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Independent Service Operators in ATM Markets*

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Abstract

This paper studies the impact of entry of non-banks (termed Independent Service Operators, ISOs) into ATM markets. We compare two different regimes by which the ISO may generate income: i) The ISO receives interchange fees and ii) the ISO charges consumers directly. We find that due to the entry of an ISO the size of the total ATM network increases independent of the way the ISO is financed. Account fees increase if the ISO receives interchange fees and decrease if the ISO charges consumers directly. Consumers may not benefit from the entry of the ISO. If a regulator can control the interchange fee, entry by an ISO financed through interchange fees increases consumer surplus, while the entry of a surcharging ISO decreases consumer surplus.

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1 Introduction

Until several years ago ATM services were only provided by banks. Recently, however, the entry of non-banks or so-called independent service operators (ISOs) can be observed. These ISOs provide withdrawal services at ATMs without offering further banking services. The issue of entry in ATM markets has received attention by policymakers. For instance, in the UK, the Cruickshank report[1] (Cruickshank, 2000) criticizes that entry in the ATM business is not free: until recently, the shared network operator (LINK) has refused non-banks to become members. Following this investigation and upon Government pressure LINK has now allowed ISOs to enter the shared network. Since then the number of ATMs provided by ISOs has steadily increased and as of 2009 a share of roughly 40% of the total UK ATM network is operated by ISOs. Figure 1 displays the number of ATM operated by banks and non-banks from 1998 to 2009.[2] During this period the number of ATMs owned by non-banks has sharply increased, peaked in 2007 and then slightly decreased thereafter. The number of ATMs provided by banks has slightly increased over this time period. Similar developments took place in other countries, for instance, in Canada and in the US (Croft and Spencer, 2004).

The economics literature has largely neglected the entry of non-banks in ATM markets. The present paper tries to fill this gap and provide insights of the consequences of ISO entry. Does the overall ATM network increase? What happens to bank profits? Do consumers benefit from the entry of the ISO? And, as the markets for banking services and ATM services are interrelated, do account fees rise or fall with the entry of an additional competitor in the ATM business?

We try to provide answers to the questions above. For this task we set up a simple model. Following recent contributions a key ingredient is that the

[1] The Cruickshank report analyzes the competitiveness of the UK banking sector. Among others, one part was concerned with the ATM sector.

[2] The data for the figure has been provided by LINK. Unfortunately, LINK does not distinguish between ATMs owned by banks and non-banks, but distinguishes between charging and free machines. As the majority of banks have free ATMs and the majority of ISOs have charging machines, we can take these data as proxies. The volume of cash withdrawals at ATMs owned by ISOs is considerably lower and varies between 3 and 4% of the total volume of withdrawals.

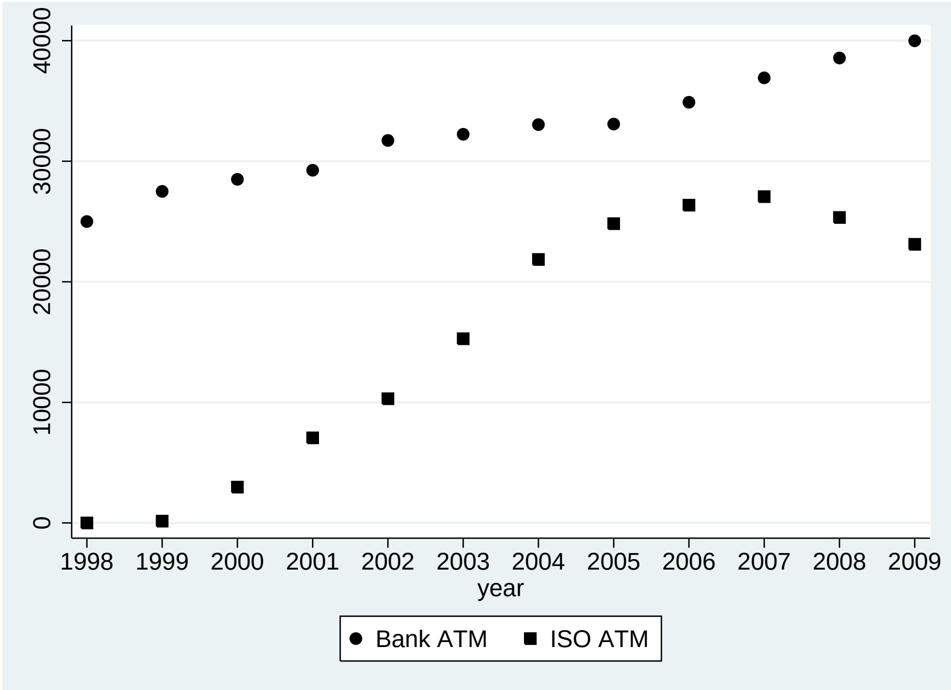


Figure 1: ATM investment in the UK by banks and non-banks

markets for banking and ATM services are interrelated. One consequence is that interchange fees may act as a collusive device (Matutes and Padilla, 1994; Donze and Dubec, 2006, 2009; Chioveanu et al., 2009). In our model, there are two banks and one ISO. Banks offer general banking services (current accounts, deposit and credit services, etc.) and cash withdrawals at ATMs. The ISO only provides ATM services. The main features of our model are in line with the present situation in the UK: There is a shared network in which all players (banks and non-banks) participate. Foreign withdrawals at ATMs owned by banks are free of charge for all consumers. There is, however, an interchange fee from the cardholder's bank to the ATM owner. The ISO directly charges consumers for using their ATMs. In addition, we study an alternative regime where the ISO receives interchange fees from the card issuer and there are no direct charges for consumers. We use this setup to study the impact of ISO entry on the size of the ATM network, account fees, profits and consumer surplus.

We find that the size of the ATM network increases due to the entry of the ISO independent of whether the ISO charges consumers directly or receives interchange fees. Which of the two regimes leads to a larger network depends on the interchange fee. If the interchange fee is rather low, the regime with direct charging leads to a larger network (and the ISO provides the significant larger share of the network). In contrast, if the interchange fee is high, there is more investment in the network when the ISO receives interchange fees.

As the markets for banking services and ATM services are linked, the entry of an ISO affects prices for banking services. In the regime where the ISO receives interchange fees the entry of the ISO leads to higher account fees. The reason is a cost-raising argument. Withdrawals at ATMs owned by the ISO are costs for banks in form of interchange payments to the ISO. These costs are passed through to customers and hence account fees rise. This effect is not present in the regime with direct charging. In this case account fees fall as the ISO enters. The reason here is that the market share of banks in the ATM network shrinks and therefore the collusive effect of interchange fees in a shared network becomes smaller.

The model presents a novel reason why banks may coordinate on high interchange fees: High interchange fees can be used to deter entry of non-banks. The existing literature emphasizes the collusive effects of interchange fees (e.g., Donze and Dubec, 2006): with high interchange fees, banks have less incentive to compete tough for customers as banks can earn significant revenues from non-customers via foreign withdrawals. In consequence, account fees (or prices for banking services in general) are high. In our model, high interchange fees may deter entry by the ISO in the case the ISO is financed by direct charges. High interchange fees induce so much investment by banks such that any investment by the ISO is crowded out. In addition, our model can explain why network operators such as LINK who are typically controlled by banks oppose ISOs to becoming members. Irrespective of the way the ISO generates revenues, bank profits decrease upon ISO entry.

In this context, the relevant policy question is whether the entry of an ISO is beneficial for consumers. We find that consumers may not always benefit from ISO entry even though the size of the total ATM network increases. In the regime where the ISO receives interchange fees this is opposed by higher account fees. If the increase in account fees is large enough consumers may be worse off due to ISO entry. The trade-offs are different in the regime where the ISO directly charges consumers. In addition to the larger network consumers benefit from lower account fees. However, consumers have to pay for the ATM use directly. Again, the overall impact of ISO entry is ambiguous and consumer may be worse off due to ISO entry. These results have been established under the assumption that the interchange fee is exogenously given.

In case a regulator can set the interchange fee, all ambiguity vanishes: The entry of an ISO financed through interchange fees increases consumer surplus and the entry of a surcharging ISO hurts consumers. Hence, if a regulator wants to induce ISO entry and is able to optimally set the interchange fee, the regime based on interchange fees is preferable. The key for this result lies in the fact that in the case of an interchange fee based ISO the trade-off between investment incentives and high account fees can be optimally balanced while ATM consumption behavior is at the efficient level. In case of a surcharge-based regime this is not the case and ATM consumption is too low as surcharging distorts this decision. In consequence, consumers are worse off.[3]

The literature on ATMs has been growing in recent years.[4] A lot of attention has been focused on the impact of ATM competition in various regimes. For instance, Donze and Dubec (2006) and Chioveanu et al. (2009) study investment and pricing in a regime based on interchange fees. Direct charging regimes where consumer pay directly for foreign ATM withdrawals are analyzed in Massoud and Bernhardt (2002) and Donze and Dubec (2009) who demonstrate that direct charging may lead to increased investment into the network, albeit at the cost of higher fees for consumers. Wenzel (2013) studies the effects of a direct charging regime in a framework where consumers are imperfectly informed about possible surcharges. He points out that the success of direct charging depends largely on consumer information as surcharges tend to increase with the number of unaware consumers.

Given that in some countries ISOs provide quite a large fraction of the total network, remarkably few papers address this issue. One notable exception

[3] We also study alternative assumptions of interchange determination. For instance, we find that if banks set the interchange fee ISO entry has no impact on consumer surplus.

[4] A survey on the older literature is provided by McAndrews (2003).

is the contribution by Donze and Dubec (2011). Motivated by the regulatory reform in Australia, Donze and Dubec (2011) study the impact of ISO entry in a direct charging regime. Their paper can be seen as complimentary to the present study that analyzes ISO entry in an interchange fee based regime (such as the UK). As in the present paper, ISO entry boosts investment into the network and decreases account fees. Very different, however, is the impact of ISO entry on bank profits. In a direct charging regime banks may actually favor ISO entry as it decreases the incentives for excessive investment (by banks) and thereby can increase bank profits.[5] In contrast, in a regime based on interchange fees, banks suffer by ISO entry due to increased competition on the withdrawal market which explains banks' reluctance to admit ISOs to the shared network in the UK (Cruickshank, 2000).

The rest of the paper is organized as follows. In Section 2 we present the model setup. Section 3 considers the benchmark model without the ISO. In Sections 4 and 5 we consider the impact of ISO entry. In Section 4 the ISO is financed through interchange fees while in Section 5 the ISO directly charges consumers. Section 6 considers the welfare effects of ISO entry if the interchange is endogenously determined. Finally, Section 7 summarizes. Derivations are relegated to the Appendix.

2 The model

Banking industry

The banking industry consists of two banks and an independent service operator (ISO). The two banks, 1 and 2, provide banking and ATM services. The costs for providing these services are normalized to zero.[6] Banks are differentiated and located at opposite ends of a unit-line (Hotelling, 1929). Bank i can charge consumers a fixed fee for opening an account (F_i). We consider a shared ATM network comparable to the one in the UK. That is, there are no direct usage fees for consumers for 'on-us' and foreign withdrawals, which means that a customer of bank 1 can withdraw cash cost-

[5] Empirical evidence for these excessive investment incentives are provided by Knittel and Stango (2011).

[6] Marginal costs of processing a withdrawals are typically small and thus can be neglected.

lessly at ATMs owned by banks 1 and 2, and vice versa. The only fee associated with foreign withdrawals at bank ATMs is an interchange fee of a from the users' bank to the owner of the ATM.

The independent service operator (ISO) solely provides ATM services whose costs are normalized to zero. In this paper, we discuss two different regimes the ISO may generate income. In the first regime, the ISO receives an interchange fee from the user's banks and there is no direct fee for users (Section 4). In the second regime, consumers are directly charged for the use of ATMs operated by the ISO (Section 5).[7]

Both, banks and the ISO, can invest in the ATM network. The number of ATMs owned by firm i is denoted by n_i and the sum of all ATMs in the economy by $N = \sum_i n_i$. There is an investment cost of c for each additional ATM.

Consumers

A mass one of consumers is located uniformly on the same unit line as the banks. Consumers derive benefits from opening an account with a bank and from withdrawing cash at ATMs. The utility from opening an account (and the subsequent banking services) is V. There are linear transportation costs at a rate t reflecting the degree of product differentiation in the market.

The second source of utility for consumers are ATM services. The gross benefit of an ATM transaction is v, where v is a random draw of $v \sim U[0, 1]$. In case the need for cash is not satisfied a consumer receives zero utility. The total number of withdrawals of a consumer is (N^γ) and is increasing in the size of the total network (N), however, at a decreasing rate as we assume $0 < \gamma < 1$. For any given transaction a consumer ends up at the ATM of bank i with probability $\frac{n_i}{N}$, where n_i denotes the number of ATMs of bank i. Hence, the expected number of withdrawals per customer at bank i is $\frac{n_i}{N} N^\gamma$. The parameter γ measures the value consumers attach to a large network. If γ is high consumers value a large network highly while the additional benefit of an additional ATM is rather small if γ is low (Donze and Dubec,

[7]In practice, in the UK both regimes coexist. A share of ATMs operated by ISOs is financed via interchange fee while another share of ATMs is financed via surcharges. For more information, we refer to the network operator LINK (www.link.co.uk).

2009). Upon finding an ATM consumers compare benefits and potential costs of ATM usage and decide to withdraw if the benefits outweigh the costs.[8] That is, a consumer decides to withdraw if $v > s$, where s is the surcharge an ISO may charge.

Total consumer utility if joining bank i then is:

$$U = V - td_i - F_i + u_{ATM}, \tag{1}$$

where d_i denotes the distance between the consumer's and the bank i's location and u_{ATM} is the utility provided by ATM services.

The following assumption ensures that the market is covered even if banks do not provide any ATMs.

Assumption 1.

$$V > \frac{3}{2}t.$$

Timing

Competition follows the following game: In the first stage, banks and the ISO decide non-cooperatively on the number of ATMs to deploy. In the second stage, all fees for banking services are determined. In the third stage, consumers decide which bank to join and on ATM use.

3 Benchmark without ISO

As benchmark we consider a banking market with only the two banks present. As there are no costs associated with ATM withdrawals, all consumers decide to withdraw money in case they encounter an ATM. Notice that the market share of the two banks does not depend on the size of a bank's network as customers can use both banks' networks without direct charges.[9]

[8]We implicitly assume that any further search is prohibitively costly. See also Chioveanu et al. (2009).

[9]This is no longer true if consumers are charged for foreign withdrawals. In this case consumers prefer banks with a large network adding some element of vertical differentiation (Chioveanu et al., 2009).

The market share of bank 1 is then

$$x = \frac{1}{2} + \frac{F_2 - F_1}{2t}, \tag{2}$$

while the market share of bank 2 is $(1 - x)$.

Bank profits consist of four parts. Banks receive income from account fees and interchange income. However, they have to pay interchange fees to the competitor for its customers' foreign withdrawals and bear the investment costs:

$$\Pi_1 = xF_1 + (1-x)\frac{n_1}{N}N^\gamma a - x\frac{n_2}{N}N^\gamma a - cn_1, \tag{3}$$

$$\Pi_2 = (1-x)F_2 + x\frac{n_2}{N}N^\gamma a - (1-x)\frac{n_1}{N}N^\gamma a - cn_2. \tag{4}$$

The analysis of the model without ISO is standard. Hence, we proceed by directly presenting the equilibrium. The symmetric equilibrium investment level is given by:

$$n^* = \frac{1}{2}\left(\frac{(1+\gamma)a}{2c}\right)^{\frac{1}{1-\gamma}}; \qquad N^* = \left(\frac{(1+\gamma)a}{2c}\right)^{\frac{1}{1-\gamma}}. \tag{5}$$

ATM deployment decreases with investment costs (c) and rises with the interchange fee, a.

Equilibrium account fees and profits are:

$$F^* = t + N^*a = t + \left(\frac{(1+\gamma)a}{2c}\right)^{\frac{\gamma}{1-\gamma}} a, \tag{6}$$

$$\Pi^* = \frac{t}{2} + \left(\frac{(1+\gamma)a}{2c}\right)^{\frac{1}{1-\gamma}} \frac{c(1-\gamma)}{2(1+\gamma)}. \tag{7}$$

In equilibrium, profits depend only on account fees and investment cost. As ATM deployment is symmetric and each bank attracts half of the consumers interchange fee payments among banks exactly cancel out.

The benchmark model confirms the existing literature's results on the impact of the interchange fee on prices and profits. Account fees and banks' profits rise with the interchange fee. Coordinating on high interchange fees can be seen as an instrument of collusion among banks. With high interchange fees banks have less incentives to compete tough for customers as they can earn significant revenues from non-customers via high income from foreign withdrawals (Donze and Dubec, 2006, 2009; Chioveanu et al., 2009). Notice that the collusive effect on account fees is stronger the larger the ATM network is.

Finally, we report consumer surplus in the benchmark regime. Net of constants, that is, net of transportation costs and net of the gross utility V for opening an account, consumer surplus can be expressed as:[10]

$$CS^* = \frac{1}{2}(N^*)^\gamma - F^* = \left(\frac{(1+\gamma)a}{2c}\right)^{\frac{\gamma}{1-\gamma}} \left(\frac{1}{2} - a\right) - t. \tag{8}$$

Basically, consumer surplus is influenced by the size of the network, which has a positive impact on surplus, and by the account fee, which reduces the surplus.

4 ISO receives interchange fees

Now we introduce an independent service operator (ISO) that is financed through interchange fees. As there are no direct fees for users from a consumer's point of view ATMs operated by banks and the ISO are perfect substitutes.

The profit functions of the three firms are given by:

$$\Pi_1 = xF_1 + (1-x)\frac{n_1}{N}N^\gamma a - x\frac{n_2}{N}N^\gamma a - x\frac{n_I}{N}N^\gamma a - cn_1, \tag{9}$$

$$\Pi_2 = (1-x)F_2 + x\frac{n_2}{N}N^\gamma a - (1-x)\frac{n_1}{N}N^\gamma a - (1-x)\frac{n_I}{N}N^\gamma a - cn_2, \tag{10}$$

$$\Pi_I = \frac{n_I}{N}N^\gamma a - cn_I, \tag{11}$$

where $N = n_1 + n_2 + n_I$ and x is given by equation (2). Compared to our benchmark without ISO, the banks' profit functions do only change in the

[10] As we do not study location and entry decisions, transportation costs are the same in all the regimes and hence we neglect their influence on consumer surplus.

additional interchange payments to the ISO. The profit function of the ISO consists of the interchange income less investment costs.

In the second stage of the game, banks decide on their account fees. The ISO has no decision variable at this stage. Maximizing banks' profit functions and solving for equilibrium account fees we get:

$$\hat{F}_i = t + \left(\frac{n_1}{N}N^\gamma + \frac{n_2}{N}N^\gamma + \frac{n_I}{N}N^\gamma\right)a = t + N^\gamma a. \tag{12}$$

Notice that the costs the ISO incurs onto banks ($\frac{n_I}{N}N^\gamma a$) are fully passed through to customers via higher account fees. Again both banks charge identical account fees irrespective of the size of their individual networks, leading to profits of

$$\hat{\Pi}_i = \frac{t}{2} + \frac{n_i}{N}N^\gamma a - cn_i. \tag{13}$$

At the investment decision in stage 1 banks aim to maximize equation (13). The profit function for the ISO at this stage is given by equation (11). The symmetric equilibrium is characterized by:[11]

$$\bar{n} = \frac{1}{3}\left[\frac{(2+\gamma)a}{3c}\right]^{\frac{1}{1-\gamma}}; \qquad \bar{N} = \left[\frac{(2+\gamma)a}{3c}\right]^{\frac{1}{1-\gamma}}. \tag{14}$$

Comparing ATM deployment with and without ISO we find that $\bar{n} < n^*$ and $\bar{N} > N^*$. That is, due to ISO entry each bank reduces its network size, however, the total size of the ATM network becomes larger.

The resulting equilibrium account fees are:

$$\bar{F} = t + \bar{N}a = t + \left(\frac{(2+\gamma)a}{3c}\right)^{\frac{\gamma}{1-\gamma}} a. \tag{15}$$

Comparing equations (15) and (6) and knowing that $\bar{N} > N^*$ it is clear that the account fees rise due to the entry of the ISO. The reason lies in the additional ATM investment by the entering ISO. A larger ATM network of the

[11] The objective functions of all players—banks and ISO—take the form of a Tullock contest where the identical contest price increases with aggregate investment and we know from Chung (1996) that a symmetric equilibrium exists. Note that the equilibrium is symmetric as all interchange fee payments are fully passed through to customers via higher account fees.

ISO incurs costs to the banks which pass them through to their customers.

Equilibrium bank profits are:

$$\bar{\Pi}_B = \frac{t}{2} + \left(\frac{(2+\gamma)a}{3c}\right)^{\frac{1}{1-\gamma}} \frac{c(1-\gamma)}{3(2+\gamma)}. \tag{16}$$

In equilibrium, bank profits consist of three parts: Banks receive account fees from consumers. The interchange fee flows between banks again net out while both banks have an interchange outflow to the ISO. In addition, banks have to bear the investment costs for their network. Comparing profits before and after ISO entry (comparing equations (7) and (16)) we find that bank profits decrease due to the entry of the ISO ($\bar{\Pi}_B < \Pi^*$).

The ISO earns the following profits:

$$\bar{\Pi}_I = \left(\frac{(2+\gamma)a}{3c}\right)^{\frac{1}{1-\gamma}} \frac{c(1-\gamma)}{3(2+\gamma)}. \tag{17}$$

Both, banks and the ISO, prefer high interchange fees as profits rise with the interchange fee. Thus, the collusive impact of interchange fees from the benchmark case is confirmed in the case where the ISO receives interchange fees.

We study whether the entry of an ISO that receives interchange fees is beneficial for consumers. Net of constants, consumer surplus in the regime where the ISO receives interchange fees is:

$$\bar{CS} = \frac{1}{2}\bar{N}^{\gamma} - \bar{F} = \left(\frac{(2+\gamma)a}{3c}\right)^{\frac{\gamma}{1-\gamma}} \left(\frac{1}{2} - a\right) - t. \tag{18}$$

Comparing equations (8) and (18), there are two effects of ISO entry on consumer surplus. On the positive side, the entry of the ISO leads to a larger total ATM network which is beneficial for consumers. On the negative side, account fees increase. Thus, the total impact on consumers depends on the relative strength of these two effects. The comparison reveals that $\bar{CS} > CS^*$ as long as $a < \frac{1}{2}$. Hence, the entry of the ISO need not be good for consumers as the increase in account fees may outweigh the positive benefits of the larger network which is the case if the interchange fee is sufficiently large.

The following proposition summarizes the impact of entry by an ISO receiving interchange fees:

Proposition 1. The entry of an ISO which is financed through interchange fees leads to i) a larger total ATM network, ii) a smaller network operated by banks, iii) higher account fees, and iv) lower bank profits. v) Consumer surplus increases if the (exogenous) interchange fee is sufficiently small.

5 ISO receives surcharges

In this section, we consider the regime where the ISO directly charges customers for cash withdrawals. Foreign withdrawals at bank ATMs are still costless.

In contrast to the above sections, not all ATMs can be used without charges and, hence, not all consumers decide to withdraw money once they encounter an ATM. Suppose the ISO charges a fee of $s_I < 1$, then only consumers with $v > s_I$ decide to withdraw money. Under the assumption of v being uniformly distributed on the unit interval, a fraction $(1 - s_I)$ uses the ATM. Hence, the ISO generates revenues of $(1 - s_I)s_I$. As all withdrawals at bank ATMs are still costless, all consumers decide to withdraw at bank ATMs. Notice that with positive surcharges ATM consumption is inefficiently low.

The profit functions are now:

$$\Pi_1 = xF_1 + (1-x)\frac{n_1}{N}N^\gamma a - x\frac{n_2}{N}N^\gamma a - cn_1, \tag{19}$$

$$\Pi_2 = (1-x)F_2 + x\frac{n_2}{N}N^\gamma a - (1-x)\frac{n_1}{N}N^\gamma a - cn_2, \tag{20}$$

$$\Pi_I = \frac{n_I}{N}N^\gamma\left(1 - s_I\right)s_I - cn_I, \tag{21}$$

where $N = n_1 + n_2 + n_I$ and x is given by equation (2).

In the second stage, fees for all banking services are set: The banks decide on account fees (F_1, F_2), the ISO decides on the surcharge (s_I). Decisions of the banks and the ISO are independent and hence,

$$\breve{s}_I = \frac{1}{2}, \tag{22}$$

and

$$\breve{F} = t + \frac{n_1 + n_2}{N} N^\gamma a. \tag{23}$$

Inserting these fees gives the profits at the investment stage:

$$\breve{\Pi}_B = \frac{t}{2} + \frac{n_i}{N} N^\gamma a - c n_i, \tag{24}$$

and

$$\breve{\Pi}_I = \frac{n_I}{N} N^\gamma \frac{1}{4} - c n_I. \tag{25}$$

The objective functions of the players at the investment stage resemble a contest with market size effects. However, in contrast to the preceding section valuations of the contest price are asymmetric. Banks value an additional ATM by a and the ISO by $\frac{1}{4}$. As has been shown in the literature on asymmetric contests equilibrium investment is no longer symmetric. In particular, not all players are necessarily active, that is, some players may not invest at all (e.g., Stein, 2002). In the Appendix, we consider a general setup where contestants are asymmetric and the contest prize is increasing in aggregate effort. In this setup we derive the set of active players and then provide the solution to our specific investment problem.

Equilibrium ATM investment is as follows:

$$\tilde{n}_B = \begin{cases} 0 & \text{if } a < \frac{\gamma}{4} \\ \frac{4a-\gamma}{2(1+2a)(1-\gamma)} \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{1}{1-\gamma}} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)} \\ \frac{1}{2}\left(\frac{(1+\gamma)a}{2c}\right)^{\frac{1}{1-\gamma}} & \text{if } a > \frac{1}{2(1+\gamma)}, \end{cases} \tag{26}$$

$$\tilde{n}_I = \begin{cases} \left(\frac{\gamma}{4c}\right)^{\frac{1}{1-\gamma}} & \text{if } a < \frac{\gamma}{4} \\ \frac{1-2a(1+\gamma)}{(1+2a)(1-\gamma)} \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{1}{1-\gamma}} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)} \\ 0 & \text{if } a > \frac{1}{2(1+\gamma)}. \end{cases} \tag{27}$$

Equilibrium investment is asymmetric and there are three different cases depending on the magnitude of the interchange fee: i) if the interchange fee is low ($a < \frac{\gamma}{4}$) banks do not invest at all. Only the ISO invests; ii) if the interchange fee is intermediate ($\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$), both types of firm invest positive amounts; and iii) if the interchange fee is high ($a > \frac{1}{2(1+\gamma)}$), then only banks invest a positive amount. In this case, the outcome corresponds to our benchmark case without ISO.

Our model points to a novel rationale for banks to coordinate on high interchange fees. While the existing theory focuses on the collusive impact of high interchange fees, the present model shows that high interchange fees may additionally serve as a device to deter entry of non-banks. The reason is that with high interchange fees banks high investment crowds out any investment by the ISO.[12]

In the following we will focus on cases where the ISO is active, that is, $a < \frac{1}{2(1+\gamma)}$. The results for an inactive ISO correspond to our benchmark case from Section 3. Adding up, the total size of the ATM network is:

$$\tilde{N} = \begin{cases} \left(\frac{\gamma}{4c}\right)^{\frac{1}{1-\gamma}} & \text{if } a < \frac{\gamma}{4} \\ \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{1}{1-\gamma}} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}. \end{cases} \tag{28}$$

While an increase in the interchange fee changes the composition of the share of the ATM network owned by banks and the ISO, the size of the overall network strictly increases. The increase in banks' network more than compensates possible decreases in investment by the ISO.

Equilibrium account fees are given by $\tilde{F} = t + a\frac{2\tilde{N}_B}{\tilde{N}}\tilde{N}^{\gamma}$:

$$\tilde{F} = \begin{cases} t & \text{if } a < \frac{\gamma}{4} \\ t + \frac{a(4a-\gamma)}{(1-\gamma)(1+2a)}\left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{\gamma}{1-\gamma}} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}. \end{cases} \tag{29}$$

Account fees with direct charging are lower than in the benchmark model as well as in the regime where the ISO receives interchange fees as the collusive impact of interchange fees, which depends on the market share of

[12] A similar case can be made when the ISO receives interchange fees, but interchange fees for banks and the ISO differ. If the interchange fee among banks is sufficiently higher than the interchange fee received by the ISO the same outcome would emerge.

banks in the ATM network, is lower. In addition, no costs in form of interchange payments to the ISO are passed over to consumers. This is easy to see in the case where only the ISO invests in the ATM network. In this case the markets for banking and withdrawal services are unconnected and account fees are only determined by the degree of product differentiation and hence correspond to the standard Hotelling price of t. The same qualitatively holds, though less pronounced, for the case where both banks and the ISO invest. Account fees are proportional to the market share of banks in the ATM market (see equation (23)) which decreases due to the entry of the ISO.

In equilibrium, profits of banks and the ISO are:

$$\tilde{\Pi}_B = \begin{cases} \frac{t}{2} & \text{if } a < \frac{\gamma}{4} \\ \frac{t}{2} + \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{1}{1-\gamma}} \frac{(4a-\gamma)^2 c}{2(1+2a)(1-\gamma)(2+\gamma)} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}. \end{cases} \tag{30}$$

$$\tilde{\Pi}_I = \begin{cases} \left(\frac{\gamma}{4c}\right)^{\frac{1}{1-\gamma}} \frac{c(1-\gamma)}{\gamma} & \text{if } a < \frac{\gamma}{4} \\ \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{1}{1-\gamma}} \frac{c(1-2a(1+\gamma))^2}{2a(2+\gamma)(1-\gamma)(1+2a)} & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}. \end{cases} \tag{31}$$

Bank profits are lower than in the base model, that is $\tilde{\Pi}_B < \Pi^*$. This can again best be seen when banks do not invest. Then, profits reduce to the standard Hotelling profits. Thus, irrespective of the way the ISO receives income banks lose profits if the ISO enters. This explains the reluctance of ATM network operators—who are traditionally dominated by banks—to allow ISOs to become members of a shared network (Cruickshank, 2000).

Now let us compare whether the entry of a surcharging ISO is beneficial for consumers. Consumer surplus in the surcharging case is given by:

$$\tilde{CS} = \tilde{N}^{\gamma} \left(\frac{\tilde{n}_I}{\tilde{N}} \frac{(1-s_I)^2)}{2} + \frac{2\tilde{n}_B}{\tilde{N}} \frac{1}{2} \right) - \tilde{F}. \tag{32}$$

Consumer surplus consists of benefits from using an ATM owned by the ISO (first term in brackets), benefits of using an ATM owned by a banks (second term in brackets) and the payment of account fees. Using equations (26) and

(27) consumer surplus can be rewritten as

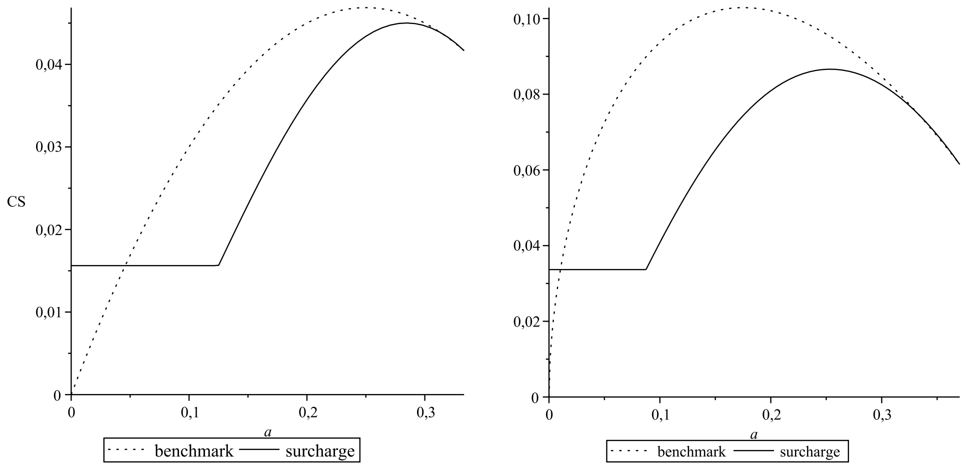
$$\tilde{CS} = \begin{cases} \frac{1}{8}\left(\frac{\gamma}{4c}\right)^{\frac{\gamma}{1-\gamma}} - t & \text{if } a < \frac{\gamma}{4} \\ \left(\frac{a(2+\gamma)}{2c(1+2a)}\right)^{\frac{\gamma}{1-\gamma}} \left(\frac{1}{8} + \frac{12a-3\gamma-8a(4a-\gamma)}{8(1+2a)(1-\gamma)}\right) - t & \text{if } \frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}. \end{cases} \tag{33}$$

Consumer surplus is affected in three ways compared to the benchmark case: The size of the network increases and account fees decrease. Both effects are positive for consumers. On the downside consumers pay fees for withdrawals at ATMs of the ISO. It turns out that the overall outcome is ambiguous and depends on the strength of the three effects. Surcharging with ISO entry is better for consumers if the interchange fee is either at low levels or at high levels. For intermediate levels, consumer surplus is higher in the benchmark case without ISO. For a low interchange fee ISO entry leads to higher surplus as the ATM network is much larger; there are only weak incentives to invest in the benchmark without ISO. For high levels of the interchange fee the collusive effect of the interchange fee on account fees is the dominant effect. And hence, ISO entry—reducing this effect—is beneficial for consumers. Consumer surplus is higher in the base model for intermediate levels of the interchange fee as in this case the positive effects on investment are strong and the negative effects on account fees are not too strong. Figure 2 provides an example of this result for $c = 1$ and for $\gamma = 0.5$ and $\gamma = 0.35$, respectively. From the figures one can notice that as consumers' preferences for a large network become more important (larger γ) the zone where the ISO leads to higher surplus gets larger. In addition, one can see that the difference between the base model and the case with a surcharging ISO becomes quite small for large values of the interchange fee, although the case with ISO performs slightly better.

We summarize:

Proposition 2. The entry of an ISO that directly charges consumers leads to i) a larger total ATM network, ii) lower account fees, iii) lower bank profits. iv) Consumer surplus increases if the (exogenous) interchange fee is either sufficiently high or sufficiently low.

Let us compare our results with Donze and Dubec (2011) who study ISO



(a) $\gamma = 0.5$ (b) $\gamma = 0.35$

Figure 2: Comparison of consumer surplus with exog. interchange fees

entry in a regime where also banks directly charge consumers for foreign withdrawals. As in our model, ISO entry leads to a larger network and reduced account fees. In addition, consumer surplus need not increase as the directs costs for consumers may not be compensated. A major difference occurs regarding the impact of ISO entry on bank profitability. While in our model ISO leads to lower bank profits, bank profits increase in Donze and Dubec (2011). The reason is that in a regime where also banks charge consumers directly, banks have excessive incentives to invest in ATMs as banks can attract more consumers with a larger network.[13] With ISO entry these investment incentives are reduced so that, as a result, investments are reduced and profits increase.

Comparison across regimes

Let us briefly compare market outcomes in terms of network size, account fees, and profits across the two regimes with ISO:

Proposition 3. i) The ATM network is larger (smaller) in the regime where

[13]This effect is not present in an interchange-based regime as consumers can use the whole network without costs, independent of who owns it. As a result, banks cannot attract additional consumers by investing into a larger network.

the ISO charges consumers directly than in the regime where the ISO receives interchange fees if the interchange fee is sufficiently small (high). ii) Account fees in the regime with direct charging at ATMs owned by the ISO are lower than in the regime where the ISO receives interchange fees. iii) Banks and ISO have opposing preferences toward the two pricing regimes.

Results are ambiguous when comparing the network size in the two regimes with ISO. If the interchange fee is relatively low we have $\tilde{N} > \bar{N}$ and in the case of a high interchange fee we find that $\tilde{N} < \bar{N}$. The reason is that for a low interchange fee the ISO invests more under direct charging compared to when it receives interchange fees. The contrary holds for high levels of the interchange fee.

Regarding account fees, from Propositions 1 and 2 it follows immediately that account fees are lower with direct charging. The entry of an ISO increases account fees in the regime with interchange fees, but decreases account fees in the regime with direct charging. Hence, account fees are lower with direct charging.

It turns out that banks and the ISO have rather opposing interest regarding the two possible regimes and that those preferences depend largely on the level of the interchange fee. For a low interchange fee, banks prefer the regime where the ISO receives interchange fees as well. For higher levels of the interchange fee, banks prefer the ISO to be financed by surcharges. This is obvious for very high levels of the interchange fee where the ISO drops out of the market. The ISO preferences towards the two pricing regimes are opposed to banks' preferences. For high interchange fees, the ISO prefers to receive interchange fees. If, on the other hand, the interchange fee is rather low, the ISO prefers to charge consumers directly.

6 Endogenous interchange fees

So far, we have analyzed the impact of ISO entry for exogenous interchange fees. In this section, we study the effects that arise for endogenously determined interchange fees. In the following, we compare different ways the interchange fee may be determined: i) by banks, ii) by the banking industry (banks and ISO) and, iii) by a regulator.

Interchange fees set by banks

Let us start by analyzing the impact of ISO entry in the case banks jointly determine the interchange fee. This is a common assumption in the literature (e.g., Donze and Dubec, 2006).

As shown above, in the benchmark case without ISO as well as in the regime where the ISO receives interchange fees, bank profits are strictly increasing with the interchange fee and, hence, jointly determined interchange fees have a collusive effect. Hence, in both cases, banks would want to increase the interchange fee until the marginal consumer is left with zero surplus.[14] Hence, with and without ISO entry the marginal consumer is left without any surplus and, as a result, total consumer surplus is unaffected by ISO entry. Possible positive benefits due to the larger network are completely offset by higher account fees.

In the surcharging regime, in addition to the collusive motive there is an exclusionary motive to increase the interchange fee. For banks it is optimal to increase the interchange beyond the level where the ISO is active. By choosing high interchange fees, banks can crowd out investment by the ISO and, hence, banks would coordinate on an interchange fee such that ISO entry does not take place.

Proposition 4. Suppose banks set the interchange fee. i) Then, the entry of an ISO that receives interchange fees has no impact on consumer surplus. ii) In the surcharging regime, no ISO entry takes place.

Interchange fees set by the banking industry

Next, let us assume that the interchange fee is set jointly by the banking industry, that is, by both banks and the ISO. In the regime where the ISO receives interchange fees, incentives are well aligned. The banks and the ISO

[14] Notice that we still assume that the market is covered. That is, the marginal consumer is better off buying a bank account than abstaining from buying.

both benefit from higher interchange fees, just as banks do in the benchmark without ISO. Hence, in both regimes the interchange fee is set such that the marginal consumer is left without surplus and consumer surplus is not affected by ISO entry.

In contrast, in the surcharging regime, a conflict of interest arises as banks and the ISO have opposing interests regarding the interchange fee. Banks prefer a high interchange fee while the ISO prefers a low one. Hence, whether or not entry of the ISO is then beneficial to consumers depends largely on the relative bargaining power of banks and the ISO. At this point we can refer to the welfare analysis with an exogenously given interchange fee (see Proposition 2): Consumer surplus increases due to ISO entry if bargaining between banks and the ISO leads to either a relatively low or a sufficiently high interchange fee.

Proposition 5. Suppose the banking industry (banks and ISO) sets the interchange fee. i) Then, the entry of an ISO that receives interchange fees has no impact on consumer surplus. ii) The entry of a surcharging ISO increases consumer surplus if bargaining between banks and the ISO leads to either a sufficiently low or a sufficiently high interchange fee.

Regulated interchange fees

Now we suppose that the interchange fee is under the control of a regulator who aims to maximize consumer surplus. Maximizing equation (8) reveals that, in the benchmark case, the regulator wants to implement an interchange fee of $\frac{\gamma}{2}$. Given this interchange fee, consumers get a surplus of

$$CS = \frac{1}{2}\left(\frac{(1+\gamma)\gamma}{4c}\right)^{\frac{\gamma}{1-\gamma}}(1-\gamma) - t. \tag{34}$$

We start by studying the entry of an ISO financed by interchange fees. In this case, the regulator also chooses an interchange fee of $a = \frac{\gamma}{2}$, which maximizes equation (18). With this interchange fee, consumer surplus can be expressed as

$$\bar{CS} = \frac{1}{2}\left(\frac{(2+\gamma)\gamma}{6c}\right)^{\frac{\gamma}{1-\gamma}}(1-\gamma) - t. \quad (35)$$

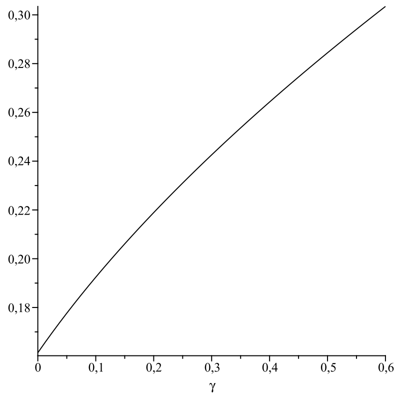
Comparing equations (34) and (35) reveals that consumer surplus is higher with ISO entry, and hence consumers benefit from the entry of the ISO. The reason is that the regulator, when choosing the interchange fee, can optimally balance the trade-off between investment incentives and high account fees. In addition, ATM use is at is efficient level. As a consequence, ISO entry is beneficial for consumers.

Next, let us turn to the interchange fee determination in the surcharging regime. In this regime, it is not possible to analytically determine the surplus-maximizing interchange fee. Thus, we have turned to numerical solutions to express the optimal interchange fee and compare consumer surplus with and without ISO. Figure 3 provides the numerical results in the case of $c = 1$.[15] In the left panel of this figure we plot the surplus-maximizing interchange fee. The right panel provides the comparison of consumer surplus. The figure reveals that consumer surplus is always higher in the benchmark regime if the regulator chooses the surplus-maximizing interchange fee in each regime.[16] Thus, consumers are hurt by the entry of an ISO that directly charges consumers. By regulating the interchange fee in the base model without ISO the regulator can optimally handle the trade-off between investment incentives and high account fees and ATM use is at the efficient level. In case of a surcharge-based regime this is no longer the case and ATM use is too low as surcharging distorts this decision. This leads to consumers being worse off with a surcharging ISO.

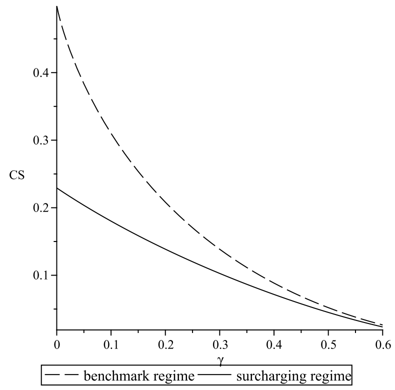
Proposition 6. Suppose a regulator sets the interchange fee as to maximize consumer surplus. Then, i) the entry of an ISO that receives interchange fees increases consumer surplus, and ii) the entry of an ISO that directly

[15] We have repeated this numerical analysis for various values of investment cost c and find that our results do not depend on the specific value of this parameter.

[16] Note that the surplus-maximizing interchange fee differs across the two regimes. As shown above, in the benchmark regime the surplus-maximizing interchange fee is set at $\gamma/2$ and in the surcharging regime the surplus maximizing surcharge is given in the left panel of figure 3.



(a) Regulated interchange fee



(b) Comparison of consumer surplus

Figure 3: Comparison of consumer surplus with an endog. interchange fee and $c = 1$

charges consumers decreases consumer surplus.

The propositions highlights that ISO entry need not be beneficial even if a regulator can control the interchange fee. This has also implications for the design of ATM markets when a regulator wants to encourage ISO entry and can also influence the charging regime. From Proposition 6 it follows immediately that the regulator should implement the regime where the ISO receives interchange fee as only in this case consumer surplus increases.

7 Conclusion

Since recently, entry of non-banks into the ATM business can be observed. This paper aims at understanding the impact of ISO entry in ATM markets (such as the UK) which are based on interchange fee payments.

Our study leads to several messages for policy makers. We show that banks' profits are reduced due to ISO entry and, hence, banks might have incentives to lobby or take other actions to impede market entry by ISOs. In this respect, competition authorities might be concerned with how the banking industry (or the network operator) decides on interchange fees as they provide a tool to hinder ISO entry. If ISOs are financed by surcharges, banks may deter ISO entry by coordinating on a high interchange fees. In case the

ISO receives interchange fees, entry deterrence can occur if banks are able to set different interchange fees for banks and ISOs.

The Cruickshank report has advocated entry by ISOs. The present paper qualifies this policy recommendation. We show that ISO entry need not necessarily be positive for consumer welfare. The positive effects of ISO entry due to larger investments into the network may be completely offset by higher account fees (in the regime where the ISO receives interchange fees) or by the direct charging of consumers at ATMs owned by the ISO. However, consumer surplus can be raised by ISO entry in the interchange fee regime provided that the interchange fee is sufficiently low. Thus, if policy makers want to promote ISO entry this might be coupled with caps on the interchange fee to ensure positive welfare effects. Though, in practice it might be difficult choosing the ”correct” cap with the danger that a too low interchange fee might reduce investment incentives.

Finally, we would like to point towards further research in this field. The existing literature has studied the impact of ISO entry in different regimes: This paper has studied the effects in an interchange-fee based regimes and Donze and Dubec (2009) have provided a complementary study in a direct charging regime. However, there has been no study that compares the effects of ISO entry across regimes in a unified framework so that the question which regime leads to better market outcomes in the presence of ISOs is so far unanswered.

A Appendix

Derivations in section 4

We compare the market outcomes in our benchmark case with the regime where the ISO receives interchange fees. The total network increases: $\bar{N} > N^* \Leftrightarrow 1 > \gamma$. Bank networks decrease: $\bar{n} < n^* \Leftrightarrow \frac{1}{3}\left(\frac{2+\gamma}{3}\right)^{\frac{1}{1-\gamma}} < \frac{1}{2}\left(\frac{1+\gamma}{2}\right)^{\frac{1}{1-\gamma}}$; true for $0 < \gamma < 1$. Bank profits decrease: $\bar{\Pi}_B < \Pi^* \Leftrightarrow \frac{1}{3(2+\gamma)}\left(\frac{2+\gamma}{3}\right)^{\frac{1}{1-\gamma}} < \frac{1}{2(1+\gamma)}\left(\frac{1+\gamma}{2}\right)^{\frac{1}{1-\gamma}}$, true for $0 < \gamma < 1$. Industry profits decrease: $2\bar{\Pi}_B + \bar{\Pi}_I < 2\Pi^* \Leftrightarrow \frac{1}{2+\gamma}\left(\frac{2+\gamma}{3}\right)^{\frac{1}{1-\gamma}} < \frac{1}{1+\gamma}\left(\frac{1+\gamma}{2}\right)^{\frac{1}{1-\gamma}}$, true for $0 < \gamma < 1$.

Derivations in section 5

Investment

To derive the investment decision we follow Stein (2002) and Matros (2006) but extend their setup to capture markets size effects. We provide the participation condition in an asymmetric contest with market size effects in a fairly general way and later apply our results to our specific investment problem.

Suppose there are K players with valuations v_i for the contest prize. Player i can expend resources n_i to win the contest price $\left(\sum_{j=1}^{K} n_j\right)^{\gamma}$. There are investment costs of c for investing an additional unit.

Order the players such that

$$v_1 \geq v_2 \geq ... \geq v_K, \tag{36}$$

and define the harmonic mean of the h largest valuations as

$$\hat{v}_h = \frac{h}{\sum_{j=1}^{h} \frac{1}{v_j}} \text{for } h = 1..K. \tag{37}$$

When investing each player has to solve:

$$\max_{n_i} \frac{n_i}{\sum_{j=1}^{K} n_j} \left(\sum_{j=1}^{K} n_j\right)^{\gamma} v_i - cn_i. \tag{38}$$

The first-order condition of this problem is:

$$\left[\frac{\left(\sum_{j=1}^{K} n_j\right)^{\gamma}}{\sum_{j=1}^{K} n_j} - \frac{n_i \left(\sum_{j=1}^{K} n_j\right)^{\gamma}}{\left(\sum_{j=1}^{K} n_j\right)^{2}} + \frac{n_i \gamma \left(\sum_{j=1}^{K} n_j\right)^{\gamma}}{\left(\sum_{j=1}^{K} n_j\right)^{2}} \right] v_i = 0 \tag{39}$$

The second-order condition is always fulfilled:

$$-\frac{v_i \left(\sum_{j=1}^{K} n_j\right)^{\gamma}}{\left(\sum_{j=1}^{K} n_j\right)^{3}} [2(1-\gamma) \left(\sum_{j \neq i} n_j\right) + \gamma(1-\gamma) n_i] \leq 0. \tag{40}$$

Re-arranging the first-order condition yields:

$$\left(\sum_{j=1}^{K} n_j\right)^{\gamma} [K-(1-\gamma)n_i]v_i = c\left(\sum_{j=1}^{K} n_j\right)^{2}. \tag{41}$$

Summing over k active players gives:

$$\hat{v}_n \frac{n-1+\gamma}{n} = \frac{cN}{N^{\gamma}}. \tag{42}$$

Now, player $k+1$ has an incentive to actively participate if

$$\frac{n_{k+1}}{\sum_{j=1}^{k} n_j + n_{k+1}} \left(\sum_{j=1}^{k} n_j + n_{k+1}\right)^{\gamma} v_{k+1} - cn_{k+1} > 0 \tag{43}$$

Re-organizing gives

$$v_{k+1} > c\left(\sum_{j=1}^{k} n_j + n_{k+1}\right)^{1-\gamma} > c\left(\sum_{j=1}^{k} n_j\right)^{1-\gamma} = \hat{v}_k \frac{n-1+\gamma}{n} \tag{44}$$

This gives the following participation condition: The active players will be the ones with the k largest valuations. The value of k is the smallest integer such that

$$v_{k+1} \leq \frac{k-1+\gamma}{k}\hat{v}_k. \tag{45}$$

This condition reduces to the same condition as in Stein (2002) in the case of no market expansion effects ($\gamma = 0$). Note that an equilibrium with one active player is possible. This is an equilibrium if contest valuations are such that

$$v_2 \leq \gamma v_1. \tag{46}$$

Without market size effects ($\gamma = 0$) this cannot happen if player 2 has a positive valuation no matter how small.

Having described the set of active players in a general way, we not turn to our investment problem with three players. Denote banks valuation as $v_B = a$ and the valuation of the ISO as $v_I = \frac{1}{4}$. We have to distinguish the two cases whether $v_B \gtrless v_I \Leftrightarrow a \gtrless \frac{1}{4}$: i) $a \leq \frac{1}{4}$. Applying condition (45) we have that for $a < \frac{\gamma}{4}$ only the ISO is active and for $a \geq \frac{\gamma}{4}$ both banks and ISO are active. ii) $a > \frac{1}{4}$. Applying (45) we have that for $a > \frac{1}{2(1+\gamma)}$ only the banks are active and for $a \leq \frac{1}{2(1+\gamma)}$ both banks and ISO are active. Taken together, we have that for $a < \frac{\gamma}{4}$ only the ISO is active, for $\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$ the ISO and both banks are active and for $a > \frac{1}{2(1+\gamma)}$ only the banks are active. Solving the first-order conditions then gives equilibrium investment as in equations (26) and (27).

Comparison ATM network size

Total investment in the regime where the ISO receives surcharges is higher than in the base model, $\tilde{N} > N^*$. i) $a < \frac{\gamma}{4}$. $(\frac{\gamma}{4c})^{\frac{1}{1-\gamma}} > (\frac{a(1+\gamma)}{2c})^{\frac{1}{1-\gamma}} \Leftrightarrow \frac{\gamma}{2} > a(1+\gamma)$, which is true in the relevant parameter space. ii) $\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$. $(\frac{a(2+\gamma)}{2c(1+2a)})^{\frac{1}{1-\gamma}} > (\frac{a(1+\gamma)}{2c})^{\frac{1}{1-\gamma}} \Leftrightarrow \frac{1}{1+\gamma} > 2a$ which is true in the relevant parameter space.

$\tilde{N} > \bar{N}$ if the interchange fee is sufficiently smaller than $a < \frac{1}{4}$. Otherwise, $\tilde{N} < \bar{N}$: i) $a < \frac{\gamma}{4}$. $\tilde{N} > \bar{N}$ if $a < \frac{3\gamma}{4(2+\gamma)}$ which is always true under $a < \frac{\gamma}{4}$. ii) $\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$. $\bar{N} > \tilde{N} \Leftrightarrow a > \frac{1}{4} = a^c$. As $\frac{\gamma}{4} \leq a^c \leq \frac{1}{2(1+\gamma)}$ it follows that $\bar{N} > \tilde{N}$ if $a > a^c$ and $\bar{N} > \tilde{N}$ if $a < a^c$.

Comparison of account fees

Compared to the base model, account fees decrease: $F^* > \tilde{F}$. This is obvious in the case only the ISO invests in the ATM network ($a < \frac{\gamma}{4}$). But it does also hold if $a > \frac{\gamma}{4}$. To show this it suffices to show that $(N^*)^\gamma > \frac{2\tilde{n}_B}{\tilde{N}}\tilde{N}^\gamma \Leftrightarrow \left(\frac{(1+\gamma)a}{2c}\right)^{\frac{\gamma}{1-\gamma}} > \left(\frac{(2+\gamma)a}{2c(1+2a)}\right)^{\frac{\gamma}{1-\gamma}} \frac{4a-\gamma}{(1+2a)(1-\gamma)}$. Re-arranging gives $H_1 = \left(\frac{1+\gamma}{2+\gamma}\right)^{\frac{\gamma}{1-\gamma}} - \frac{4a-\gamma}{(1+2\delta a)(1-\gamma)^{\frac{1}{1-\gamma}}} > 0$. We have to show that $H_1 > 0$ in $a \in [\frac{\gamma}{4}, \frac{1}{2(1+\gamma)}]$. First note, that $\frac{dH_1}{da} < 0$. Then, note that $H_1(a = \frac{1}{2(1+\gamma)}) > 0$. Hence, $H_1 > 0$ in $a \in [\frac{\gamma}{4}, \frac{1}{2(1+\gamma)}]$. As $\bar{F} > F^*$, it follows immediately that $\bar{F} > \tilde{F}$.

Comparison of profits

$\Pi^* > \tilde{\Pi}_B \Leftrightarrow H_2 = \left(\frac{1+\gamma}{2+\gamma}\right)^{\frac{1}{1-\gamma}} \frac{(1-\gamma)^2(1+2a)(2+\gamma)(1+2a)^{\frac{1}{1-\gamma}}}{(1+\gamma)(4a-\gamma)^2} - 1 > 0$. First, note that $\frac{dH_2}{da} < 0$ and $H_2(a = \frac{1}{2(1+\gamma)}) = 0$. And hence, for all $a < \frac{1}{2(1+\gamma)}$, $H_2 > 0$. Hence, $\Pi^* > \tilde{\Pi}_B$.

a) The banks prefer the ISO to be financed by interchange fees if the interchange fee is regulated sufficiently low. Otherwise, they prefer the ISO to charge consumers directly: i) $a < \frac{\gamma}{4}$. It is immediately clear that $\tilde{\Pi}_B < \bar{\Pi}_B$. ii) $\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$. $\tilde{\Pi}_B \gtrless \bar{\Pi}_B \Leftrightarrow H_3 = \left(\frac{3}{2(1+2a)}\right)^{\frac{1}{1-\gamma}} \frac{3(4a-\gamma)^2}{2(1-\gamma)^2(1+2a)} - 1 \gtrless 0$. As $\frac{dH_3}{da} > 0$ and $H_3(a = \frac{\gamma}{4}) < 0$ and $H_3(a = \frac{1}{2(1+\gamma)}) > 0$ we know there exists a critical $\bar{a}$ such that for $a < \bar{a}$ it holds that $\tilde{\Pi}_B < \bar{\Pi}_B$ and for $a > \bar{a}$ it holds that $\tilde{\Pi}_B > \bar{\Pi}_B$.

b) The ISO prefers to receive interchange fees if the interchange fee is regulated sufficiently high. Otherwise, the ISO prefers to charge consumer directly: i) $a < \frac{\gamma}{4}$. It is immediately clear that $\tilde{\Pi}_I > \bar{\Pi}_I$. ii) $\frac{\gamma}{4} \leq a \leq \frac{1}{2(1+\gamma)}$. $\tilde{\Pi}_I \gtrless \bar{\Pi}_I \Leftrightarrow H_4 = \left(\frac{3}{2(1+2a)}\right)^{\frac{1}{1-\gamma}} \frac{3(1-2a(1+\gamma))^2}{2a(1-\gamma)^2(1+2\delta a)} - 1 \gtrless 0$. As $\frac{dH_4}{da} < 0$ and $H_4(a = \frac{\gamma}{4}) > 0$ and $H_4(a = \frac{1}{2(1+\gamma)}) < 0$ we know there exists a critical $\bar{a}$ such that for $a < \bar{a}$ it holds that $\tilde{\Pi}_I > \bar{\Pi}_I$ and for $a > \bar{a}$ it holds that $\tilde{\Pi}_I < \bar{\Pi}_I$.

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