that went from no internet access in 1999 to access in 2006
	Dweb11	Dummy variable for households that went from internet access in 1999 to access in 2006
	agecat2	Dummy variable for household respondent who is between the ages of 25 and 25 in 1999
	agecat3	Dummy variable for household respondent who is between the ages of 35 and 50 in 1999
	agecat4	Dummy variable for household respondent who is older than 50 in 1999
	school	Maximum level of education attained within a household

Table 6: Household Changes in Banking Habits

COEFFICIENTS	LABELS	D.PC (OLS)	D.PC (IV)	D.Teller (OLS)	D.Teller (IV)
Dpresence1	Δ presence (1/2km)	-0.0210	-0.223	0.00801	0.240
		(-2.27)	(-2.49)	(0.60)	(1.97)
Dweb01	Web ($0 \rightarrow 1$)	0.0488	0.0488	0.00289	0.00284
		(7.74)	(7.67)	(0.37)	(0.35)
Dweb11	Web ($1 \rightarrow 1$)	0.0251	0.0264	-0.00221	-0.00364
		(9.97)	(10.0)	(-0.62)	(-0.99)
agecat2	Age: $25 - 35$	-0.0393	-0.0364	0.0206	0.0173
		(-2.44)	(-2.21)	(1.65)	(1.33)
agecat3	Age: $35 - 50$	-0.0416	-0.0387	0.0110	0.00760
		(-2.66)	(-2.41)	(0.90)	(0.59)
agecat4	Age: 50+	-0.0453	-0.0441	0.0132	0.00987
		(-2.91)	(-2.67)	(1.07)	(0.77)
Weak Instrument F-Test			13.2		13.2
Hansen J-Test (χ_3)			1.46		2.11
Observations		12755	12755	12755	12755

Robust z statistics in parentheses. Standard-errors are clustered at the household level.
The explanatory variables include a full set of year/bank indicator variables.
Dependent variables are the change in e-banking usage (the mean is 2.1%) and teller usage (-0.6%).
The set of 4 IVs for Δ presence are the total change in the number of branches of the same bank in a 2km and 3km radius around a household, between 1998 and year $t - 1$. These two variables are also interacted with a TD and CT presence indicator variable.

Table 7: Decision to Start Online Banking

COEFFICIENTS	LABELS	PC adopt	PC adopt (IV)	PC adopt (TD/CT)
Dpresence1	Δ presence (1/2km)	-0.445	-3.023	-0.679
		(-2.97)	(-2.07)	(-2.65)
Dweb01	Web (0 → 1)	0.766	0.698	0.615
		(11.5)	(7.65)	(4.37)
Dweb11	Web (1 → 1)	0.701	0.654	0.734
		(14.7)	(9.27)	(7.51)
workweb	Web (work)	0.187	0.168	0.301
		(3.64)	(3.19)	(2.84)
agecat2	Age: 25-35	-0.356	-0.224	-0.620
		(-2.20)	(-1.31)	(-1.71)
agecat3	Age: 35-50	-0.380	-0.249	-0.397
		(-2.46)	(-1.50)	(-1.14)
agecat4	Age: 50+	-0.524	-0.378	-0.590
		(-3.42)	(-2.18)	(-1.70)
Observations		7190	7219	1756

Robust z statistics in parentheses
Standard-errors clustered at the household level.
The explanatory variables include a full set of year/bank indicator variables.
The set of 4 IVs for Δ presence are the total change in the number of branches of the same bank in a 2km and 3km radius around a household, between 1998 and year $t-1$.
These two variables are also interacted with a TD and CT presence indicator variable.

Table 8: Summary Statistics at the Census Division

Variable	Table	Observations	mean	std. deviation
D.PC use	9	85	0.15	0.04
D.PC adopt	9	85	0.27	0.07
D.Teller use	9	85	-0.03	0.04
PC use	10	99	0.21	0.05
PC adopt	10	99	0.53	0.09
Teller use	10	99	0.29	0.08

Table 9: Change in Banking Habits 1999-2006 as a Function of Market Structure

VARIABLES	D.PC use OLS	D.PC adopt OLS	D.Teller use OLS	D.PC use IV	D.PC adopt IV	D.Teller use IV
HH index (1998)	0.0188	0.211	-0.292	0.384	1.023	-0.531
	(0.25)	(2.21)	(-2.97)	(1.62)	(2.26)	(-2.35)
Δ Home web	0.295	0.426	-0.170	0.266	0.361	-0.151
	(4.28)	(3.92)	(-2.19)	(3.21)	(2.52)	(-1.71)
Δ Work web	-0.0350	0.180	-0.0193	-0.0702	0.102	0.00374
	(-0.39)	(1.42)	(-0.24)	(-0.81)	(0.75)	(0.043)
Pop. change	0.101	0.0318	-0.114	0.143	0.124	-0.142
	(1.57)	(0.35)	(-1.90)	(2.72)	(1.27)	(-2.10)
Δ Share 20-34	-0.0215	-0.0266	-0.00178	-0.0248	-0.0338	0.000360
	(-2.92)	(-1.92)	(-0.15)	(-2.92)	(-2.05)	(0.031)
Δ Employment	-0.201	-0.478	0.197	-0.296	-0.688	0.259
	(-1.82)	(-2.33)	(1.44)	(-2.20)	(-2.60)	(1.75)
Δ Income	-0.00620	-0.0316	0.0302	0.0361	0.0624	0.00253
	(-0.14)	(-0.43)	(0.60)	(0.68)	(0.64)	(0.043)
Weak Instrument F-Test				6.9	6.9	6.9
Observations	85	85	85	85	85	85

Robust t statistics in parentheses

Instrumental variables = Share of francophone in 1998.

Sample markets include all census divisions with more than 25 households surveyed in 1999 and 2006.

Variables measured in changes measure the difference in log between 1999 and 2006.

Table 10: Banking Habits 2005-2006 as a Function of Market Structure

VARIABLES	PC use OLS	PC adopt OLS	Teller use OLS	PC use IV	PC adopt IV	Teller use IV
HH index (1998)	0.130	0.306	-0.401	0.802	1.574	-3.797
	(1.80)	(2.38)	(-2.93)	(1.83)	(1.96)	(-2.26)
Home web access	0.300	0.593	-0.222	0.411	0.802	-0.783
	(6.33)	(6.59)	(-2.45)	(4.24)	(4.48)	(-2.28)
Work web access	0.0747	0.140	-0.285	-0.00463	-0.00992	0.115
	(1.17)	(1.10)	(-2.31)	(-0.055)	(-0.065)	(0.37)
Share 20-34 (2006)	0.213	0.174	-0.112	0.452	0.624	-1.317
	(0.97)	(0.49)	(-0.31)	(1.55)	(1.26)	(-1.32)
Income (2006)	-0.00614	-0.0202	-0.0141	0.0253	0.0391	-0.173
	(-0.48)	(-0.90)	(-0.57)	(1.23)	(1.18)	(-2.47)
Employment (2006)	12.54	26.42	38.20	1.920	6.404	91.81
	(0.93)	(0.95)	(1.33)	(0.11)	(0.20)	(1.62)
Population density	0.00226	0.0150	-0.0312	0.00758	0.0250	-0.0580
	(0.49)	(1.76)	(-1.81)	(1.00)	(1.68)	(-1.60)
Weak Instrument F-Test				5.2	5.2	5.2
Observations	99	99	99	99	99	99

Robust t statistics in parentheses

Usage and web access variables are constructed using the pooled sample of hosehold respondants for 2005 and 2006.

Instrumental variable = Share of francophones in 1998.

Sample markets include all census divisions with more than 25 households surveyed in 2005 and 2006.

Table 11: The Change in the Number of Bank j's Branches per Capita

COEFFICIENT	LABELS	dbdens_jm	dbdens_jm
share1998	Bank j share of branches (1998)	-0.352	-0.254
		(-4.12)	(-2.60)
dpop	Δ Population	0.253	0.321
		(2.64)	(3.22)
dshare2034	Δ Share 20-34	-0.0586	-0.0586
		(-2.39)	(-2.37)
davgemp	Δ Employment	0.200	0.111
		(1.14)	(0.61)
davgincome	Δ Income	-0.198	-0.188
		(-1.69)	(-1.65)
avgdsl	Avg. DSL	-0.112	-0.0649
		(-2.04)	(-1.15)
avg_sales_empl	Avg. retail sales	0.000870	0.000638
		(1.03)	(0.77)
HHi98	H^{-j} (1998)		0.229
			(2.54)
Observations		1229	1229
R^2		0.40	0.41

Robust t statistics in parentheses

Table 12: The Change in the Average Number of Branches per Market 1999-2006

COEFFICIENT	LABELS	dbdens_m OLS	dbdens_m OLS	dbdens_m IV
HH1998	HH index (1998)	-1.085	-0.977	-2.321
		(-12.3)	(-9.03)	(-8.98)
dbank	Δ nb. banks	-0.215	-0.249	-0.232
		(-1.57)	(-1.81)	(-1.50)
avgdsl	DSL access	-0.358	-0.349	-0.506
		(-3.67)	(-3.32)	(-3.81)
avg_sales_empl	Avg. retail sales	-0.00335	-0.00213	-0.00276
		(-3.00)	(-1.57)	(-1.50)
dpop	Pop. change		-0.110	0.325
			(-0.50)	(1.08)
dshare2034	Δ Share 20-34		-0.0950	0.0452
			(-1.17)	(0.37)
davgemp	Δ Employment		0.357	0.797
			(0.88)	(1.53)
davgincome	Δ Income		0.606	-0.0235
			(2.74)	(-0.077)
Weak Instrument F-Test				84.07
Observations		245	245	245

Robust z statistics in parentheses

Dep. variable: Change in the average number of branches per square Km.

Instrumental variable for $HH1998$ = Share of Francophones in 1998

Specifications include demographic characteristics in level.

Table 13: The Change in the Average Number of Branches per Market 1999-2006

COEFFICIENT	LABELS	dbdens_m OLS	dbdens_m OLS	dbdens_m OLS	dbdens_m OLS
HH1998	HH index (1998)	-1.658	-1.622	-1.616	-1.494
		(-3.714)	(-3.939)	(-4.034)	(-3.609)
dbank	Δ nb. banks	0.628	0.645	0.643	0.612
		(4.476)	(4.364)	(4.293)	(3.984)
dpop	Pop. change	0.225	0.227	0.0930	0.195
		(0.795)	(0.856)	(0.363)	(0.739)
dshare2034	Δ Share 20-34	-0.0989	-0.252	-0.232	-0.130
		(-0.240)	(-0.643)	(-0.566)	(-0.331)
davgemp	Δ Employment	1.009	0.804	0.810	0.729
		(1.518)	(1.270)	(1.257)	(1.131)
davgincome	Δ Income	0.560	0.597	0.613	0.591
		(1.428)	(1.698)	(1.648)	(1.734)
avgdsl	DSL access	-0.461	-0.434	-0.477	-0.512
		(-2.005)	(-1.850)	(-1.972)	(-2.168)
dhomeweb	Δ Home web	-0.588			
		(-2.059)			
dworkweb	Δ Work web	0.306			
		(1.071)			
dpcuse	Δ PC usage		-0.993		
			(-2.127)		
dpcadopt	Δ PC adopt.			-0.314	
				(-1.168)	
dtelleruse	Δ Teller usage				0.837
					(2.135)
	Observations	85	85	85	85

Robust t statistics in parentheses
Dep. variable: Change in the avg. number of branches per sq. KM.
Sample: Markets with more than 25 households surveyed in 1999/2006.
Specifications include demographic characteristics in level.