Entry of non-financial firm and competition in the retail payments market*

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Abstract

We investigate the effects of non-financial firms’ entry on the competition in retail payments market from the perspectives of duopoly between an incumbent and an entrant with potential vertical restraints. Considering the cross-platform externality in payments processing, differentiated preference for payment platforms, and competitive bottleneck on the consumer side, we derive the following result. First, when only the entry of vertical integrated (or end-to-end service) provider is allowed, no partial multi-homing appears: either all merchants choose to multi-home or no entry occurs, regardless of the regulatory requirement. On the other hand, if the entry of downstream-only (or front-end service) provider is possible, a partial multi-homing equilibrium result can emerge for some conditions under which the entry of end-to-end service provider does not occur. Without regulation, however, the vertically integrated incumbent deters the entry if the entrant has no alternatives. In addition, the welfare result is better when the entry of downstream-only service is possible due to the lowered entry cost, although the entire increased welfare gain goes to the entrant payments platform. Our results imply that proper regulatory measures may be necessary to reach a socially desirable outcome from the new entry in the retail payments market.

JEL classification: L11, G23, G28

Keywords: FinTech, entry, vertical restraints, front-end, end-to-end

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1. Introduction

The advances in information and communications technology (ICT) lead to the rapid developments and expansion of new and innovative financial services, often termed as FinTech. According to Accenture (2014), the worldwide investment in FinTech has grown three times for the last five years. While the innovations happen in various area of finance, retail payments become an extremely competitive area because (i) non-cash payments has rapidly increased\(^1\) (ii) payment acquisition has emerged as a key area for innovation in FinTech (Capgemini and RBS 2013), and (iii) front-end services provide the additional strategic value for payments service providers due to its proximity to consumers (Busch and Moreno 2014).

The retail payments landscape is characterized by a wide diversity of payment instruments and activities along the different stages of the payment process.\(^2\) To provide retail payments service to consumers, a payment platform needs to complete the entire stages of payment process. On the other hand, due to the tiered structure of payment process, the platform may not need to own all necessary facilities as well as licenses to provide payments service to consumers if it can access and use the other’s.

Taking into account the stages of the payment chain, type of service provided, and predominant type of relationship with banks, CPMI (2014) classifies four categories of non-financial firms’ payments service provision: (i) front-end providers (ii) back-office providers (iii) operators of retail payment infrastructure, and (iv) end-to-end providers.\(^3\) We specifically focus on the competition between the front-end and end-to-end providers, which are the types of providers that directly face the consumers.

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\(^1\)From 2009 to 2012, the world’s annual growth rate of non-cash payment was 7.5%, and increased to, 9.4% in 2013. (Capgemini and RBS 2013)

\(^2\)CPMI (2014) categorizes the payment process into five stages: (i) pre-transaction (ii) authorization (iii) clearing (iv) settlement (v) post-transaction. A more detailed list of the different activities in each stage can be found in CPMI (2014). DeGennaro (2006) also provides a detailed analysis of payment card process and associated risks.

\(^3\) In CPMI (2014), back-end providers includes back-office services like data centers, security firms, audit or compliance entities. Operators of retail payment infrastructure are defined to be specialists in clearing and settlement services. We use ‘back-end’ in a more abstract sense, to indicate every service other than those from front-end providers.
Frond-end providers, including payment gateways (PGs), ApplePay and KakaoPay, offer the entire or parts of front-end services like pre-transaction, authorization, and post-transaction. They often relying on the back-end services and infrastructure provided from others, possibly a rival end-to-end provider in the market, and paying the fees. On the other hand, end-to-end providers, including banks, credit card companies PayPal and Alipay can afford both the front-end and the back-end service, including the entire or part of the clearing and settlement process, with their own infrastructure. In the context of industrial organization, the end-to-end providers can be considered as vertically-integrated firms while the front-end providers as downstream firms. The retail payments market in this sense is a downstream market. Figure 1 and 2 represent the process of retail payment provided by integrated and front-end only service providers, respectively.

[Insert Figure 1 near here]

[Insert Figure 2 near here]

CPSS (2012) documents a number of economic characteristics of the retail payments market. First, the provision of payments service bears the characteristics of network industries and often generates economics of both scale and scope. Second, the consumption of payments service often benefits from ‘cross-platform externality’, as each additional merchant that accept a payments service increases the value of the service for all consumers. New networks are often hard to establish because a critical mass of users is required to meet the network’s start-up cost. Thus, it is not a coincidence that non-financial firms that enter the retail payments market are often big ICT companies or affiliated ones such as Paypal, Apple, Alipay, and Kakao, which possess a vast number of users.

4 To be sure, VISA and Master, unlike AMEX, Discover, and Diners Club, can be technically classified as (iii). They actually provide networks between acquirers and issuers, mostly financial institutions, in the back-end. Considering the aspect of consumers’ perception, however, we still consider them as end-to-end service providers.

5 Details about vertical restraints and relations can be found in Tirole (1988). Mariotto and Verdier (2014) also provide a survey of how the IO literature can be used to study the impact of recent technological innovations on the retail banking industry.
We investigate the effect of non-financial firms’ entry of the retail payments market, the existing firms’ response to the event, and the equilibrium fees and market shares from the perspectives of vertical restraints and competitions. Specifically, we consider the environment where the provision of front-end services by an entrant, which is an ICT company providing novel payments acquisition service, is technically possible via the back-end services and the infrastructure available from its competitor, an incumbent financial company providing relatively less novel payments service. We derive the following results.

In the case of entry when only the entry of end-to-end provider is allowed, either all or no merchants choose to subscribe both the incumbent’s and the entrant’s platform (i.e. multi-home), which is often observed in the previous literature like [Rochet and Tirole (2003)]. The merchants’ multi-home choices depend on whether the value of payments service exceeds a cutoff level. In the case of entry with the front-end service, if the merchants’ value of payments service exceed a cutoff level, the same result occurs as in the previous case. However, a partial multi-homing equilibrium result, which is scarcely found in the literature, may emerge for some external conditions under which no entry of end-to-end provider occurs. The result requires that the end-to-end provider cannot deny the provision of back-end service to the front-end only provider. Finally, overall welfare is enhanced with front-end only entry. We provide an explanation as follows.

Consumers can subscribe only one payments platform (i.e. single-home) for a transaction while merchants can choose either the incumbent or both platforms. In other words, a competitive bottleneck is on the consumer side, which in turn leads to no fees for consumers and no positive surplus for merchants. Assuming no surcharge obligation on merchants, the consumers' choice of payment platform depends only on their preference for the payment platform and service quality. That is, consumer share of platforms and amount of purchases always stay the same.

We recommend, however, a cautious interpretation of the result because the eventual welfare enhancement is derived from the (assumed) reduced cost of entry with front-end service, and the payment platforms take the entire additional surplus.

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6 We recommend, however, a cautious interpretation of the result because the eventual welfare enhancement is derived from the (assumed) reduced cost of entry with front-end service, and the payment platforms take the entire additional surplus.
Suppose that all merchants already subscribe the incumbent’s payment platform. In this circumstance, the merchants' decision on subscribing the entrant’s platform is solely about comparing benefits from accessing to the consumers via the entrant’s platform with the costs of (i) fees paid for the entrant’s service, and (ii) the reduced chance of sale due to the increased proportion of merchants that subscribe the entrant’s platform. Because the cross-group externality influence the benefit of transaction and the chance of sales, the merchant’s objective function is quadratic in the entrant’s consumer share. If only the entry of an end-to-end provider is allowed, merchants’ subscription decision on the entrant is still all or none, which means a corner solution. However, if the entry of front-end provider is also possible, the competitive pressure is weakened because the incumbent can collect fee, assuming ad specific, from the entrant. The incumbent is now less pressed to lower the per transaction fee from merchants. Consequently, for some conditions under which no merchant choose to subscribe the entrant’s platform when only the entry of end-to-end provider is allowed, some, but not all, merchants may choose to do so when the entry of front-end provider occurs, which means an inner solution.

Our results also provide some insights about the effect of regulatory environments. First, the entry decision with the end-to-end provision is not affected by regulation. Second, without regulation, the incumbent wants to deny the entry of front-end service provider. That is, without regulation, the partial multi-homing result would not appear. If the entry has an option to enter both with vertical integrated form and front-end service only, the incumbent provides back-end service with the fee that makes the entrant indifferent between the types of service provision. The result implies that regulation of the back-end infrastructure provision by the incumbent may be necessary if other conditions such as security issues are met.

Baxter (1983) first proposes the idea of charging differentiated prices.

7 This makes sense only for a front-end provider which covers parts, not all, of the front-end services. On the other hand, well-known front-end services like ApplePay and KakaoPay actually provide only payments acquisition services and require pre-existing cards. This assumption not only simplifies the settings but also reflects this situation.
for two-sided consumers, cardholders and merchants, by payment platform. Since [Baxter (1983)], many of previous studies in retail payments focuses on either (i) the “intercharge fee” between payment networks [8] or (ii) the effect of legal obligations such as “no-surcharge” (e.g. [Edelman and Wright, 2015]) and “must-take-card” rules (e.g. [Rochet and Tirole, 2011]). Most of the literature adopt a kind of two-sided market model, which is the standard approach when there exists cross-platform externality.

Unlike the previous literature, our focus is more on the competition between the retail payments platforms. We build a model combining two-sided market and vertical restraints. While the usage externality model (e.g. [Rochet and Tirole, 2003]) is better-regarded for payments cards context, we adopt the membership externality model [9] (e.g. [Armstrong, 2006]) for the following reasons. First, the recent retail payments market competitions are triggered by the entry of non-financial, usually tech-based firms of which strength is providing better user experience in payments service via online or smart devices than the existing non-financial firms. The focus of competition, thus, is more about the platforms than the cross-group externality or expansion of sales. The approach of [Armstrong (2006)] is better-suited in this case. Moreover, the competitive bottleneck model of [Armstrong (2006)] is basically the same with [Rochet and Tirole (2003)] [10] if there are fixed fees, too, and consumers use a single card, which also apply to our model.

Second, the integration with the vertical restraints model is simpler with the membership externality approach. We can focus better on the status of competition between two platforms with vertical relations.

The rest of the paper is organized as follows. Section 2 describes the

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[8] The role of interchange fees is the internalization of consumers’ externality by imposing the acquirer a fee paid to the issuer. [Verdier (2011)] provides an excellent literature survey on the issue of interchange fee.

[9] The membership externality approach is originally intended for such services as media, shopping malls, and social networks where all inter-group interactions are assumed to occur via platform. Figure 1 of [Rochet and Tirole (2006)] nicely describes the difference between membership externalities and usage externalities.

[10] In the analysis by [Rochet and Tirole (2003)], the credit card platforms levy charges purely on a per-transaction basis, and there are no lump-sum fees for either side. In a symmetric equilibrium, all retailers accept both credit cards (or neither) while consumers always use their preferred credit card.
model. Section 3 characterizes the equilibrium when only the entry of end-to-end provider is allowed, and Section 4 does the same process when the entry of front-end provider is possible. Section 5 analyzes the results and gives interpretation and implication. Finally, Section 6 concludes the paper.

2. The Model

2.1. Players and Transactions

There are two payments platforms in the retail payments market: an incumbent $I$ and a potential entrant $E$. Following a vertical restraints context, we define an end-to-end payments service provider as a vertically integrated financial firm providing front-end services to consumers and owns its infrastructure, including license, for the back-end services like clearing and settlement. In contrast, a front-end payments service provider is defined as a downstream firm providing only services directly facing consumers such as payments acquisition and finalization. In our model, $I$ is an end-to-end provider, and $E$ may enter either as an end-to-end or as a front-end provider. In the latter case, $E$ must be able to afford the back-end services via $I$.

The fee for using the incumbent’s bank-end services (or leasing the infrastructure) is assumed to be affected by the regulatory requirement. Without regulation, the incumbent can determine $r$.

There are $N$ consumers, indexed by $n$, where $N$ is a sufficiently large number. The consumer’s transactional benefit from the payments service by platform bears positive cross-group externality from the share of merchants subscribing the platform, which is the key feature of two-sided market. Moreover, the consumer’s utility is additionally affected by consumers’ horizontal preference over payments platforms as well as the quality of payments service from each platform. Finally, consumers can choose only one platform (i.e. single-home) for a transaction.

There are $M$, which is also sufficiently large, merchants indexed by $m$.\footnote{An example for this case is the relation between ApplePay, which only performs payments acquisition, and American Express in the US.}
Like consumers, the merchant’s transactional benefit from the payments service also bears positive cross-group externality from the share of consumers subscribing the platform. Unlike consumers, however, they can choose to subscribe either (single-home) or both (multi-home) payments platforms. all merchants subscribe the incumbent’s payment platform: $s_I$ is assumed to be always 1. They do not have any horizontal preference over $I$ and $E$, either.

**Assumption 2.1.** For the rest of this paper, we assume the following

1. There are indefinitely repeated periods where every consumer always purchases unit product for sure.
2. At each period, the types of every consumer and merchant are randomly determined, following uniform probability distribution, along a unit circle and matched with the nearest counterpart.
3. The merchants are risk-neutral and decisions are only based on ex ante payoffs.
4. Products are homogenous and all merchants charge the same price.

Assumption 2.1 states the different nature of transactional uncertainty between consumers, who single-home for payment and face no uncertainty in purchase, and merchants, who can multi-home and face uncertainty. That is, in each stage, consumers treat transactional charge and per fixed charge in the same manner, but not merchants. Depending on a random match result, merchant may sell none, one or multiple products in each stage. Finally, item 4 makes the payoff from the sale/purchase be a constant and, thus, need not be considered from decision makings.

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12 This assumption also reflects the relation between ApplePay and AMEX in the sense that ApplePay users need to already have a pre-issued AMEX card.

13 If we consider the whole life-cycle of payment, then we need to consider the possibility of multi-homing in consumers’ subscription of payment platform, which makes model more complicated and less tractable. Instead, we focus on the decision at the time of transaction when a consumer choose only one payment method.
2.2. Payoffs

The game has three stages. In the first stage, the entrant makes the entry decision and, if it enters, chooses the type of entry, as either an end-to-end provider or front-end provider. In the second stage, the incumbent chooses and the entrant choose fees. The actual transactions happen in the third stage where Assumption 2.1 is applied.

Platforms charge customers $a_{EI}^C$ and $a_{EE}^C$, respectively, per period. The consumer’s transactional benefits, $b^C s_I$ and $b^C s_E$ respectively, increase in the share of merchant subscribing each platform. Thus, $b^C$ is the value when the entire merchants subscribe to a payments platform. Note that $b^C$ is the same for both platforms. Next, $B_I$ and $B_E$ ($B_I < B_E$) are consumers’ maximum possible benefits from the payments service by platform $I$ and $E$, respectively. Finally, consumers have horizontal preference over platforms and are uniformly distributed along $(0,1)$ indexed by individual consumer’s bliss point of platform preference $x$, which is referred to as consumer type. The incumbent and entrant are located at 0 and 1, respectively. The marginal cost for difference in the preference is $t$.

If a consumer of type $x$ chooses $I$ and purchases a product from merchant $m$, her utility per transaction is

$$u_{n}^I = b^C s_I - a_{II}^C + B_I - t \cdot x$$

and if $x$ chooses $E$, her utility per transaction is

$$u_{n}^E = b^C s_E - a_{EE}^C + B_E - t \cdot (1 - x)$$

for choosing $E$.

We define threshold type $\hat{x}$ of consumers who are indifferent between $I$ and $E$ from the following equation

$$b^C s_I - a_{II}^C + B_I - t \hat{x} = b^C s_E - a_{EE}^C + B_E - t(1 - \hat{x}).$$

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14Fixed fee for consumer in this case is meaningless because, in Assumption 2.1, a consumer is assumed to buy one unit of product for sure in every period.
which leads to

\[ \hat{x} = \frac{1}{2} + (b^C(s_I - s_E) - (a_I^C - a_E^C) + B_I - B_E)/(2t) \]

The consumers on the left of \( \hat{x} \), or whose types are less than \( \hat{x} \), choose the incumbent and those on the right of \( \hat{x} \), or whose types are greater than \( \hat{x} \), choose the entrant. Because \( \hat{x} \in (0, 1) \), \( \hat{x} \) and \( 1 - \hat{x} \) also respectively coincide with each platform’s market share. From now on, we abuse notation and use \( \hat{x} \) and \( 1 - \hat{x} \) to represent each platform’s market share.

Platform \( I \) and \( E \) charge merchants \( a_I^M \) and \( a_E^M \), respectively, for their service fee per transaction, and \( F_I \) and \( F_E \) as subscription or fixed fee. \( b^M \) is the per transaction benefit to merchants from the payment process itself, which is the same for both \( I \) and \( E \). Like the case of the consumer benefit from transaction, the merchant benefits is affected by the share of consumers choosing the payment platform, too, and \( b^M \) is the value when the entire consumers choose the service from one payments platform.

Unlike consumers, merchants are not sure about the number of sales. Merchant \( m \)'s expected payoff for each period from sales via \( I \)'s payments service is

\[ \pi^I_m = \left( N \frac{\hat{x}}{(Ms_I)} \right) \left( p_m - c_m + b^M \hat{x} - a_I^M \right) - F_I, \]

and that via \( E \)'s payments service is

\[ \pi^E_m = \left( N \frac{1 - \hat{x}}{(Ms_E)} \right) \left( p_m - c_m + b^M (1 - \hat{x}) - a_E^M \right) - F_E. \]

where \( \hat{x}/s_I \) and \( (1 - \hat{x})/s_E \) are the expected numbers of transactions and \( F_I \) and \( F_E \) are fixed fees per time for the access to platform \( I \) and \( E \), respectively. If \( m \) chooses to multi-home, its expected payoff per transaction is simply the sum of the expected payoffs from accessing each platforms’ consumer group, or \( \pi^I_m + \pi^E_m \), because the consumers cannot multi-home at the time of purchase.

Note that, in our model, the merchant’s objective function is quadratic in the payments platform’s consumer share because the cross-group externality influences both the benefit of transaction and the chance of sales. First,
the greater consumer share of a platform increases merchants’ benefit from transaction processing, \( b^M \hat{x} \) and \( b^M (1 - \hat{x}) \) respectively, via the platform by reducing the distance of matching with consumers. Second, the greater share also increase the expected numbers of consumers, \( \hat{x}/s_I \) and \( (1 - \hat{x})/s_E \) respectively, that visit a merchant. Because the functional form is important to derive our result, we present our rationale as follows.

Suppose that all merchants and consumers are differentiated and randomly determined along a unit line, or circle for mathematical comprehension, and that the reciprocal of the distance between the matched merchant affects the benefit of transaction processing. Suppose also that the allocation of position is random, but the match between merchants and consumers is assortative (i.e. with the nearest neighbor). In this case, given a uniform distribution, if there are \( M \) merchants, a consumer’s expected distance to the nearest merchant is proportional to \( 1/M \). The same logic holds for the merchants, too, which leads to the positive cross-group externality in the transactional benefit from payments processing. For merchants, this cross-group externality is a different, if not mutually exclusive, kind of the externality from the increased expected number of sales, which is not applicable for consumers because of the unit purchase per period assumption. Thus, the merchants’ utility is a quadratic function of the share of consumers.

We now see the platforms’ payoffs. Let \( C_I \), \( C_E \) and \( c_E \) be the average per-period costs of the incumbent, the end-to-end provider entrant, and the front-end entrant.\(^{15}\) We assume that \( C_I < C_E \), reflecting that new networks are often hard to establish and that new entries often have less experience and pay extra cost for leaning and adapting themselves to new environments, and that \( c_E < C_I \), reflecting that the entrant only need to own the facilities for front-end service (or payments acquisition).

If both the incumbent and the entrant are vertically integrated platforms, the payoffs per period for each platform are

\[
\Pi_I = N\hat{x}\hat{a}_I^C + (N\hat{x}/s_I)a_I^M + F_I M s_I - C_I
\]

\(^{15}\)The investment on the infrastructure, of course, is often done in a fixed, one-time fashion. \( C_I \), \( C_E \) and \( c_E \) should be understood in the context of long-run average costs.
for the incumbent, and
\[ \Pi_E = N(1 - \hat{x})a_E^C + (N(1 - \hat{x})/(Ms_E))a_E^M + F_EMs_E - C_E \]
for the entrant, respectively.

Alternatively, \( E \) can choose to lease \( I \)'s infrastructure and pays \( r \) per transaction as a rent.

In that case, payoffs per transaction are
\[ \Pi_I = N\hat{x}a_I^C + N(1 - \hat{x})r + (N\hat{x}/(Ms_I))a_I^M + F_IMs_I - C_I \]
and
\[ \Pi_E = N(1 - \hat{x})(a_E^C - r) + (N(1 - \hat{x})/(Ms_E))a_E^M + F_EMs_E - c_E. \]

Assumption 2.2 is about the regularity conditions that enables the mathematical plausibility and sensibility of results.

**Assumption 2.2. (Range and values of variables)**

- \(-t \leq \delta \leq 0\) where \( \delta = B_I - B_E \): the entrant’s service is better than incumbent, but not so better that the incumbent cannot charge the positive fee from merchants.
- \( b^C + \delta \geq t \): the threshold type \( \hat{x} \geq 1 \) when \( s_E = 0 \). It also implies that the value of the incumbent’s service to the consumer of type \( x = 1 \) is non-negative.
- \( b^C \geq b^M \geq t \) and \( b^C \geq 1 \geq t \): (i) the consumer benefit from transaction processing service is greater than the merchant’s benefit, (ii) the merchant benefit is greater than the marginal distaste(cost) of consumer’s platform preference, and (iii) the marginal distaste is smaller than the longest horizontal distance so that all consumers choose the incumbent in case of no new entry.
- \( b^M - 2t > -1 \): The lowest value of \( b^M \) for mathematical sensibility.

\(^{16}\)The rent payment can be lump sum. The payoff equations do not change at all other than adding and subtracting the transfer payment to the incumbent and from the entrant, reflecting present discount of the fee per period.
3. Result: Entry with vertical integration

3.1. Platforms’ Choice

With Assumption 2.2, the threshold type \( \hat{x} \) is rewritten as

\[
\hat{x} = \frac{1}{2} + \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)}
\]

The platforms’ payoffs are

\[
\Pi_I = N \hat{x} a_i^C + N \hat{x} a_M^I + F_I M - C_I
\]

\[
= N \left( \frac{1}{2} + \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)} \right) (a_i^C + a_M^I) + F_I M - C_I
\]

and

\[
\Pi_E = N (1 - \hat{x}) a_E^C + N (1 - \hat{x}) a_E^M + F_E M s_E - C_I
\]

\[
= N \left( \frac{1}{2} - \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)} \right) (a_i^C + a_M^I) + F_I M s_E - C_E
\]

A merchant’s payoff from a sale via payment platform \( I \) and \( E \) are

\[
\pi_m^I = \frac{N \hat{x}}{M} \left( b^M (\hat{x} - a_i^M) - F_I \right) = \frac{N a_i^M}{M} (1/2 + \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)})^2 - \frac{N a_i^M}{M} (1/2 + \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)}) - F_I
\]

and

\[
\pi_m^E = \frac{N(1 - \hat{x})}{M S_E} \left( b^E (1 - \hat{x}) - a_E^M \right) - F_E
\]

\[
= \frac{N a_E^M}{M S_E} (1/2 - \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)})^2 - \frac{N a_E^M}{M S_E} (1/2 - \frac{b^C(1 - s_E) - (a_i^C - a_E^C) + \delta}{(2t)}) - F_E
\]

respectively.
The payment platforms’ first order conditions are

$$\frac{\partial \Pi_I}{\partial a^C_I} = N \left( \frac{1}{2} + \frac{b^C (1 - s_E) - (a^C_I - a^C_E) + \delta}{2t} \right) - N \frac{(a^C_I + a^M_I)}{(2t)} = 0$$

for the incumbent, and the entrant’s is

$$\frac{\partial \Pi_E}{\partial a^C_E} = N \left( \frac{1}{2} - \frac{b^C (1 - s_E) - (a^C_I - a^C_E) + \delta}{2t} \right) - N \frac{(a^C_E + a^M_E)}{(2t)} = 0$$

which can be written as

$$t + b^C (1 - s_E) + a^C_E + \delta = 2a^C_I + a^M_I$$

and

$$t - b^C (1 - s_E) + a^C_I - \delta = 2a^C_E + a^M_E$$

It is not surprising that the best response is represented as a (weighted) sum of two control variables $a^C_I$ and $a^M_I$ (and $a^C_E$ and $a^M_E$) once we recognize that $\Pi_I$ (and $\Pi_E$) is an increasing linear function of $a^M_I$ (and $a^M_E$). That is, the platforms can charge any amount of transaction fee from the merchants as long as merchants’ participation constraints are satisfied.

3.2. Merchants’ Decision on Multihome

Payments platforms want to increase the consumer market share, which in turn leads to greater benefit to and service fee from merchants. For the incumbent, with $s_I = 1$, there is no way of increasing consumer base other than lowering the consumer’s fee $a^C_I$. For the entrant, it can change $\hat{x}$ by changing the value of $a^C_E$ and $a^M_E$, which in turn lead to the change of $s_E$. We can derive $a^M_I$ and $a^M_E$ as follows

$$a^M_I = t + (b^C (1 - s_E) + \delta)$$

and

$$a^M_E = t - (b^C (1 - s_E) + \delta)$$
Then, $\pi_m^E$ is rewritten as

$$\pi_m^E = \frac{Nb^M}{Ms_E}(1/2 - (b^C(1 - s_E) + \delta)/(2t))^2$$

$$- \frac{2tN}{Ms_E}(1/2 - (b^C(1 - s_E) + \delta)/(2t))^2 - F_E$$

$$= -\frac{N(b^M - 2t)}{Ms_E}(1/2 - (b^C(1 - s_E) + \delta)/(2t))^2 - F_E$$

We separate two cases (i) $b^M - 2t > 0$ and (ii) $b^M - 2t > 0$. The case of low merchant benefit may reflect the feature of offline transactions where face-to-face transactions depreciate the value of service from retail payments platforms. On the other hand, the high merchant benefit is suitable for the online and mobile transactions where the service from payments platforms is a must.

**Case I: $b^M - 2t < 0$**

If $b^M - 2t < 0$, that means the benefit from transaction given $a_E^M$ is negative and need to be compensated by $F_E$. In this case, the first order condition is

$$\frac{\partial \pi_m^E}{\partial s_E} = -\frac{N(b^M - 2t)}{Ms_E^2}(1/2 - (b^C(1 - s_E) + \delta)/(2t))^2$$

$$+ \frac{2N(b^M - 2t)}{Ms_E}(1/2 - (b^C(1 - s_E) + \delta)/(2t)) \frac{b^C}{(2t)} = 0$$

which leads to

$$-1/2 + (b^C(1 - s_E) + \delta)/(2t) + b^C/t \cdot s_E = 0$$

and thus we have

$$s_E = (t - \delta)/b^C - 1$$

By Assumption 2.2, however, there is no such case as $1 < (t - \delta)/b^C$. In other words, the first order condition is not positive for any non-negative $s_E$ and merchants choose not to subscribe.
Case II: $b^M - 2t > 0$

If $b^M - 2t > 0$, the optimum binds at some $s_E = 1$ by assumption 2.2 and the rest of variables are determined as $a^M_I = t + \delta$, $a^M_E = t - \delta$, and $\hat{x} = 1/2 + \delta/(2t)$. Plugging in these values, we know that the value of a merchant’s benefit from the entrant’s payments service $N/M(2t)(1/2 - \delta/(2t))^2$ is greater than zero. The entrant sets $F_E$ as this value so that $\pi^E_m$ becomes zero. The merchant benefit from the incumbent’s service $N/M(2t)/(4t^2)(t + \delta)^2$ is also greater than zero, and by the same logic, the incumbent sets $F_I$ as this value so that $\pi^I_m$ becomes zero.

The incumbent’s payoff $\Pi_I$ is

$$\Pi_I = N(1/2 + \delta/(2t))(t + \delta) + N(b^M - 2t)/(4t^2)(t + \delta)^2 - C_I$$

and the entrant’s payoff $\Pi_E$ is

$$\Pi_E = N(1/2 - \delta/(2t))(t - \delta) + N(b^M - 2t)/(4t^2)(t - \delta)^2 - C_E$$

While the entrant’s revenue is greater than the entrant, note that the result for the entrant is achieved out of the assumptions and a corner solution $s_E = 1$ of the first order conditions. If, for some reason, $s_E < 1$ at the time of entry, the merchant fee and revenue would decrease, possibly lower than $C_E$ which is assumed to be greater than $C_I$. In addition, the entrant’s cost $C_E$ is assumed to be greater than the incumbent’s cost $C_I$ whose market share is certainly established at $s_I = 1$.

The following proposition summarizes the result.

**Proposition 1.** If $b^M - 2t < 0$, no entry occurs. If $b^M - 2t > 0$, an entry occurs and every merchant subscribes both payment platforms (i.e. multi-home).

Again, one of plausible interpretations of the result in this section is that $b^M - 2t < 0$ is a case of merchants’ benefit per offline transaction from payments service, and $b^M - 2t > 0$ is the case of the benefit per online or mobile transaction. That is, the current buzz of online-to-offline(O2O)
payments service by non-financial firms such as Alipay or ApplePay, which extend online payments service to offline transactions, may not turn out to be a real success unless those services increase the value of the benefit per transaction to merchants. On the other hand, if the value to merchants is actually increased, O2O payments service will be widespread. Even in this case, old payments service such as plastic cards will still be able to coexist.

4. Result: Entry with Front-end Service Only

4.1. Platforms’ Choice

Suppose first that the bank-end infrastructure access fee paid to the incumbent is endogenously determined. The incumbent can control the consumer fee \( a_C^I \) and merchant fee \( a_M^I \) as in the previous section and the structure of decision is also the same. The same is applied to the entrant.

The platforms’ payoffs with the service-only entry are now written as

\[
\Pi_I = N \hat{x} a_C^I + N(1 - \hat{x}) r + N \hat{x} a_M^I + F_I M - C_I
\]

\[
= N(1/2 + (b_C^I(1 - s_E) - (a_C^I - a_C^E) + \delta)/(2t))(a_C^I + a_M^I)
\]

\[
+ N(1/2 - (b_C^I(1 - s_E) - (a_C^I - a_C^E) + \delta)/(2t))r + F_I M - C_I
\]

for the incumbent, and

\[
\Pi_E = N(1 - \hat{x})(a_C^E - r) + N(1 - \hat{x}) a_M^E + F_E M s_E - c_E
\]

\[
= N(1/2 - (b_C^E(1 - s_E) - (a_C^I - a_C^E) + \delta)/(2t))(a_C^E + a_M^E - r) + F_E M s_E - c_E
\]

for the entrant. The first order condition for the incumbent is

\[
\frac{\partial \Pi_I}{\partial a_C^I} = N(1/2 + (b_C^I(1 - s_E) - (a_C^I - a_C^E) + \delta)/(2t))(a_C^I + a_M^I)
\]

\[
- N/(2t)(a_C^I + a_M^I - r) = 0
\]

\[\text{Decreasing the value of } t \text{ also generates the same effect and plausible approach, depending on the modeling. In this paper, however, we assume that } t \text{ is an intrinsic value to consumers and not changed by neither payments platforms nor merchants, which is a common assumption in a linear city model.}\]
and

\[
\frac{\partial \Pi_{E}}{\partial a_{E}} = N (1/2 - (b^C (1 - s^E) - (a^C_I - a^C_E) + \delta)/(2t)) \\
- N/(2t)(a^C_E + a^M_E - r) = 0
\]

for the entrant. These conditions can be rewritten as

\[
t + b^C (1 - s^E) + a^C_E + \delta + r = 2a^C_I + a^M_I
\]

and

\[
t - b^C (1 - s^E) + a^C_I - \delta + r = 2a^C_E + a^M_E
\]

This result shows that both the incumbent and entrant platforms would additionally impose \( r \) compared with the result in the previous section.

For consumers, the inclusion of \( r \) does not affect their decision as long as the consumer fee is zero because the threshold type

\[
\hat{x} = 1/2 + (b^C (1 - s^E) + \delta)/(2t)
\]

is the same as what we derived in the previous section. On the other hand, the merchant charges are increased by \( r \) as

\[
a^M_I = t + (b^C (1 - s^E) + \delta) + r
\]

and

\[
a^M_E = t - (b^C (1 - s^E) + \delta) + r
\]

4.2. Merchants’ Choice of Multi-home

A merchant’s payoff from the incumbent’s payments service is

\[
\pi^I_m = \frac{N}{M} \hat{x}(b^M \hat{x} - a^M_I) - F_I
\]

\[
= N/M(b^M - 2t)(1/2 + (b^C (1 - s^E) + \delta)/(2t))^2 \\
- N/M(1/2 + (b^C (1 - s^E) + \delta)/(2t))r - F_I
\]
and

\[ \pi^E_m = \frac{N(1 - \hat{x})}{M^s_E} (b^M (1 - \hat{x}) - a^M_E) - F_i \]

\[ = \frac{N b^M}{M^s_E} \left( \frac{1}{2} - \frac{(b^C (1 - s_E) + \delta)}{(2t)} \right)^2 \]

\[ - \frac{2tN}{M^s_E} (1/2 - (b^C (1 - s_E) + \delta)/(2t)) (1/2 - (b^C (1 - s_E) + \delta - r)/(2t)) - F_E \]

\[ = \frac{N(b^M - 2t)}{M^s_E} \left( \frac{1}{2} - \frac{(b^C (1 - s_E) + \delta)}{(2t)} \right)^2 \]

\[ + \frac{2Ntr}{M^s_E} (1/2 - (b^C (1 - s_E) + \delta)/(2t)) - F_E \]

from the entrant’s payments service. As in the previous section we separate two cases.

**Case I: \( b^M - 2t < 0 \)**

In this case, note that the benefit from transaction, after paying the fee \( a^M_E \), to merchants is negative and need to be compensated by \( F_E \). The first order condition is

\[
\frac{\partial \pi^E_m}{\partial s_E} = - \frac{N(b^M - 2t)}{M^s_E^2} \left( \frac{1}{2} - \frac{(b^C (1 - s_E) + \delta)}{(2t)} \right)^2 \\
+ \frac{2N(b^M - 2t)}{M^s_E} \left( \frac{1}{2} - \frac{(b^C (1 - s_E) + \delta)}{(2t)} \right) \frac{b^C}{2t} \\
- \frac{2Ntr}{M^s_E^2} \left( \frac{1}{2} - \frac{(b^C + \delta)}{(2t)} \right) = 0
\]

Now, unlike the first order condition in the previous section, there is an additional positive term \(-\frac{2Ntr}{M^s_E}(1/2 - (b^C + \delta)/(2t))\) that possibly makes the first order condition positive for the same value of \( s_E \) derived in the previous section.

The FOC is rewritten as

\[
(b^M - 2t)(2(b^C)^2 - 1)s^2_E - (b^M - 2t)(t - (b^C + \delta))^2 + 4t^2 r(b^C + \delta - t) = 0
\]
which should be lead to positive solution $s_E^*$ as
\[
s_E^* = \sqrt{\frac{(b^M - 2t)(t - (b^C + \delta))(2(t^2 - (b^C + \delta - t))}{(b^M - 2t)(2(b^C)^2 - 1)}}
\]

Depending on the values of parameters, there can exists $0 < s_E^* < 1$, which implies the possibility of a partial multi-home result in equilibrium. If $s_E^* \geq 1$, we have a corner solution at $s_E^* = 1$.

Note that the entrant need to compensate the loss of merchants by making $F_E$ negative in this case.

Now we have $\hat{x} = 1/2 + (b^C(1-s_E^*)+\delta)/(2t)$, $a^M_I = t + (b^C(1-s_E^*)+\delta)+r$, and $a^M_E = t - (b^C(1-s_E^*)+\delta)+r$. Knowing that $F_I$ and $F_E$ are set to make merchants have zero payoffs, $F_I$ is derived from
\[
\pi_m^I = \frac{N}{M} \hat{x}(b^M \hat{x} - a^M_I) - F_I
\]
\[
= \frac{N}{M} (b^M - 2t)(1/2 + (b^C(1-s_E^*)+\delta)/(2t))^2
- \frac{N}{M} (1/2 + (b^C(1-s_E^*)+\delta)/(2t)r - F_I
\]

and $F_E$ is from
\[
\pi_m^E = \frac{N(1 - \hat{x})}{Ms_E^*} (b^M(1 - \hat{x}) - a^M_E) - F_I
\]
\[
= \frac{N b^M}{Ms_E^*} (1/2 - (b^C(1-s_E^*)+\delta)/(2t))^2
- \frac{2Ntr}{Ms_E^*} (1/2 - (b^C(1-s_E^*)+\delta)/(2t))(1/2 - (b^C(1-s_E^*)+\delta-r)/(2t)) - F_E
\]
\[
= \frac{N(b^M - 2t)}{Ms_E^*} (1/2 - (b^C(1-s_E^*)+\delta)/(2t))^2 + \frac{2Ntr}{Ms_E^*} (1/2 - (b^C(1-s_E^*)+\delta)/(2t)) - F_E
\]
Finally, the incumbent platform’s payoff is

$$\Pi_I = N(1 - \hat{x})r + N\hat{x}a^M_I + F_I M - C_I$$

$$= N(1/2 - (bC(1 - s^*_E) + \delta)/(2t))r + N(1/2 + (bC(1 - s^*_E) + \delta)/(2t))(t + bC(1 - s^*_E) + \delta + r) + F_I M - C_I$$

$$= 2Nt(1/2 + (bC(1 - s^*_E) + \delta)/(2t))^2 + Nr + F_I M - C_I$$

and the entrant’s is

$$\Pi_E = N(1 - \hat{x})(a^M_E - r) + F_E Ms^*_E - c_E$$

$$= N(1/2 - (bC(1 - s^*_E) + \delta)/(2t))(t - (bC(1 - s^*_E) + \delta)) + F_E Ms^*_E - c_E$$

Given that the incumbent provide the back-end infrastructure to the entrant with an exogenous \( r \), the following proposition summarize the result in the case of front-end only entry.

**Proposition 2.** If \( b^M - 2t < 0 \), unlike in the case of vertical integration, there exists an equilibrium where some, but not all merchants choose to subscribe both platforms.

**Case II:** \( b^M - 2t > 0 \)

The benefit from transaction is now positive for merchants. The value of \( s^*_E \), derived from the first order condition, is now the critical mass initially required for successful entry. Note that \( s^*_E \) is now smaller than the one in Case I because the signs of two terms, \( (t-(bC+\delta))^2/(2(b^M-2t)) \) and \( -(4t^2+(bC+\delta-1))/(b^M-2t)(2(b^M-2t)-1) \), are now different. For any \( s_E > s^*_E \), the first order condition is positive, which leads to \( s^*_E = 1 \). If there is no real-valued solution, that means the first order condition is always positive. In other words, \( s^*_E = 1 \), too. The critical mass is not needed in this case.

Knowing that the equilibrium share of the merchant’s subscription binds at \( s_E = 1 \), the threshold type is the same as in the previous section, \( \hat{x} = 1/2 + \delta/(2t) \), and the merchants fees are \( a^M_I = t + \delta + r \) and \( a^M_E = t - \delta + r \), respectively.
After plugging in these values, the merchant’s fixed fees for the incumbent’s payments service is derived from

$$\pi^I_m = \frac{N}{M}(b^M - 2t)(1/2 + \delta/(2t))^2 - \frac{N}{M}(1/2 + \delta/(2t))r - F_I$$

and that for the entrant’s is

$$\pi^E_m = \frac{N}{M}(b^E - 2t)(1/2 - \delta/(2t))^2 - \frac{N}{M}(1/2 - \delta/(2t))r - F_E$$

Finally, the platforms profits are

$$\Pi_I = N(1 - \check{x})r + N\check{x}a^M_I + F_I - C_I$$
$$= N(1 - \check{x})(t + \delta + r) + (N/M(b^M - 2t)(1/2 + \delta/(2t))^2 - N/M(1/2 + \delta/(2t))r)M - C_I$$
$$= Nb^M(1/2 + \delta/(2t))^2 + N(1/2 - \delta/(2t))r - C_I$$

for the incumbent, and

$$\Pi_E = N(1 - \check{x})(a^M_E - r) + F_E - c_E$$
$$= N(1 - \check{x})(t - \delta) + (N/M(b^M - 2t)(1/2 - \delta/(2t))^2 - N/M(1/2 - \delta/(2t))r)M - c_E$$
$$= Nb^M(1/2 - \delta/(2t))^2 - N(1/2 - \delta/(2t))r - c_E$$

for the entrant.

Proposition 3. If $b^M - 2t > 0$, $s_E = 1$, is reached: all merchants choose to subscribe both platforms in equilibrium. The critical mass of merchants subscription needs to be reached depending on values of parameters.

5. Analysis

If $b^M - 2t > 0$, the incumbent’s and the entrant’s payoffs are linear functions of $r$, respectively. That is, the payoffs from vertical-integrated entry by the entrant are the minmax payoffs. In this case, if the incumbent has
bargaining power, it sets \( r \) up so that the entrant is indifferent between the vertical-integration and service-only entries. If the entrant has bargaining power, it sets \( r \) up so that the incumbent is indifferent between the entry with vertically-integrated form and allowing the entrant’s access to the incumbent’s back-end infrastructure. Note that unless the regulation prevents the entry of end-to-end payments service, regulation does not affect the equilibrium result.

If \( b^M - 2t < 0 \) and the incumbent has bargaining power, we need to investigate whether there exists an inner solution of \( r \) that maximizes the incumbent’s profit, or a corner solution that binds at \( \Pi_E = 0 \), and makes \( s^*_E \) non-negative. From Assumption 2, we know that both \( \Pi_I \) and \( \Pi_E \) are convex quadratic functions of \( r \), rewritten as

\[
\Pi_I = \frac{N}{t} \left( \frac{b^M}{t} + 1 \right) r^2 - \frac{N}{t} (b^C + \delta - t + 2b^M (b^C + \delta)/t) r
+ \frac{Nb^M}{t^2} (b^C + \delta)^2 - C_I
\]

for the incumbent, and

\[
\Pi_E = \frac{N}{t} (1 + b^M - 2t) r^2 - \frac{N}{t} (b^C + \delta - t) (3 + 2b^M - 4t) r
+ \frac{N}{t} (2 + b^M - 2t) (t - b^C - \delta)^2 - c_E
\]

for the entrant.

Let \( r^* \) be the rent that makes the entrant’s profit zero. If there exist parameters that leads to the value of \( r^* \) greater than zero, assuming \( c_E \) is sufficiently low, a profitable entry is possible by regulation of the rent. However, the value of \( r^* \) does not exceed the value of \( a^M_I \), which means the the incumbent does not want to voluntarily allow provide the back-end service to the entrant, or allow the entrant’s access to its infrastructure.

The following proposition summarizes the behavior of incumbent.

**Proposition 4.** Without regulatory obligation, if \( b^M - 2t > 0 \) and the incumbent has the bargaining power, the incumbent voluntarily allow access to the entrant so that the entrant is indifferent between the entry with end-to-end service and front-end service only. On the other hand, if \( b^M - 2t < 0 \),
it always deny the access to its back-end infrastructure.

If there exist parameters that leads to the value of $r^*_E/r^R_I$ greater than one, given $c_E$ is sufficiently low, the incumbent allow the entrant’s access to its infrastructure. For example, let $b^C = 2$, $t = 0.75$, $\delta = -0.25$, and $b^M = 0.8$. Then, we have $r^*_E = 2.667$ and $r^R_I = 0.871$. The value of $r > 1$, which is less than 2.667, leads to positive $s_E$.

Note that even $r^*_E$ is smaller than $a^M_I = 2(b^C + \delta)$.

6. Concluding Remarks

We investigate the effect of non-financial firms’ entry into retail payment markets, the existing firms’ response, and the equilibrium from the perspectives of vertical restraints and competitions. With cross-platform externality in transaction processing, horizontal preference for payments service, and repetition of unit purchase by consumers, we have the following result. First, in the case of entry when only the entry of end-to-end provider is possible, no partial multi-homing appears: either all merchants multi-home or no entry happens, with or without the mandatory provision of bank-end infrastructure obligation. On the other hand, in the case of entry with the front-end service, a partial multi-homing equilibrium result can emerge if under proper exogenous conditions. Without regulation, however, the vertically integrated incumbent wants to deny the entry if it has no alternatives.

The case of low merchant benefit may reflect the benefit of so-called O2O (online-to-offline) transactions where face-to-face situations depreciate the value of the entrant’s new payments service. On the other hand, the case of high merchant benefit may reflect the online and mobile transactions where the service from payment platforms is a must for the completion of transactions.

The results imply that mandatory back-end infrastructure provision may be necessary, if other conditions such as security issues are met, in the sense that the consumer’s benefit is increased when the entrant’s payments service is available and overall welfare is increased due to reduced cost of investments.
by the entrant.

We admit that there are some caveats in our model. One of them is the unit demand and exogenous price assumption which eliminates the need for considering the change in the demand and supply, which can be found in Rochet and Tirole (2003). While the assumption simplifies the settings and let us focus on the competition between platforms, it does not reflect the reality at all. We also want to note that other results are drawn under several strong assumptions and conditions, and, thus, should be interpreted with caution. For example, the overall welfare implication is derived from the assumption of lower entry cost of the front-end only provider. At this point, we leave these drawbacks as topics for future research.
Appendix A. Retail Payments: Block Diagrams

Note that it is an bank-non-bank transfer, not payment, model, but satisfactory to capture the idea.

End-to-end providers

![Diagram 1](image1)

Fig. 1. A model of service by non-financial firm with vertical integration of front and back-end (BIS 2014)

Front-end providers

![Diagram 2](image2)

Fig. 2. A model of service by non-financial firm with front-end service only (BIS 2014).
References


