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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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Locked out by loyalty: entry deterrence through rebates in payment card markets*

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Abstract

Payment card markets are globally dominated by a few large card networks, which give significant rebates to issuing banks. Policy makers are concerned about rising merchant fees and the overreliance on these networks' payment services. A common assumption is that profitable entry is blockaded by the entry costs to set up the payment system and network, resulting in a monopolistic or duopolistic market structure. The question analyzed in this paper is under which conditions a card network sets rebates at a higher level such that competitors cannot profitably enter the market. Deterrence becomes more profitable for a large card network when transaction benefits increase - especially if issuing banks pass rebates through to cardholders. At the same time, entry becomes more blockaded if issuing banks face costs to switch their card issuance to a different card network - indicating that large card networks may use rebates to increase switching costs. These lock-in effects explain why domestic card networks are pushed aside and new card networks struggle to gain ground and may have important implications for payment regulation.

Key Words: Payment cards; Rebates; Entry deterrence; Interchange fee; Card networks
JEL Classification: L12; L13; L14; L20; L21

*The views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank or of the Eurosystem. I am grateful for helpful comments by Wilko Bolt, Maarten van Oordt, Teele Rossi, Carin van der Cruijsen, Nicole Jonker, and two anonymous referees. All remaining errors are my own.

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I. Introduction

One Chinese (UnionPay) and two US card payment networks (Visa and Mastercard) together processed up to 91% of global card expenditure in 2022 (Datos Insights 2024), achieving net profit margins of roughly 45–55% (Mastercard 2025; Visa Inc. 2024). This profit margin is substantially higher than those of major technology companies – firms often criticized for their exceptionally high profitability.[1] Two trends show an increase in their market power. First, international card networks overtook domestic card networks. Domestic card networks saw their relevance dwindle between 2017 and 2022, accounting for a mere 3% of all global card expenditure by the end of that period (Datos Insights 2024). Second, international card networks have expanded into the digital wallet market via virtual payment cards. These can be used to make mobile payments at the point-of-sale (POS) directly and via "Click to Pay" in e-commerce (Mastercard 2025; Visa Inc. 2024).

Card network market power had led to several concerns by policy makers.[2] First, a number of regulators have honed in on increasing fees charged to merchants. Second, an emerging concern among (especially European) policymakers has been the overreliance on foreign card networks. These concerns have led governments across the globe to support domestic (or European) payment alternatives and reduce dependency on international card networks but "success has proved elusive" (Worldpay, 2024). Consumers in card dominated countries have very little incentives to switch to alternative payment methods due to ease of use, purchase protections and loyalty rewards.

This paper reveals how card networks may sustain market dominance by ruling out competing payment methods. We show that card network may set payment fees in such a

[1] Visa and Mastercard make a net profit of 19.7 billion US dollars and 12.9 billion US dollars respectively in 2024, which is about 55% percent of Visa's gross revenues and 46% percent of Mastercard's gross revenues (Mastercard 2025; Visa Inc. 2024). In comparison, extremely profitable big tech companies like Apple and Alphabet report net profit margins of 32% and 29% respectively in their annual statement in 2024 (Alphabet Inc. 2025; Apple Inc. 2024). Union Pay does not publish any financial statements online.

[2] See Son (2024), Payment System Regulator (2025), European Central Bank (2025) and Worldpay (2024) for examples of regulatory initiatives and new real-time payment systems in Australia, Canada, the United States, the United Kingdom and Europe.

way that profitable entry is impossible. Figure 1 illustrates the flow of payment fees. Card networks charge transaction fees to issuing and/or acquiring banks (also called processing and scheme fees), but at the same time issuing banks are subsidized (i.e. receive rebates) in two ways.

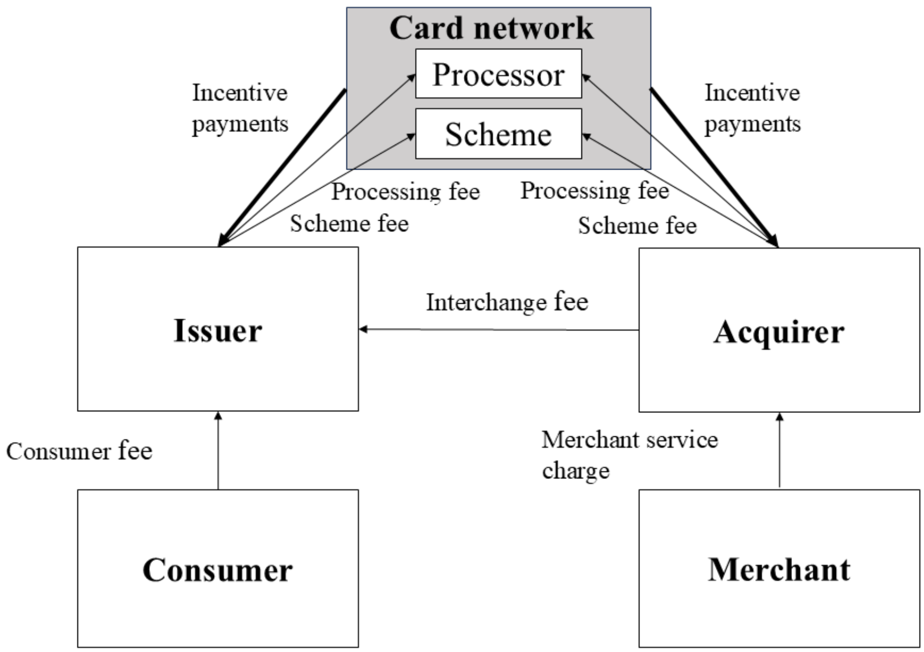


Figure 1: Four-corner model flow of fees

(1) Card networks impose an interchange fee, which acquiring banks pay to issuing banks per transaction.

(2) Card networks may give issuing banks higher incentive payments than they give acquiring banks. Incentive payments are usually negotiated between card networks and banks. For example, this happens when issuing banks start issuing a new type of payment card or acquiring banks roll out a new POS-terminal to merchants.

To keep the four-corner model tractable, we net all processing/scheme fees and combine all interchange fee revenues and incentive payments. This means that we use the term "rebates" to refer to all the money that issuing banks receive for enabling card transactions (the sum of incentive payments and interchange fees deducted by issuing processing/scheme fees) and "acquiring fees" to refer to the total fees that acquiring banks pay (acquiring processing/scheme fees deducted by incentive payments).[3]

A card network can rule out competitors by setting rebates to issuing banks at a level such that competitors cannot make a profit, but it will only do so if entry is not blockaded or accommodated by the level of entry costs to run the card network.[4] That is, the card network has three options based on the level of entry costs:

(1) set monopolistic rebates under blockaded entry,

(2) set collusive rebates and accommodate entry,

(3) set contestable rebates and deter entry.

If entry costs are excessive, entry is blockaded and the incumbent can sustain monopolistic market power. However, if entry costs are sufficiently low, the incumbent has to make a choice to either deter entry by offering larger rebates or to accommodate entry by offering smaller rebates. The incumbent thus faces a trade-off. High rebates reduce the profit margin,

[3]According to their 2024 annual statements, Visa and Mastercard spent about 14 billion and 18 billion US dollar respectively as incentive payments in 2024, which is about 28 percent of Visa's gross revenues and 39 percent of Mastercard's gross revenues (Mastercard 2025; Visa Inc. 2024). Both the incentive payments and the interchange fee are usually set by the card network, but the latter is paid by acquiring banks and not directly by the card network. Interchange fees are paid when a transaction occurs, while incentive payments are less transparent. According to anonymous industry experts, incentive payments consist of substantial discounts over scheme/processing fees (with increasing transaction volume) to issuing banks, but may also include other perks such as consultancy services or fixed upfront payments to cover costs. Transaction discounts would be economically equivalent to interchange fees. Therefore we make no distinction between interchange fees and incentive payments. As noted by our referee, an interesting extension to this paper would be to endogenize the choice between incentive payments and interchange fees.

[4]From annual statements of card networks, operating expenses include mainly general expenses (personnel, professional fees, technology, buildings) which do not increase at the same pace as payment volume. In fact, Visa's yearly general and operating expenses are around 8 billion dollar (which is 80 percent of total expenses). This is about as high as Mastercard's yearly general and operating expenses of 7,8 billion dollar (89 percent of total expenses). At the same time, Visa's yearly net revenue is around 30 billion dollar, while Mastercard's yearly net revenue is around 20 billion dollar (Mastercard 2025; Visa Inc. 2024). Arguably Visa is able to sustain a higher net profit margin (+/- 55 percent) than Mastercard (+/- 45 percent), as it operates at a greater scale. Scale economies increase the costs that a smaller competitor would face to remain profitable.

but increase demand as it makes it unprofitable for an entrant to enter. Low rebates induce the competitor to also offer low rebates and increase the profit margin, but demand is lower as the incumbent needs to share the market.

This paper explains why a new payment method often lacks sufficient support from issuing banks. Most consumers have a payment account with a bank – giving issuing banks a key position to choose the type of card network that will be used. Issuing banks face a cost to switch card networks as they need to issue a new card to a client and/or adapt their internal transaction processing services.[5] Switching costs may differ across clients as some clients need a new card soon, while others have just been issued a new card. These switching costs give card networks market power over issuing banks but should be weighted against transaction benefits. Transaction benefits reflect the utility of using a card for payment relative to another instrument (such as cash). In a payments context, a card network is able to set monopolistic rebates and merchant fees if a potential competitor is blockaded from entering the market due to high entry costs and/or switching costs. However, when transaction benefits increase this blockade of the payment market is effectively reduced as card networks can earn more transaction revenues. Rebates are low if card networks face a competitor with entry costs for which entry is accommodated, and rebates are high when there is an entrant with entry costs for which entry is deterred. We show that entry into payment markets becomes increasingly deterred with increasing transaction benefits. This effect becomes stronger if issuing banks pass through rebates to consumers, but less strong if issuing banks face switching costs to change card issuance between card networks. This paper explains that card networks have strong incentives to deter competition by setting high rebates to issuing banks in a two-sided market with high transaction benefits for both consumers and merchants.

To the best of our knowledge, no paper has examined the strategic impact of rebates on the market structure in payments. The Stackelberg-Spence-Dixit model provides a simple

[5] The magnitude of this cost is unknown as data is mostly lacking.

conceptual framework to analyse the strategic impact of rebates in markets with entry costs (Dixit 1980; Spence 1977). The question addressed in this paper (that is, under which conditions a card network sets rebates at a higher level such that competitors cannot profitably enter the market) is important, because welfare effects in a two-sided market are different from a "regular" one-sided market. In regular markets, entry deterrence makes the market contestable and brings the equilibrium outcome closer to the optimal welfare outcome. However, in a two-sided market the opposite may be true. High consumer rebates to deter entry lead to higher fees on the merchant side, because merchants' willingness to pay for card payments incorporates consumer's utility of card transactions (Rochet and Tirole, 2011). This provides another reason for regulatory scrutiny of rebates and insights into policies that aim to reduce dependency on US card networks and support new innovative payment methods.

The rest of this paper is structured as follows. Section II gives an overview of existing literature and links this paper to previous work. Section III introduces the basic model where the incumbent sets consumer rebates before an entrant. Section IV derives the conditions under which entry is blockaded and analyses how an incumbent chooses between entry accommodation and entry deterrence. Section V discusses our critical assumptions and the scope for further research. Section VI states our conclusions and policy implications. Formal proofs can be found in the appendix in Section A.

II. Literature Review

Earlier work has analysed payment card networks within the framework of a two-sided market. These papers typically take the market structure as given and analyse the optimal level of the interchange fee.[6] A common result is that monopolistic interchange fees may be too high compared to the socially optimal level (Bedre-Defolie and Calvano, 2013; Rochet and Tirole, 2011; Wright, 2004). For example, the "must-take card" principle arises if merchants internalize transaction surplus of consumers (Rochet and Tirole, 2011). This

[6] See Rysman and Wright (2015) and Verdier (2011) for a literature review

leads to a higher than socially optimal level of the interchange fee or, in our case, to rebates to consumers on a per transaction basis. Essentially, a card network could increase rebates and merchant fees to capture more merchant surplus without losing (too much) merchant demand.

Other papers focus on a competitive equilibrium for payment card networks. Guthrie and Wright (2007) and Wang (2025) show that competition could increase rewards to consumers and fees to merchants reducing welfare. Guthrie and Wright (2007) show that if consumers are singlehoming (use a payment card from only one network), while merchants are multihoming (accept payment cards from different networks), there is effectively only competition on the consumer side. In their model, merchants compete for consumers. Due to business stealing effects, merchants are forced to accept cards with high consumer rebates - essentially a new version of the "must-take card" principle. Wang (2025) shows that since merchants would lose sales, they are also reluctant to turn down cards even when consumers are multihoming, as merchants have a lower elasticity of demand than consumers. Conversely, Chakravorti and Roson (2004) show that without transaction rebates (consumers pay an annual fee) and the "must-take card principle" welfare increases with competition, because merchants do not pay more than their own benefit. Frost et al. (2025) evaluate the effects of a public option. They analyse competition between bank deposits and platform tokens and add a fast payment system (or CBDC) that ensures interoperability among these private payment instruments. They find that although this public option may entail some degree of bank disintermediation, it has the potential to enhance financial inclusion and generate gains in social welfare.

We add to this strand of literature by endogenizing the market structure. The results in the papers above only hold under certain conditions that determine the market structure. We explore these conditions. Important factors are

(1) the level of entry costs,

(2) the degree to which issuing banks pass-through rebates to consumers,

(3) the level of issuing banks' switching costs and

(4) the level of transaction benefits.

We show that the market may not be monopolistic or competitive, but rather collusive or contestable by nature. In the face of the threat of entry it may not be possible to set monopolistic rebates. Instead, an incumbent card network decides to set lower than competitive rebates to accommodate entry (collusive) or higher than competitive rebates to deter entry (contestable). In this way, rebates could be used to rule out competitors and we determine when a card network resorts to this strategy. We do so by combining the ideas from the two-sided market literature about platform pricing with results from the "traditional" contestability literature about competition *for* the market.[7] Indeed, the fact that in a market only one or two card networks are active does not mean that these market positions are not contested by entrants.

Caillaud and Jullien (2001, 2003) show that the threat of entry in case of two-sided platform competition with "pure" matchmaking (ie, no platform differentiation by means of other services) will drive profits to zero and will lead to an equilibrium where only one platform is active. Platforms can exploit "unfavorable beliefs" to "tip" the market and attract all users to their platform. However, Caillaud and Jullien (2001, 2003) do not analyze the conditions of market tipping in a market with entry costs, switching costs and where platforms cannot set prices directly to users. This paper shows that entry costs, switching costs and low rebate pass-through by issuing banks essentially work against market tipping. Platforms do not necessarily deter entry, as they could set monopolistic rebates or collusive rebates as well. This paper analyses these trade-offs.

[7] See Belleflamme and Peitz (2018), Jullien, Pavan, et al. (2021), and Jullien and Sand-Zantman (2021) for excellent overviews. All argue that most of the platform competition literature focuses on competition *within* the market. That is, when the market structure has stabilized and users have coordinated on a stable market allocation with more than one platform which happens when there is sufficient platform differentiation and/or multihoming.

III. Model

A. Framework

An *incumbent* card network faces the potential threat of an *entrant*, indexed by $k = I, E$ respectively. In this model, there is one period with three stages. The incumbent card network is the Stackelberg leader and moves before the entrant. The incumbent card network could be interpreted as a large international card network, while the entrant could be interpreted as a small domestic card network (or card scheme) with non-negligible entry costs to set up a payment system.[8] The incumbent moves in stage one, the entrant moves in stage two, and the banks and end-users move in stage three.

There exists a unit mass of consumers and merchants, indexed by $i = c, m$ respectively. Consumers decide which merchants they will buy from. The demand and unit cost for goods and services is given and inelastic to card fees and rebates.[9] Consumers know the price of the goods and services and merchant's acceptance policy before making this choice. Once in the store, consumers select a payment method (card or cash), provided that the merchant accepts cards. Consumers can always pay with cash.[10] There is price coherence, so merchants cannot surcharge card payments or discount cash payments.[11]

[8]See section V for a brief analysis if the roles are reversed. This could be the case, for example, if a domestic player is already present, while the international card network contemplates to enter the market. Also note that we focus here on domestic transactions. We thank our anonymous referee for pointing out that a domestic card network could offer an inferior product as it may not be accepted internationally, see section V for a discussion. Lastly, the entrant could also be interpreted as another large international card network with lower entry costs – explaining why in many countries two large international card networks are present.

[9]This assumption is common in the literature as one may argue that rebates are too small to increase consumer demand for goods and services, see Schwartz and Vincent (2006, 2020) for a notable exception.

[10]Note that in some countries, such as the Netherlands, some merchants do not accept cash (DNB, 2025). Since the transaction benefits in our model are interpreted as the costs of using "cash", lower cash acceptance could be interpreted as a higher transaction benefit for consumers.

[11]In most countries merchants cannot discriminate in prices between card users and cash users – also known as imposing the "No Surcharge Rule" (NSR) in four-party card networks. As first shown by Gans and King (2001) and Rochet and Tirole (2002), card networks would no longer have incentives to provide rebates without the NSR. Consumers would need to pay a higher price for products exactly equal to the rebates received. See also Bolt et al. (2010) for empirical results which suggest that merchants would surcharge too much.

Consumers and merchants derive utility from making and receiving card payments. This utility is referred to as the transaction benefit α_i, $i = c, m$, and we assume that these benefits are identical across consumers and merchants. It could alternatively be interpreted as the costs of handling cash. The end-users do not derive intrinsic utility from choosing a particular card network, as long as they can make and receive payments. Thus, the transaction benefit is homogeneous and does not depend on the incumbent or entrant. Let $\alpha_t = \alpha_c + \alpha_m$ be the total transaction benefits of consumers and merchants combined.

Each consumer and each merchant has an existing relationship with an issuing and an acquiring bank respectively. There are n_l homogeneous issuing and acquiring banks, where $l = is, ac$. The model allows for a different market structure for banks, but takes this market structure as given with a (fixed) mark-up exogenously determined by the market conditions of banks in a specific country. The reason for this modeling choice is that consumers' and merchants' banking choice are generally driven by factors unrelated to card network pricing (Anderson et al., 1976; Devlin and Gerrard, 2005; Ricci and Caratelli, 2014). In fact, empirical research suggests that consumers show a low price elasticity of demand with regards to fixed banking fees, but are more sensitive to interest rates (Dick, 2008). To keep the model tractable, we take these factors as a given. This also implies that issuing and acquiring banks' pricing choices are exogenously driven by the banks' business model. Acquiring banks just pass through their costs with a fixed markup. Issuing banks set a total price for all banking services independent of their cost.

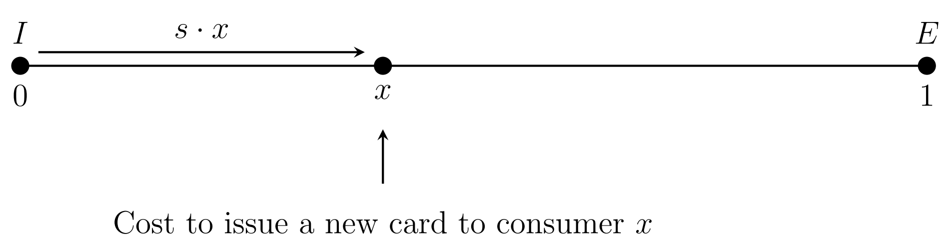
In our model, issuing banks choose one card network for each client, while acquiring banks offer both card networks to each merchant. Note that issuing banks are "multihoming" in a sense that they may choose a different card network for each client, but consumers use only this payment card for their everyday payments (ie, are "singlehoming").[12] Consumers pay a fixed monthly price P_c to their issuing banks to obtain a payment card with their banking services. The price that consumers pay is the same regardless of the card network chosen by

[12] As discussed in section V, although consumers may have multiple cards, in practice we observe that consumers often have a single preferred payment method (Rysman, 2007).

the issuing bank. Total consumer demand for both card networks $(n_{c,I} + n_{c,E})$ is given by $\gamma_{is} n_c n_{is}$, where $\gamma_{is} = \frac{1}{n_{is}}$ is the market share of each issuing bank, n_c is the number of clients at each issuing bank that wants a payment card and n_{is} the number of issuing banks as defined above. Total merchant demand for each card network is given by $\gamma_{ac} n_{m,k} n_{ac}$, where $\gamma_{ac} = \frac{1}{n_{ac}}$ is the market share of each acquiring bank, $n_{m,k}$ is the number of clients at each acquiring bank that accepts the payment card of card network k, and n_{ac} is the number of acquiring banks as defined above. Merchants pay a price $p_{m,k}$ per transaction to their acquiring banks to accept card payments of card network k. Merchants decide for themselves (no role for acquiring banks) whether to accept cards from card network k or not. Merchants may accept both cards. (ie, the merchant "multihomes").

Issuing banks choose a card network for each client based on the type of a client. The type of a client is determined by the costs to serve this client. More specifically, a continuum of consumers are uniformly distributed on a line segment over the unit interval $[0, 1]$. A consumers' location on the line determines the banks' cost to serve this consumer with a new payment card. For example, this cost differs across consumers as some consumers are in need of a new payment card, while others have just received one. The distribution of consumers is the same across issuing banks. The incumbent is located at the left side of the interval $S_I = 0$ and the entrant might enter at the right side of the interval $S_E = 1$. The entrant enters if its profits $\pi_E \geq 0$. The issuing bank of consumer x chooses one card network to issue the payment card for this client (consumer). Each issuing bank charges a total price P_c per cardholder for its banking services, but also faces a cost C_c per cardholder to offer the card services to the cardholders.

Figure 2: Issuing bank switching costs s



As shown in figure 2, issuing banks face a finite switching costs s, where $s > 0$. These switching costs indicate the costs for banks to issue new payment cards with a different card network than the one they used for old payment cards. We model switching costs for banks rather than consumers to reflect the idea that consumers choose a bank to open a payment account and this bank subsequently chooses the card network to issue the payment card. Consumers oftentimes cannot choose the card network for their payment card. Issuing banks have a preference for existing clients to use the card network with which they have a preexisting relationship, because they would incur an additional costs to issue a new payment card and/or connect to a new system. At the same time, they may have a preference for new clients to use the entering card network, because for example this card network has better fraud protection measures and/or other beneficial features. Thus, switching costs s differ across consumers within banks, depending on where the consumer is located on the line segment $x \in [0, 1]$. In the rest of this paper it will be interpreted as the switching costs to go from one card network to the other card network.

The card networks may offer rebates $R_{c,k}$ per transaction to the issuing banks. A card network gives rebates if the total transaction benefits defined above for both merchants and consumers are higher than a certain threshold. If $R_{c,k}$ is negative, it should be interpreted as a transaction fee, but a card network gives rebates in almost all equilibrium states. The banks can either keep the rebates for themselves or pass them through to the consumers at the pass-through rate $r \in [0, 1)$. Thus, consumers may receive rebates by their issuing banks increasing their transaction benefit by $rR_{c,k}$.

An issuing bank gets a mark-up $M_{c,I}$ from offering a card to a consumer at location $x \in [0, 1]$ via the incumbent card network:

$$M_{c,I}(x) = P_c + (1 - r)R_{c,I}n_{m,I} - C_c - sx \tag{1}$$

or it could offer a card via the entrant (if the entrant enters) and obtain a mark-up:

$$M_{c,E}(x) = \big[P_c + (1-r)R_{c,E}n_{m,E} - C_c - s(1-x)\big]1_E \tag{2}$$

with indicator function

$$1_E = \begin{cases} 1 & \text{if } E \text{ enters,} \\ \\ 0 & \text{if } E \text{ does not enter,} \end{cases}$$

and $n_{m,k}$ is the number of merchants that accept the card of card network k.

In our simple model, the pass-through rate is irrelevant to the issuers' mark-up and consumers' utility, because a higher (or lower) pass-through of rebates increases consumers' willingness to pay (and thus the consumer fee) by the same amount. Arguably, the pass-through rate is driven by external exogenous factors relating to the banks' business models and regulation. For example, an interchange fee cap could reduce incentives to pass-through rebates, as in this case banks have little incentive to stimulate card usage. Similarly, in a low interest rate environment, banks may be inclined to increase consumer prices to make up for low interest rate margins. This would also reduce the pass-through rate of rebates.[13]

Assuming quasi-linear preferences, formally each consumer derives a net payoff

$$u_c(P_c) = (\alpha_c + rR_{c,k})n_{m,k} - P_c \tag{3}$$

for having a payment card. Each consumer gets one payment card with its payment account for its everyday payments. The consumer demand for payment cards at each issuer is given by:

$$n_c = D_c(P_c) = \begin{cases} 1 & \text{if } P_c \leq (\alpha_c + rR_{c,k})n_{m,k}, \\ \\ 0 & \text{if } P_c > (\alpha_c + rR_{c,k})n_{m,k}. \end{cases} \tag{4}$$

[13]One of the anonymous referees rightly pointed out that endogenizing the pass-through rate would be an interesting extension for the future. However, this would require modeling consumers' banking choices which as explained above is generally affected by factors unrelated to card network pricing.

The total proportion of consumers that uses a payment card from card network k is given by $n_{c,k} = \gamma_{is} n_{is} \sigma_k n_c$, where $\gamma_{is} = \frac{1}{n_{is}}$ is the market share of each issuing bank, n_{is} is the number of issuing banks in a market and $\sigma_k \in [0, 1]$ is the proportion of cardholders at each issuing bank that receives a card from card network k.

On the merchant side, each merchant may accept both cards (i.e. the merchant "multihomes") and decides for itself (no role for acquiring banks) whether to accept cards from card network k or not. We assume the costs to on-board a merchant do not differ between different types of merchants, because merchants can accept multiple card networks at the same time. Therefore, the preferences and choices of which card network to choose are less important than on the issuing side.

This paper follows the "must-take cards" idea of Rochet and Tirole (2011). Thus, merchants perceived benefit of accepting the card of network k is equal to the sum of their own convenience benefit $u_{m,k}$ and the transaction benefit it brings to consumers. As proven below, this holds both under monopolistic merchants as perfectly competitive merchants. Merchant's own net convenience benefit per transaction via card network k is given by

$$u_{m,k}(p_{m,k}) = \alpha_m - p_{m,k}. \tag{5}$$

The total proportion of merchants that accepts card network k is given by[14]

$$n_{m,k} = D_m(p_{m,k}) = \begin{cases} 1 & \text{if } p_{m,k} \leq \alpha_c + rR_{c,k} + \alpha_m, \\ \\ 0 & \text{if } p_{m,k} > \alpha_c + rR_{c,k} + \alpha_m. \end{cases} \tag{6}$$

This can be proven as follows. If merchants are monopolistic, then the retail monopolist extracts all consumer surplus. Accepting cards allows the merchant to increase the price by

[14]Note that the total proportion of merchants that accepts card network k is equal to the proportion of merchants at each acquiring bank that accepts card network k, because acquiring banks are homogeneous, i.e. $\gamma_{ac} n_{ac} = 1$.

$\alpha_c + rR_{c,k}$, but increases its cost by $p_{m,k} - \alpha_m$. Thus, a retail monopolist accepts cards if and only if $p_{m,k} \leq \alpha_c + rR_{c,k} + \alpha_m$. If merchants are perfectly competitive, they charge a retail price p equal to marginal cost. If the merchant does not accept cards, then $p = \gamma$ where γ is the marginal cost of production. If the merchant accepts cards then $p = \gamma + p_{m,k} - \alpha_m$. Consumers choose retailers who accept cards if and only if their card benefit $\alpha_c + rR_{c,k}$ exceeds the price increase $(p_{m,k} - \alpha_m)$. Thus, there are only two types of merchants. Those that accept cards if and only if $p_{m,k} \leq \alpha_c + rR_{c,k} + \alpha_m$ and those that do not accept cards if and only if $p_{m,k} > \alpha_c + rR_{c,k} + \alpha_m$.

The merchant demand function given by equation (6) reflects the idea that if consumers are perfectly informed about merchants' card acceptance decisions, then merchants internalize consumers' transaction surplus. This means that merchants accept cards even if their net cost of a card transaction is positive $(p_{m,k} > \alpha_m)$. Merchants incur this extra cost $(p_{m,k} - \alpha_m)$ to offer better quality of service to consumers.

The acquiring banks charge a total price $p_{m,k}n_{c,k}$ per merchant, but acquiring banks also pay a fee $f_{m,k}$ per transaction made with a card from card network k to card network k. The acquiring banks have a constant mark-up $M_{m,k}$

$$M_{m,k} = (p_{m,k} - f_{m,k})n_{c,k} - C_m, \tag{7}$$

for offering the card services to each merchant, where $n_{c,k}$ is the total amount of consumers (at all issuing banks) that use card network k. Note that this acquiring mark-up allows us to analyze different acquiring market structures. If we assume perfectly competitive acquirers (as most payment papers do), then $M_{m,k} = 0$, as new acquiring banks will enter until $p_{m,k} = f_{m,k} + \frac{C_m}{n_{c,k}}$.

Figure 3 gives overview of the flow of fees toward the international card network. The flow of fees of the domestic card network are similar, except for the issuing mark-up as defined above.

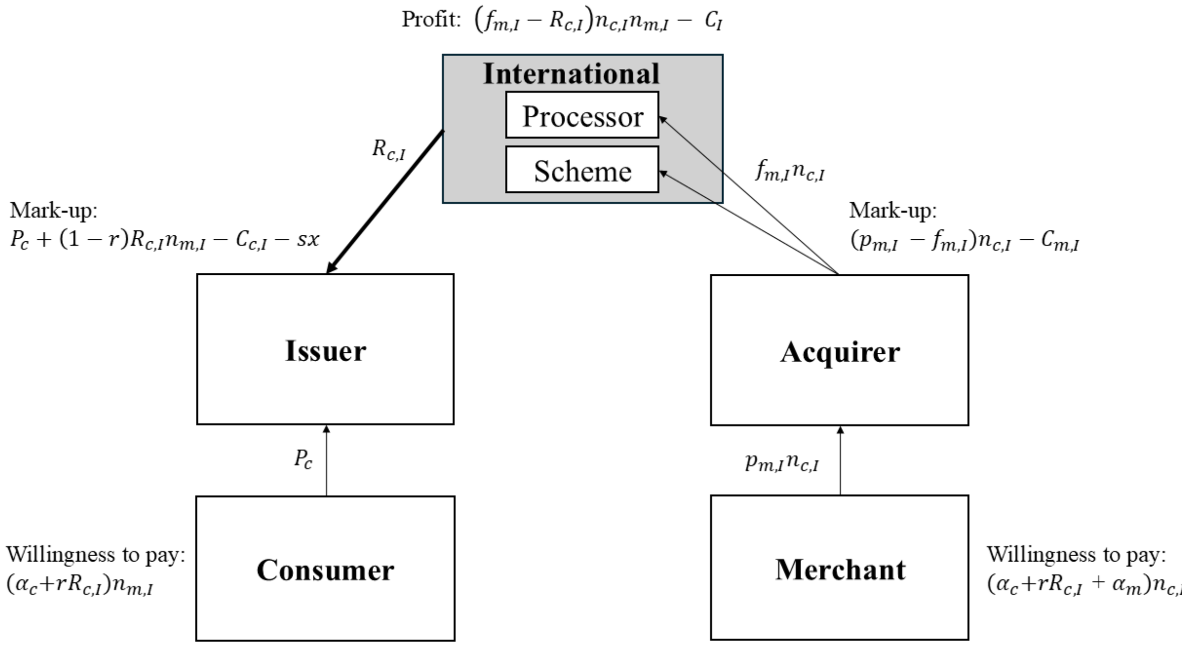


Figure 3: The flow of fees of the international card network.

As common in the literature, the total payment card usage is assumed to increase proportionally with the share of users on both sides:

$$D_k(P_c, p_{m,k}) = D_{c,k}(P_c, n_{m,k})D_{m,k}(p_{m,k}, n_{c,k}). \tag{8}$$

The transaction costs for each card network are marginally negligible, but each card network faces fixed costs C_k to set up the payment system. In the rest of this paper we refer to the fixed costs of the entrant C_E as entry costs. Given the assumptions above, each card network's profits is specified by:

$$\Pi_k = (f_{m,k} - R_{c,k})n_{c,k}n_{m,k} - C_k. \tag{9}$$

B. Timing

The timing of the model is as follows – unless we refer to a duopolistic equilibrium (defined below in Definition 1). In a duopolistic equilibrium stage 1 and 2 collide to one stage: Card network I and E both pay fixed costs C_k and set fees $f_{m,k}$ and rebates $R_{c,k}$ simultaneously, so as to maximize their sum of profits.

Timing.

Stage 1: The incumbent card network I pays fixed costs C_I and sets fees $f_{m,I}$ and rebates $R_{c,I}$, so as to maximize its sum of profits. The incumbent commits to this level of rebates by contractual obligations with issuing banks. Rebates cannot be lowered but can be instantaneously increased at the discretion of the incumbent card network.[15]

Stage 2: The entrant observes the rebates set by the incumbent and decides whether or not to enter. If it enters it faces entry costs C_E and sets fees $f_{m,E}$ and rebates $R_{c,E}$, so as to maximize its sum of profits. The entrant also commits to this level of rebates by contractual obligations with issuing banks. Rebates cannot be lowered but can be instantaneously increased if the incumbent changes its strategy. If the entrant does not enter, its profits are 0.

Stage 3a: The issuing banks decide which card will be issued for each client and set the prices to consumers. The acquiring banks set prices for merchants to accept each card.

Stage 3b: Consumers and merchants realize their pay-off u_c and $u_{m,k}$. Consumers decide whether to get a card. Merchants decide whether to accept the card offered by card network k. Merchants can accept both cards at the same time.

[15]One may argue that the incumbent's fixed costs are "sunk" and should be 0. This makes no difference in our results.

C. Equilibrium definition

We solve for a Subgame Perfect Nash Equilibrium (SPNE). Card networks maximize profits by setting $f_{m,k}$ and $R_{c,k}$. Issuing banks maximize profits by choosing which card to issue for their clients and by setting P_c. Acquiring banks maximize profits by setting $p_{m,k}$ for each card network. Consumers maximize utility by choosing whether to get a card. Merchants maximize utility by deciding whether to accept each card.

IV. Equilibrium Outcome

It follows from equation (1), (2) and (7) that the issuing and acquiring banks set the prices to consumers and merchants at the maximum level such that all merchants accept each card and all consumers want a card. The total fee per transaction via card network k paid by each merchant is obtained by setting (6) equal to the maximum fee where merchants still accept the card of card network k:

$$p_{m,k} = \alpha_c + rR_{c,k} + \alpha_m. \tag{10}$$

It follows that all merchants accept both card networks, i.e. $n_{m,I} = 1$ and $n_{m,E} = 1$. The total transaction fee that the acquiring banks pay to card network k is obtained by solving (7):

$$f_{m,k} = p_{m,k} - \frac{M_{m,k} + C_m}{n_{c,k}}. \tag{11}$$

By equation (4), we can infer that the total payment made by each consumer is equal to:

$$P_c = (\alpha_c + rR_{c,k})n_{m,k} \tag{12}$$

and $n_c = 1$. Suppose that card network E does not enter ($1_E = 0$). Each issuing bank chooses whether or not to issue payment cards. Issuers will only participate and issue a card to client x if its mark-up is positive. The demand for the incumbent card network is the location of client x^* where each issuer is indifferent between offering a payment card to client x^* or not. Set $M_{c,I}(x^*) = 0$ and solve for x^* to get the consumer market share of card network I at each issuer. Note that the consumer market share of card network I at each issuer is equal to the total consumer market share, because issuing banks are homogeneous, i.e. $\gamma_{is} n_{is} = 1$. Thus, the demand for card network I is a function of the level of consumer rebates:

$$n_{c,I} = \sigma_I(R_{c,I}) = \frac{\alpha_c - C_c + R_{c,I}}{s}. \tag{13}$$

This can be proven as follows. Note that $n_{m,I} = 1$.

$$\begin{aligned} M_{c,I}(x^*) &= 0 \\ (\alpha_c + rR_{c,I})n_{m,I} - C_c + (1-r)R_{c,I}n_{m,I} - sx^* &= 0 \\ \alpha_c + R_{c,I} - C_c - sx^* &= 0 \\ x^* &= \frac{\alpha_c - C_c + R_{c,I}}{s}. \end{aligned}$$

Suppose that card network E enters ($1_E = 1$). Each issuing bank chooses a card network for client x where it has the highest mark-up. Demand for the incumbent card network at each issuer is the location of client x^{**} on the line segment where the issuer is indifferent between choosing the card network of the incumbent or that of the entrant. Consumers "to the right" of client x^{**} will be given a payment card of the entrant. Set $M_{c,I}(x^{**}) = M_{c,E}(x^{**})$ and solve for x^{**} to get the consumer market share of card network k at each issuer. Note that the consumer market share of card network k at each issuer is equal to the total consumer market share, because issuing banks are homogeneous, i.e. $\gamma_{is} n_{is} = 1$. Consumer demand for card network k is a function of the level of consumer rebates of both card networks:

$$n_{c,k} = \sigma_k(R_{c,k}, R_{c,l}) = \frac{1}{2} + \frac{R_{c,k} - R_{c,l}}{2s} \tag{14}$$

where $k \neq l,\ k,l \in \{I, E\}$.

This can be proven as follows. The entrant enters, so $1_E = 1$. Note that $n_{m,k} = 1$.

$$
\begin{aligned}
M_{c,I}(x^{**}) &= M_{c,E}(x^{**}) \\
(\alpha_c + rR_{c,I})n_{m,I} + (1-r)R_{c,I}n_{m,I} - sx^{**} &= (\alpha_c + rR_{c,E})n_{m,E} + (1-r)R_{c,E}n_{m,E} - s(1-x^{**}) \\
R_{c,I} - sx^{**} &= R_{c,E} - s(1-x^{**}) \\
x^{**} &= \frac{1}{2} + \frac{R_{c,I} - R_{c,E}}{2s} \\
1 - x^{**} &= \frac{1}{2} + \frac{R_{c,E} - R_{c,I}}{2s}.
\end{aligned}
$$

To solve the model, we analyse three cases depending on the level of entry costs C_E leading to the four different equilibrium outcomes defined below. We use subscripts to denote the party incurring the cost (e.g. the entrant E), and superscripts for thresholds. Let C_E^B and C_E^D denote the entry costs thresholds where entry is blockaded and deterred, respectively. If entry costs are below these thresholds, then entry is accommodated. Below we first highlight the case of blockaded entry leading to a monopolistic equilibrium, followed by the case where entry is accommodated either resulting in a duopolistic or collusive equilibrium, and finally we solve the case where the incumbent deters entry leading to a contestable equilibrium. In the last section we compare the different equilibrium results.

Definition 1 *A **duopolistic equilibrium** is an equilibrium outcome without entry costs where the entrant is already present ($C_E = 0$). Both card networks simultaneously set rebates, assuming that the demand conditions in (14) hold, and no card network can make a profit by unilaterally changing its level of rebates.*

Definition 2 *A **collusive equilibrium** is an equilibrium outcome with entry costs which are sufficiently low such that entry of the entrant is accommodated ($0 < C_E < C_E^D$). The incumbent card network strategically sets a lower rebate level than in the duopolistic equilibrium, taking the response of the entrant into account, even though it loses some market* *share to the entrant.*

Definition 3 *A **contestable equilibrium** is an equilibrium outcome where the entry costs are in between the collusive equilibrium and the monopolistic equilibrium ($C_E^D \leq C_E \leq C_E^B$). The incumbent card network sets rebates to deliberately deter entry by the entrant, even though entry is not blockaded.*

Definition 4 *A **monopolistic equilibrium** is an equilibrium outcome where the entry costs are sufficiently high such that entry of the entrant is blockaded ($C_E > C_E^B$). The incumbent card network sets the rebate level to maximize its own profit, assuming the demand conditions in (13) hold.*

A. *Entry blockaded*

Suppose C_E is too high such that there is no need to deter entry. In this case, entry is blockaded resulting in a monopolistic equilibrium defined in Definition 4. The incumbent acts as a monopolist as if there is no potential threat of entry. A monopolist will optimize its profit function with consumer demand given by equation (13). It is easy to see that if $R_{c,I} = C_c - \alpha_c + s$, that demand is maximized $n_{c,I} = 1$. There is no reason for the incumbent to increase rebates further. We therefore have a boundary solution with a covered market where all consumers have cards which arises if and only if

$$s \leq \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2} \tag{15}$$

and an interior solution where some consumers do not have a card which arises if and only if condition (15) is not satisfied. In most of this paper, we focus on the case where switching costs are below the threshold given by (15). If switching costs were to exceed the threshold given by (15), then the costs of offering cards differ substantially for different clients. Issuing banks would decide not to issue any card to "expensive" consumers. We focus on an equilibrium where banks offer payment accounts to all clients, even if their preferred card network does not enter the market. This assumption seems reasonable, as the card networks' offering of card payment services is generally perceived to be relatively homogeneous.

The monopolistic rebates are given by:

$$R^M_{c,I} = \begin{cases} \dfrac{\alpha_m + r\alpha_c + (1-r)C_c}{2(1-r)} & \text{if } s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}, \\ s - \alpha_c + C_c & \text{if } s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}. \end{cases} \tag{16}$$

Suppose that the switching costs s are below the threshold of equation (15). This indicates that issuing banks would want to issue a payment card regardless of the type of client. In other words, although issuing banks would preferably offer a payment card of the entrant (if the entrant were to enter) to new clients, they would still offer the payment card of the incumbent to these clients without the entrant. The monopolist will set the rebates at the minimum level such that all issuers issue cards to all clients and has no incentive to increase rebates further.

The incumbent can only set this level of rebates if entry by the entrant is unprofitable. The next step is to solve for the profits of the entrant E (as specified in equation (9)) given this level of rebates $R^M_{c,I}$. First note that we get the best response function of card network l by taking first-order conditions:

$$R^*_{c,l}(R_{c,k}) = \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{R_{c,k} - s}{2}, k \neq l. \tag{17}$$

This will give the rebate of the entrant in response to the monopolistic rebate of the incumbent $R^M_{c,I}$. We solve for the entrant's profit. Entry is unprofitable if and only if:

$$C_E \geq C_E^B \equiv (f_{m,E} - R^*_{c,E}(R^M_{c,I}))D_{c,E}(R^M_{c,I}, R^*_{c,E}(R^M_{c,I}))$$
$$= \begin{cases} \dfrac{[\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c + 2s)]^2}{(1-r)32s} - M_{m,E} - C_m & \text{if } s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}, \\ \dfrac{[\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c)]^2}{(1-r)8s} - M_{m,E} - C_m & \text{if } s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}. \end{cases} \quad (18)$$

This equation reflects a couple of interesting insights which are summarized in Proposition 1.

First, as may be expected, entry becomes more blockaded as banks' costs and acquiring mark-up increases. The threshold falls as the costs C_m and C_c and/or mark-up $M_{m,E}$ of the banks increase. The reason is that issuing costs C_c lead to higher monopolistic rebates. This reduces the entrant's profit and thus the threshold. On the acquiring side, costs C_m and mark-up $M_{m,E}$ reduce the acquiring transaction fee and thus profits.

Second, when there is full market coverage, entry becomes less blockaded with rebates pass-through rate r and more blockaded with switching costs s. The pass-through rate of rebates on the issuing side r increases the threshold for which entry is blockaded. The acquiring transaction fee $f_{m,E}$ increases with rebate pass-through r. This increases the profit of the entrant (and thus the entry costs threshold). The opposite holds for switching costs s. Switching costs make it harder for the entrant to sign contracts with issuing banks. This reduces the profit of the entrant (and thus the entry costs thresholds). In an interior solution, the effect is arbitrary, as in this case switching costs are so high that they could also increase the entrant's profit since there is less competition for the banks that prefer the entrant.

Third, it follows from equation (18) that transaction benefits increase the threshold of the entry costs that block entry. This is in line with the findings of (Buccella and Fanti, 2016) who model a normal (not two-sided) network good and find that "network externalities make the threshold of the entry costs that block entry higher than that with standard goods". The condition above shows that consumer transaction benefits increase the threshold more than merchant transaction benefits. This is due to the "must-take card" principle. This holds in both the boundary solution and the interior solution.

Proposition 1 *Suppose an incumbent card network I sets rebates before an entrant E and the entrant faces fixed entry costs C_E:*

- *The incumbent gives the **minimum** level of rebates given by equation (16) such that all issuers issue cards if the entrant faces entry costs higher than the threshold C_E^B given by equation (18) and switching costs are lower than the threshold given by equation (15).*
- *The entry cost threshold C_E^B **increases** with higher transaction benefits. Entry is **less** blockaded for higher transaction benefits.*
- *If switching costs are below the threshold given by equation (15), the pass-through rate of issuer rebates r to consumers **increases** the entry cost threshold C_E^B, but switching costs s **decrease** the threshold. Entry is **less** blockaded with rebates pass-through and **more** blockaded with switching costs.*

Proof. In the appendix in section A. ■

B. Entry accommodation

Suppose C_E is too low to deter entry and entry is accommodated. There are two ways to solve the equilibrium outcome. First, if the entrant has already entered ($C_E = 0$) and both card networks simultaneously set rebates (stage 1 and 2 collapse), we end up in a standard duopolistic equilibrium as defined in Definition 1. The best response functions of the two card networks are given by equation (17) as solved in the previous section. Now, when we solve these two best response functions, the card networks both set rebates as follows:

$$R_{c,k}^{*} = \frac{\alpha_m + \alpha_c}{(1-r)} - s. \tag{19}$$

Second, suppose the entrant still needs to enter and faces some entry costs ($0 < C_E < C_E^D$) such that network E decides to enter and the incumbent sets rebates before the entrant. The incumbent may choose a tacit collusion strategy and we end up in a collusive equilibrium as defined in Definition 2. The incumbent card network I integrates the best response function of card network E given by equation (17) into its own profit function (where $n_{m,I} = 1$):

$$\Pi_I = (f_{m,I} - R_{c,I})D_{c,I}(R_{c,I}, R^*_{c,E}(R_{c,I})) - C_I \tag{20}$$

Optimizing the profit function of the incumbent, the entry accommodation rebate for the incumbent card network I becomes:

$$R^A_{c,I} = \frac{\alpha_m + \alpha_c}{(1-r)} - \frac{3s}{2}. \tag{21}$$

Subsequently, we substitute the rebate of the incumbent $R^A_{c,I}$ in the best response function of the entrant given by equation (17), which then sets rebates as follows:

$$R^A_{c,E} = \frac{\alpha_m + \alpha_c}{(1-r)} - \frac{5s}{4}. \tag{22}$$

The incumbent offers lower rebates than in a duopolistic equilibrium even though it knows that the entrant will gain a larger market share. This is because the profits of the incumbent in the collusive equilibrium are higher than in a duopolistic equilibrium:

$$\Pi^A_I - \Pi^S_I = \frac{(1-r)s}{16} > 0, \tag{23}$$

where Π^A_I is the profit of the incumbent in the collusive equilibrium (where entry is accommodated) and Π^S_I is the profit of the incumbent in a duopolistic equilibrium (where entry is simultaneous). Suppose C_E is sufficiently small such that the incumbent card network knows that the entrant will enter. Note that if the game continues indefinitely and rebates could be increased instantly (as may be assumed in reality), then the incumbent will choose a tacit collusion strategy under any discount rate. To see this, note that

$$\frac{\Pi_I^A}{1-\delta} \geq \frac{\Pi_I^S}{1-\delta} \tag{24}$$

under any discount factor $\delta \in (0,1)$. Since card network I's profits are higher under this collusive equilibrium than under a duopolistic equilibrium, a large incumbent might foresee a "race to the bottom" with an entrant and strategically choose avoiding a duopolistic equilibrium by setting lower rebates. In the terminology of Fudenberg and Tirole (1984) this means that the incumbent I uses a "Puppy Dog" strategy, so as to not trigger an aggressive response from the entrant E.

The above equations reflect a couple of interesting insights, which are summarized in Proposition 2. First, the optimal level of rebates of both the incumbent and entrant increase with the total transaction benefits $\alpha_m + \alpha_c$ of merchants and consumers. If issuing banks do not pass-through rebates ($r = 0$), then rebates increase at the same rate as the total transaction benefits. If issuing banks do pass-through rebates ($r \in (0,1)$), then competition becomes stronger and the marginal increase in rebates exceeds the marginal increase in total transaction benefits (i.e. $dR^*_{c,k}/d(\alpha_c + \alpha_m) = 1/(1-r) > 1$).

Second, the optimal level of rebates decreases with the switching costs parameter s, indicating issuing banks' cost to switch card networks. If switching costs increase, there is less incentive to offer rebates. The reason is that there is less competition due to lock-in effects.

Finally, the entrant rebates are always higher than the rebates set by incumbent – indicating a second-mover advantage. We define a second-mover advantage as when the entrant's profit is higher than the incumbent's profit given equal cost:

$$\Pi_E^A - \Pi_I^A = \frac{(1-r)7s}{32} > 0. \tag{25}$$

This advantage increases with s and decreases with r. If it becomes more costly for issuing banks to switch card networks after contracts are signed, then the entrant has a better second-mover advantage. The rationale behind this result is that more issuing banks would like to make the switch to a new card network with higher rebates as more consumers need a new payment card. If issuing banks pass-through more rebates to consumers, then competition becomes stronger and the rebates converge.

Proposition 2 *Suppose an incumbent card network I sets rebates before a new entrant E and expects the entrant to enter:*

- *The rebates set by the entrant are given by equation (22) and* ***higher*** *than the rebates set by the incumbent given by equation (21). The incumbent resorts to a "puppy dog" strategy rather than competing with higher rebates.*
- *If issuing banks pass-through rebates $r \in (0, 1)$, the marginal increase in rebates exceeds the marginal increase in total transaction benefits for both the incumbent and the entrant, indicating* ***stronger*** *competition.*
- *The entrant has a second-mover advantage, which* ***increases*** *with issuing banks' cost to switch s, but* ***decreases*** *with the pass-through rate of rebates r.*

Proof. In the appendix in section B. ■

C. Entry deterrence

The last case - entry deterrence - is the most interesting case. If C_E is in between the entry accommodation and entry blockaded case, the incumbent chooses a level of rebates such that entry becomes unprofitable. The collusive equilibrium above illustrates how the incumbent (card network I) can determine the market share of card network E. However, the results only hold for low enough entry costs C_E, such that the incumbent cannot deter entry. As will be shown in this section, for a higher level of C_E, the incumbent might choose to offer higher rebates such that entry by card network E becomes unprofitable. In the terminology of Fudenberg and Tirole (1984) this means that the incumbent I uses a "Top Dog" strategy, as a higher rebate makes the incumbent play aggressively ("tough").[16]

Entry is deterred if the incumbent's rebates $R_{c,I}$ are chosen such that card network E's profits $\Pi_E(R_{c,I}, R_{c,E})$ turn negative. As in the previous sections, the FOC in equation (17) determines card network E's best response function: $R^*_{c,E}(R_{c,I})$. Subsequently, card network I sets $R_{c,I}$ such that card network E does not make a profit:

$$\begin{aligned}\Pi_E &= (f_{m,E} - R^*_{c,E}(R_{c,I}))D_{c,E}(R_{c,I}, R^*_{c,E}(R_{c,I})) - C_E \\ &= \frac{[\alpha_c + \alpha_m - (R_{c,I} - s)(1-r)]^2}{8s(1-r)} - M_{m,E} - C_m - C_E = 0\end{aligned} \tag{26}$$

Solving this equation yields the entry deterrence rebate, denoted by $R^D_{c,I}$. The required minimum level of rebates to deter entry of network E is:

$$R^D_{c,I} \equiv R_{c,I} \geq \frac{\alpha_c + \alpha_m}{(1-r)} + s - \sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}}, \tag{27}$$

where $C_E < C^B_E$. Note that this rebate is by definition higher than in any competitive equilibrium. Suppose there were a higher rebate, then the entrant would not enter as its profits would be negative. As a result – given a pass-through rate of $r \in (0,1)$ – the merchant transaction fee $p_{m,k} = \alpha_c + \alpha_m + rR_{c,k}$ is highest in an entry deterrence equilibrium. This is shown in figure 4. We assume that if the incumbent I sets this entry deterrence rebate, then consumer demand for the incumbent is maximized $n_{c,I} = 1$. This means that switching costs are below the threshold given by 15 (see the discussion in section A).

The incumbent faces a trade-off between the profit obtained in a contestable equilibrium under entry deterrence $\Pi_I(R^D_{c,I})$ with that obtained in a collusive equilibrium under entry accommodation $\Pi_I(R^A_{c,I}, R^*_{c,E}(R^A_{c,I}))$. A contestable equilibrium results in higher demand at

[16] We implicitly assume that the incumbent commits to a level of rebates through contractual obligations with issuing banks. Rebates cannot be lowered (only increased) if the entrant were to enter. This assumption seems reasonable as rebates are contractually enforced between issuing banks and card networks for a couple of years when new cards are issued. Issuing banks would be happy to change the contract with higher rebates, but issuing banks would be unhappy to change the contract with smaller rebates.

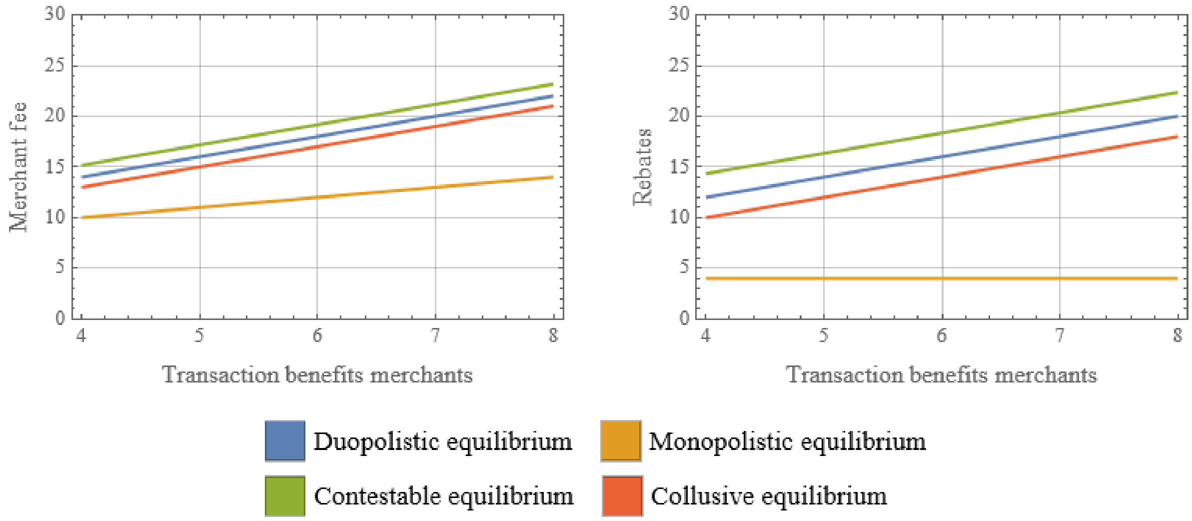


Figure 4: The merchant fee and total rebates (to issuing banks) with merchant transaction benefits in different equilibrium outcomes. The figure is set for $s = 4$, $r = 0.5$, $C_c = 4$, $C_E + M_{m,k} + C_m = 0.5$ and $\alpha_c = 4$. Note that in the collusive equilibrium both card networks set different fees/rebates and only those of the incumbent are reported here.

the cost of higher rebates. A collusive equilibrium results in lower demand (as the incumbent shares the market) at the benefit of lower rebates. This comparison results in the maximum rebate under which an incumbent finds entry deterrence profitable. The incumbent deters entry if and only if:

$$\Pi_I^D \geq \Pi_I^A \tag{28}$$

The maximum rebate under which entry deterrence is profitable for the incumbent is:

$$R_{c,I} \leq \frac{\alpha_c + \alpha_m}{(1-r)} - \frac{9s}{16}. \tag{29}$$

Equation (29) shows that the maximum rebate under which entry deterrence is profitable increases with transaction benefits of both consumers and merchants. The same holds true for the pass-through rate of issuing rebates to consumers.

When we fill in the required rebate solved in equation (27) into equation (28) and solve for C_E it follows that entry is deterred if:

$$C_E \geq C_E^D \equiv \frac{625s(1-r)}{2048} - M_{m,E} - C_m. \tag{30}$$

This equation reflects a couple of interesting insights which are summarized in Proposition 3.

First, the entry deterrence threshold falls as the costs C_m and/or mark-up $M_{m,E}$ on the acquiring side increases, while fixed card issuing costs C_c play no role. Indeed, C_c plays no role in either the incentives to give rebates in the entry accommodation or in the entry deterrence case. Card networks give higher rebates than issuing costs in both cases, which increases the issuing mark-up M_c. Demand is only determined by the difference in rebates and switching costs. On the acquiring side, costs and mark-up reduce the acquiring transaction fee. This makes it easier to deter entry by the entrant.

Second, the threshold falls as the pass-through rate of rebates on the issuing side r increases. As pointed out in section B, competition becomes stronger in case of entry accommodation. This makes entry deterrence more attractive.

Third, the threshold increases as issuing banks' costs to switch card network s increases. As pointed out in section B, competition becomes less strong in case of entry accommodation due to lock-in effects. This makes entry deterrence less attractive.

Fourth, equation (30) also reveals that higher (exogenous) transaction benefits have no effect on the entry deterrence threshold. The reason is that as long as transaction benefits are the same on both card networks, these do not increase the incumbent's entry deterrence profits or the incumbent's entry accommodation profits. Marginal transaction revenues are given back as rebates.

Proposition 3 *Suppose an incumbent card network I sets rebates before an entrant E and the entrant faces entry costs C_E:*

- *The incumbent offers **greater** rebates (than in a duopolistic or collusive equilibrium) to issuing banks to deter entry of a competing card network if the entrant faces entry* *costs $C_E \geq C_E^D$ given by equation (30).*

- *The entry costs threshold C_E^D **falls** with r, while it **rises** with s. Entry deterrence becomes **more** attractive than entry accommodation with increasing pass-through of rebates and **less** attractive with increasing switching costs.*

- *The merchant transaction fee $p_{m,k} = \alpha_c + \alpha_m + rR_{c,k}$ is given a pass-through rate of $r \in (0, 1)$ **higher** in the contestable equilibrium compared to a duopolistic equilibrium.*

Proof. In the appendix in section C. ∎

D. Overall equilibrium analysis

In this section we compare the likelihood of different equilibrium outcomes with respect to different parameter values α_t, r and s. If entry costs are higher than the entry blockaded threshold in equation (18), the payment card market is monopolistic. If entry costs are in between entry blockaded threshold and the entry deterrence threshold in equation (30), then the incumbent resorts to a "top dog" strategy and entry is deterred. If entry costs are lower than the entry deterrence threshold derived in equation (30), then the incumbent resorts to a "puppy dog" strategy and entry is accommodated.

With respect to market structure, we compare the difference between the entry deterrence threshold, derived in section C, and the threshold for which entry is blockaded, derived in section A. We focus on the case where switching costs are below the threshold given by equation (15). If switching costs were to exceed the threshold given by equation (15), then the costs to offer cards between different clients differs substantially. Issuing banks would decide not to issue any card to "expensive" consumers. We again focus on an equilibrium where banks offer payment accounts to all clients, even if their preferred card network does not enter the market (see the discussion in section A).

We deduct the entry deterrence threshold given by equation (30) from the entry blockaded threshold given by equation (18):

$$C_E^B - C_E^D = \frac{[\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c)]^2}{(1-r)8s} - \frac{(1-r)625s}{2048} \tag{31}$$

We can draw three conclusions based on α_t, r and s. The results are summarized in Proposition 4.

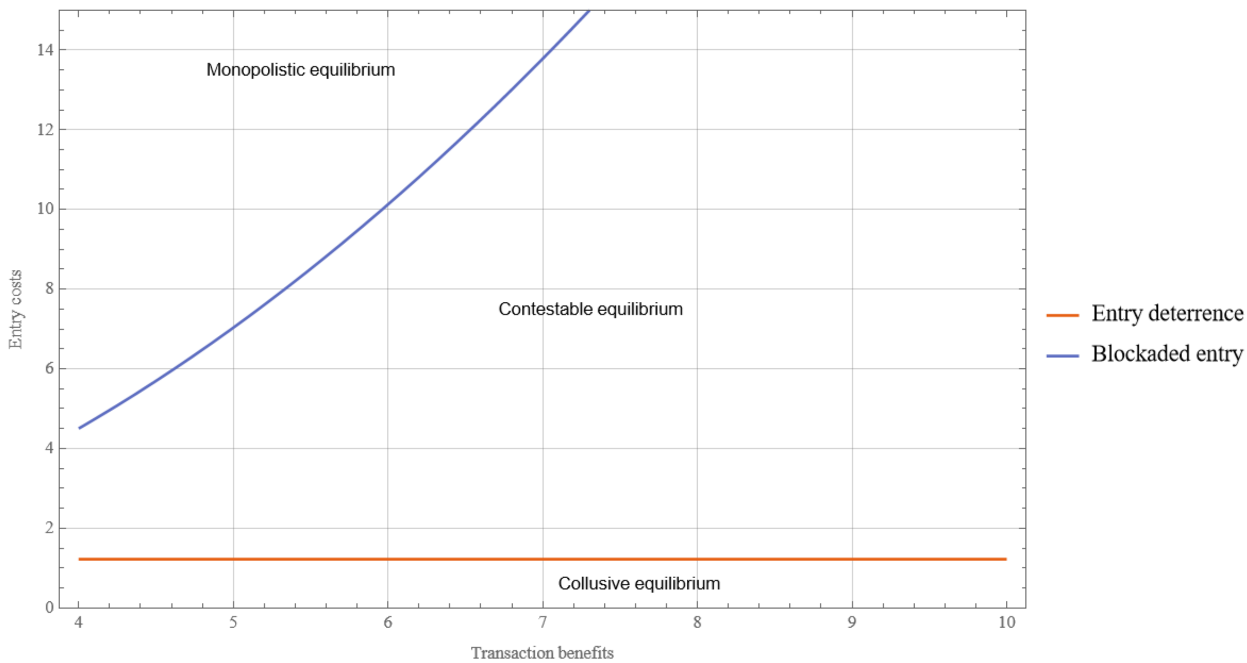


Figure 5: The entry costs thresholds C_E for which the incumbent card network chooses different strategies as a function of total homogeneous transaction benefits $\alpha_c = \alpha_m$. The figure is set for $s = 4$ and $r = C_c = M_{m,k} = C_m = 0$.

First, as shown in figure 5, the payment card market sees more deterrence with increasing transaction benefits. The threshold for which entry is blockaded increases with both consumer and merchant transaction benefits, while the threshold for which entry is deterred remains constant. The difference between the two thresholds increases with transaction benefits. To prove this, we take the derivative of equation (31) with respect to α_c and α_m and note that these have a clear relationship with the number of consumers that the entrant can get:

$$\frac{\partial(C_E^B - C_E^D)}{\partial \alpha_c} = \frac{(\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c))(2-r)}{(1-r)4s} = (2-r)n_{c,E}^B$$
$$\frac{\partial(C_E^B - C_E^D)}{\partial \alpha_m} = \frac{\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c)}{(1-r)4s} = n_{c,E}^B$$

Note that $r \in (0,1)$ and $n_{c,E}^B \geq 0$.

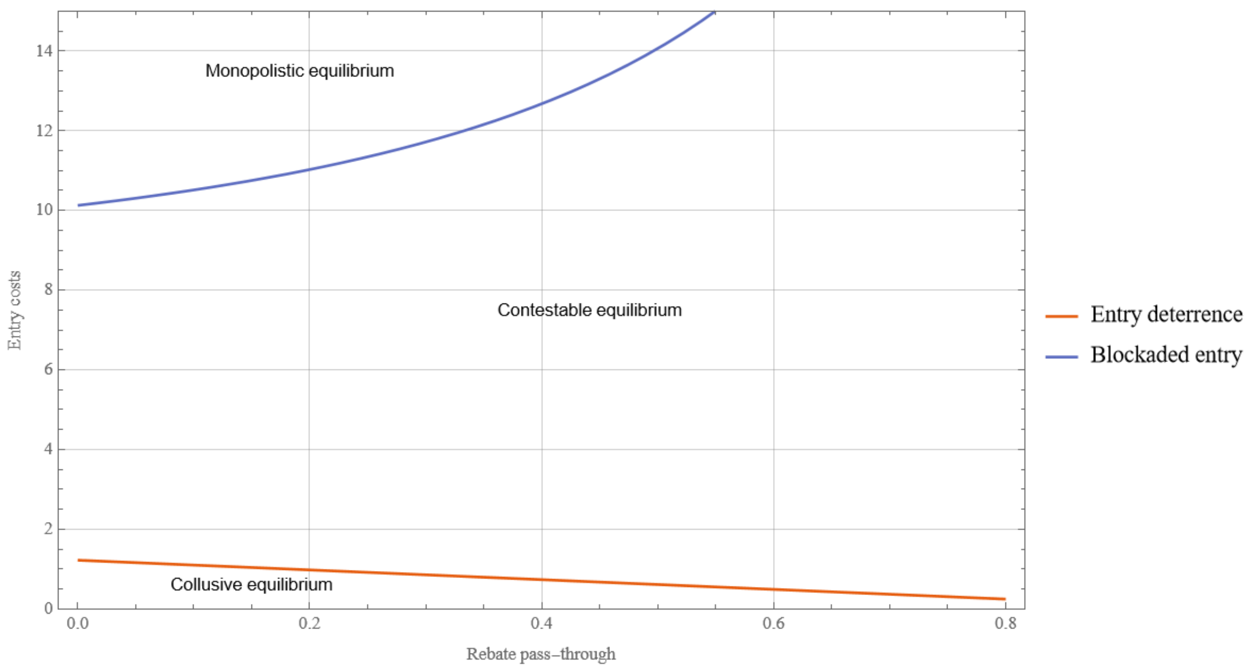


Figure 6: The entry costs thresholds C_E for which the incumbent card network chooses different strategies as a function of the issuing pass-through rate $r \in [0,1)$. The figure is set for $s = 4$, $\alpha_c = \alpha_m = 6$ and $C_c = M_{m,k} = C_m = 0$.

Second, as shown in figure 6, the payment card market sees more deterrence with a higher rebate pass-through rate $r \in (0,1)$. The threshold for which entry is blockaded increases with the pass-through rate, while the threshold for which entry is deterred decreases with the pass-through rate. The difference between the two thresholds increases. To prove this, we take the derivative of equation (31) with respect to r:

$$\frac{\partial(C_E^B - C_E^D)}{\partial r} = \frac{(\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c))(\alpha_m + r\alpha_c + (1-r)C_c)}{(1-r)^2 8s} + \frac{625s}{2048} > 0$$

Note that $r \in (0,1)$ and $s > 0$. The inequality holds as entry is only profitable if:

$$f_{m,E} - R^*_{c,E}(R^M_{c,I}) = \frac{1}{2}\left(\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c)\right) - \frac{M_{m,E} + C_m}{n_{c,E}} \geq 0$$

$$\implies \alpha_m + \alpha_c + (1-r)(\alpha_c - C_c) > 0$$

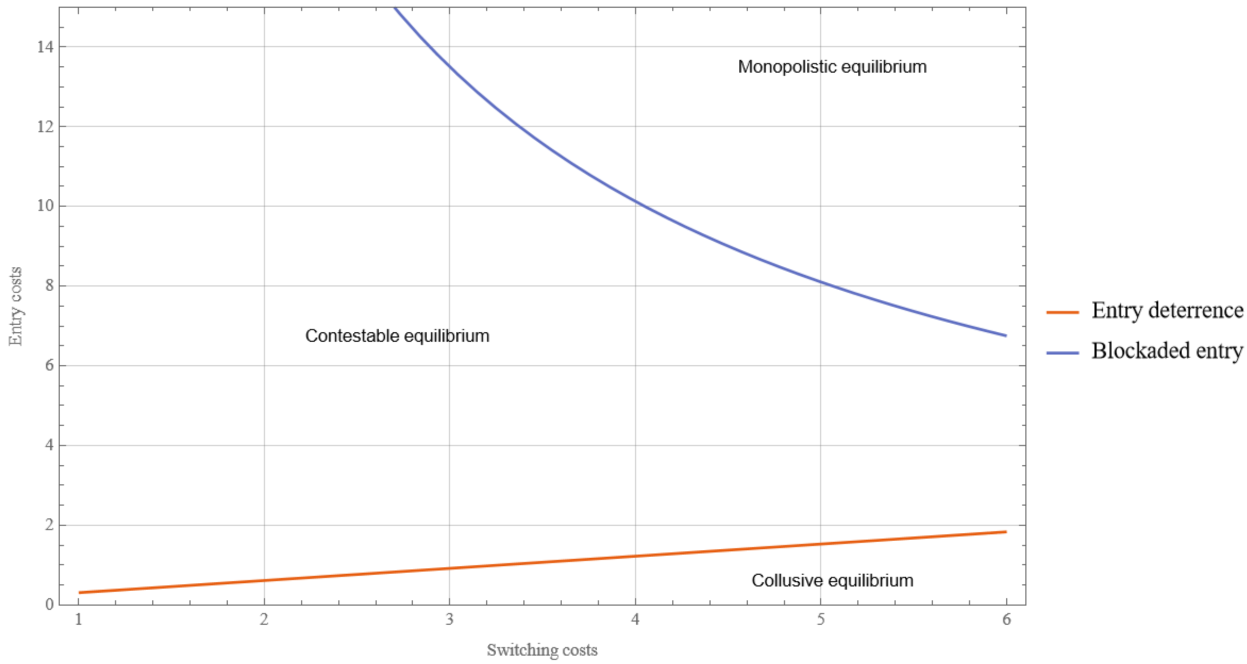


Figure 7: The entry costs thresholds C_E for which the incumbent card network chooses different strategies as a function of the switching costs s. The figure is set for $\alpha_c = \alpha_m = 6$ and $r = C_c = M_{m,k} = C_m = 0$.

Third, as shown in figure 7, the payment card market sees less deterrence with switching costs $s > 0$. The threshold for which entry is blockaded decreases with switching costs, while the threshold for which entry is deterred increases with switching costs. The difference between the two thresholds decreases with switching costs. To prove this, we take the derivative of equation (31) with respect to s:

$$\frac{\partial(C^B_E - C^D_E)}{\partial s} = -\frac{(\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c))^2}{(1-r)8s^2} - \frac{625(1-r)}{2048} < 0$$

Proposition 4 *Suppose an incumbent card network I sets rebates before an entrant E and* *the entrant faces entry costs C_E and switching costs s are below the threshold given by equation (15):*

- *Entry is **more** deterred but the market is **less** monopolistic with higher transaction benefits of consumers α_c and merchants α_m.*
- *Entry is **more** deterred but the market is **less** monopolistic with higher rebates pass-through r.*
- *Entry is **less** deterred but the market is **more** monopolistic with higher switching costs s.*

Proof. For the proof see the preceding text. ■

V. Discussion

A. Domestic leader

This paper assumes that the domestic card network responds to the international card network. Suppose that it were the other way around and the domestic card network sets rebates before the international card network. In this case the international card network can never set the monopolistic rebate as it would first need to displace the domestic card network. The entry accommodation profit of the international card network increases due to the second-mover advantage, while the entry deterrence profits remain the same. It follows that entry becomes less deterred and more accommodated. Thus, it is harder for an international card network to displace an existing card network than to deter entry of a new one.

This paper also assumes that the domestic card network offers the same quality as the international card network. Consumers and merchants do not derive intrinsic utility from choosing a particular card network, as long as they can make and receive payments. Some may argue that an international card network could have wider cross-border acceptance or the domestic card network could offer a niche product that does not require universal merchant acceptance. In our model, this would result in a higher (lower) transaction benefit for consumers on the international (domestic) card network. As long as this difference is not too big, the results still hold. For larger differences, the entry deterrence threshold falls (rises) and it becomes easier (harder) for the international (domestic) card network to displace the other network.

B. Homogeneous end-users

While the existing literature focuses on demand-side heterogeneity (varying consumer preferences), we introduce supply-side heterogeneity based on the banks' idiosyncratic costs of servicing different consumer segments. We model a payment card market where banks decide on the type of payment card issued with a payment account and consumers in general do not care what type of payment card they receive with their payment account. Oftentimes, a consumer just receives a payment card as part of its banking services. Therefore, four-party card networks have only limited means to set prices to end-users – as they sign contracts with banks.

The drawback of this assumption is that it does not allow us to analyze price distortions. In reality, heterogeneity of preferences determine elasticities of demand. If consumers exhibit greater heterogeneity in their preferences for payment methods than merchants do, then consumer demand will tend to be more responsive to price changes. As a result, the card network may set a rebate that exceeds the socially optimal level (Wang, 2025; Wright, 2004). On the merchant side, it is easier to price discriminate between different types of venues (Ho et al., 2022). This allows acquiring banks to take merchant surplus – essentially leading to a similar result as when merchants are homogeneous. In the limiting case where consumers are heterogeneous but merchants are homogeneous, the network selects the maximum rebate consistent with merchants' continued acceptance of card payments (Rochet and Tirole, 2002). Our model leads to similar results as one with heterogeneous consumer preferences and homogeneous merchant preferences, because only the consumer side is responsive to price changes.

A model with double-sided heterogeneity would likely also result in entry deterrence if transaction benefits increase above a certain threshold. Belleflamme and Peitz (2018, 2019) show in a platform competition model where users are differentiated in a Hotelling fashion that there is no unique equilibrium if transaction benefits are higher than the switching costs parameter (as assumed in our paper). The market would "tip" to a single platform – which could be either of the two card networks. White and Weyl (2016) show that a unique market-sharing equilibrium also exists with heterogeneous users as long as card networks set insulated tariffs and the joint distribution of benefits satisfy concavity assumptions. We leave this for future research.

C. Static model

As stated by Jullien, Pavan, et al. (2021), "almost all contributions on the dynamics of competition focus on one-side network effects". In case of a two-sided market context, such "coordination" on expectations of network size takes place between the two sides of the market. This could potentially lead to different results than in a market with a one-sided network good.

Suppose that the game in this paper would be repeated multiple times and every period an entrant could enter. Since a SPNE requires that the strategies constitute a Nash equilibrium in every possible subgame of the overall game, it follows easily that the equilibrium results still hold. In this case, we implicitly assume that card networks can determine their market share by setting rebates independently of consumer expectations.

The matter would be different if we would allow for different expectations of network size. Suppose that quality is determined by the size of the network at a certain time. As first demonstrated by Katz and Shapiro (1985), users' expectations about the network size of each platform determine the market structure. The concept is straightforward: if users expect a single network to be large, they are more likely to join it, resulting in a monopoly. Conversely, if users expect two networks to be large, they might join either, leading to a duopoly. Accordingly, it has been well documented that in the presence of network effects, firms with a large installed base benefit from a "competitive hedge" that may prevent entry, see Farrell and Klemperer (2007) for an overview.

However, Biglaiser and Crémer (2020) and Halaburda et al. (2020) show that while this "incumbency advantage" creates barriers to entry, potential entry still puts constraints on the strategy of incumbents. If there are no switching costs, there is no reason for users of the incumbent platform to use a new entrant if the entrant offers a better quality. The dynamics of competition in a two-sided market appears to be an under-researched area. We aim to contribute to this literature in later papers.

D. Consumer singlehoming

Our model does not allow for consumer "multihoming", while an extended model as in Wang (2025) allows for some consumers to multihome and use several payment alternatives. If consumers were to use several payment methods, card networks no longer have a monopoly over providing access to this group of consumers via payment services to merchants. Our results would likely show lower consumer rebates, as cross-subsidization may be reduced or even disappears when both sides of the card network multihome (Bakos and Halaburda, 2019). Guthrie and Wright (2007) show that multiple equilibria are possible, depending on how consumers and merchants settle on a particular payment method, but interchange fees (or rebates) are always in between two polar cases (full consumer singlehoming and full consumer multihoming). Suppose all consumers want both cards. In this case, it is easy to see that there is no longer competition for issuers and both card networks set the rebate at a monopolistic level. In this case the "must-take cards" assumption likely does not hold (Rochet and Tirole, 2011).[17] When consumers multihome, card networks have less

[17]According to Rochet and Tirole (2011) proposition 6, the interchange fee passes the tourist test if all consumers are multihoming and issuers pass-through cost (which we assume). The interchange fee passes

market power over merchants, because merchants could "steer" consumers towards their preferred payment method by singlehoming on the cheaper payment method (Rochet and Tirole, 2003). Indeed, if consumers were to "multihome", the merchant fee would be lower, rebates would be smaller, and it would be harder to deter entry.

Yet, even if consumers carry multiple cards, our assumption of "singlehoming" consumers may be justified by the fact that consumers often have a preferred payment method (see, for example, Bagnall et al. (2016), Rysman (2007), and van der Cruijsen and van der Horst (2016)). As shown in Wang (2025), even if consumers are "multihoming" in payment instruments, merchants would lose too much business by turning down alternatives. Consumer loyalty towards a preferred card has a similar effect as "singlehoming" (Teh et al., 2023). In this case each card network still has market power over merchants. In this sense, our model should be interpreted as a setting where issuing banks issue only one card to each client (which is the preferred method of payment) and choose which card. For example, when a consumer receives a debit card as part of its payment account.

VI. Conclusion and policy implications

This paper shows that rebates may be contestable or collusive rather than monopolistic or duopolistic by nature. If there is a competitor with low entry costs, card networks collude on a lower rebate as they know that the competing card network will do the same. If there is a competitor with higher entry costs, card networks will deter entry with larger rebates, and make entry unprofitable. Entry deterrence is easier in a two-sided market than in a normal (one-sided) market. The difference compared with a normal one-sided market is that in a two-sided market, the incumbent can change the price structure between the two sides of the market. In the case of a competitive bottleneck, where consumers singlehome and merchants multihome, card networks compete for consumers and there is no competition for merchants. Thus, a price increase to the merchant (via the acquirers) by the incumbent is irrelevant to

the tourist test "if accepting the card does not increase the retailer's net operating cost", i.e. $p_m < \alpha_m$.

the entrants' profits. Entrance to the payment market becomes more deterred by transaction benefits of both consumers and merchants. This effect increases with rebates pass-through but decreases with issuing bank switching costs. A monopolistic outcome arises only with low rebate pass-through, lower transaction benefits and higher issuing bank switching costs.

The paper also showed that entry deterrence leads to higher merchant fees. In normal markets, the effect of entry deterrence is often ambiguous, because in order to deter entry, the incumbent needs to set capacities higher and/or prices lower to make entry unprofitable. The threat of entry could thus bring the market closer to an efficient equilibrium. Strictly speaking, in a normal market a contestable equilibrium is more competitive and therefore welfare improving. However, the opposite may be true in a two-sided market. In payments, the incumbent can increase the price for acquiring banks without affecting the entrant's profit. Thus, *ceteris paribus* entry deterrence is more likely to have detrimental welfare effects. We leave it to future work to analyze the effect of entry deterrence on price distortions.

This paper has important implications for payment regulation, with gaps identified for further analysis. We show that rebates (including the interchange fee and incentive payments) could be used to alter the market structure. This should be taken into account when designing regulations that seek to optimize the IF and/or incentive payments. Banks' switching costs and the rate at which issuing banks pass-through rebates to consumers are important in determining the market structure. Innovative payment methods may be unable to enter the market as card networks likely use rebates to make entry unprofitable. It is thus a profitable strategy to use rebates to create lock-in effects (increase switching costs) by, for example, increasing rebate levels with increasing transaction volume. Whether incentive payments should be regulated to protect merchants against rising fees and support innovation in payment markets is an open question. A richer model would allow for a distinction between interchange fees and incentive payments by allowing incentive payments in order to create switching costs. In this case an incumbent card network would likely be able to sustain a higher profit margin than with flat incentive payments that do not increase switching costs, as we have shown that switching costs make the market more monopolistic by effectively blocking new entrants from the card payment network. We leave this as an interesting avenue for future research.

References

Anderson, W. T., Iii, E. P. C., & Fulcher, D. G. (1976). Bank Selection Decisions and Market Segmentation. *Journal of Marketing*, *40*(1), 40. https://doi.org/10.2307/1250674

Bagnall, J., Bounie, D., Huynh, K. P., Kosse, A., Schmidt, T., Schuh, S., & Stix, H. (2016). Consumer Cash Usage: A Cross-Country Comparison with Payment Diary Survey Data. *International Journal of Central Banking*, *12*(4). https://doi.org/10.2139/ssrn.2436365

Bakos, Y., & Halaburda, H. (2019). Platform Competition with Multi-homing on Both Sides: Subsidize or Not? *Management Science*, *66*(12), 5599–5607. https://doi.org/10.2139/ssrn.3468457

Bedre-Defolie, O., & Calvano, E. (2013). Pricing Payment Cards. *American Economic Journal: Microeconomics*, *5*(3), 206–231. https://doi.org/10.1257/mic.5.3.206

Belleflamme, P., & Peitz, M. (2018). Platforms and network effects. In *Handbook of Game Theory and Industrial Organization, Volume II* (pp. 286–317). Edward Elgar Publishing.

Belleflamme, P., & Peitz, M. (2019). Platform competition: Who benefits from multihoming? *International Journal of Industrial Organization*, *64*, 1–26. https://doi.org/10.1016/j.ijindorg.2018.03.014

Biglaiser, G., & Crémer, J. (2020). The Value of Incumbency When Platforms Face Heterogeneous Customers. *American Economic Journal: Microeconomics*, *12*(4), 229–269. https://doi.org/10.1257/mic.20180225

Bolt, W., Jonker, N., & van Renselaar, C. (2010). Incentives at the counter: An empirical analysis of surcharging card payments and payment behaviour in the Netherlands. *Journal of Banking & Finance*, *34*(8), 1738–1744. https://doi.org/10.1016/j.jbankfin.2009.09.008

Buccella, D., & Fanti, L. (2016). The effect of network externalities on entry in a Spence-Dixit model.

Caillaud, B., & Jullien, B. (2001). Competing cybermediaries. *European Economic Review*, *45*(4-6), 797–808. https://doi.org/10.1016/S0014-2921(01)00123-4

Caillaud, B., & Jullien, B. (2003). Chicken & Egg: Competition among Intermediation Service Providers. *The RAND Journal of Economics*, *34*(2), 309–328. https://doi.org/10.2307/1593720

Chakravorti, S., & Roson, R. (2004). Platform Competition in Two-Sided Markets: The Case of Payment Networks. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.564564

Devlin, J., & Gerrard, P. (2005). A study of customer choice criteria for multiple bank users. *Journal of Retailing and Consumer Services*, *12*(4), 297–306. https://doi.org/10.1016/j.jretconser.2004.10.004

Dick, A. A. (2008). Demand estimation and consumer welfare in the banking industry. *Journal of Banking & Finance*, *32*(8), 1661–1676. https://doi.org/10.1016/j.jbankfin.2007.12.005

Farrell, J., & Klemperer, P. (2007). Chapter 31 Coordination and Lock-In: Competition with Switching Costs and Network Effects. In *Handbook of Industrial Organization* (pp. 1967–2072). Elsevier. https://doi.org/10.1016/S1573-448X(06)03031-7

Frost, J., Rochet, J.-C., Shin, H. S., & Verdier, M. (2025). Competing digital monies. *Toulouse School of Economics Working Papers*, *n. 25-164*.

Fudenberg, D., & Tirole, J. (1984). The Fat-Cat Effect, the Puppy-Dog Ploy, and the Lean and Hungry Look. *The American Economic Review*, *74*(2), 361–366.

Gans, J. S., & King, S. P. (2001). The Neutrality of Interchange Fees in Payment Systems. *Topics in Economic Analysis and Policy*, *3*(1), 1069–1069. https://doi.org/10.2139/ssrn.276228

Guthrie, G., & Wright, J. (2007). Competing Payment Schemes. *The Journal of Industrial Economics*, *55*(1), 37–67. https://doi.org/10.1111/j.1467-6451.2007.00302.x

Halaburda, H., Jullien, B., & Yehezkel, Y. (2020). Dynamic competition with network externalities: How history matters. *The RAND Journal of Economics*, *51*(1), 3–31.

Ho, C.-Y., Xu, L., & Zhang, D. (2022). Price Negotiation with Merchant Heterogeneity in the Payment Card Industry. *The Review of Economics and Statistics*, *104*(6), 1191–1205. https://doi.org/10.1162/rest_a_00986

Jullien, B., Pavan, A., & Rysman, M. (2021). Two-sided markets, pricing, and network effects. In K. Ho, A. Hortaçsu, & A. Lizzeri (Eds.), *Handbook of Industrial Organization* (pp. 485–592). Elsevier. https://doi.org/10.1016/bs.hesind.2021.11.007

Jullien, B., & Sand-Zantman, W. (2021). The Economics of Platforms: A Theory Guide for Competition Policy. *Information Economics and Policy*, *54*, 100880. https://doi.org/10.1016/j.infoecopol.2020.100880

Katz, M. L., & Shapiro, C. (1985). Network Externalities, Competition, and Compatibility. *The American Economic Review*, *75*(3), 424–440.

Ricci, O., & Caratelli, M. (2014). Consumer choice in retail banking: Are prices really relevant? *Journal of Strategic Marketing*, *22*(3), 240–256. https://doi.org/10.1080/0965254X.2013.876071

Rochet, J.-C., & Tirole, J. (2002). Cooperation among Competitors: Some Economics of Payment Card Associations. *The RAND Journal of Economics*, *33*(4), 549. https://doi.org/10.2307/3087474

Rochet, J.-C., & Tirole, J. (2003). Platform Competition in Two-Sided Markets. *Journal of the European Economic Association*, *1*(4), 990–1029. https://doi.org/10.1162/154247603322493212

Rochet, J.-C., & Tirole, J. (2011). Must-take Cards: Merchant Discounts and Avoided Costs. *Journal of the European Economic Association*, *9*(3), 462–495. https://doi.org/10.1111/j.1542-4774.2011.01020.x

Rysman, M. (2007). An Empirical Analysis of Payment Card Usage. *The Journal of Industrial Economics*, *55*(1), 1–36. https://doi.org/10.1111/j.1467-6451.2007.00301.x

Rysman, M., & Wright, J. (2015). The Economics of Payment Cards. *Review of Network Economics*, *13*(3), 303–353. https://doi.org/10.1515/rne-2015-0005

Schwartz, M., & Vincent, D. R. (2006). The No Surcharge Rule and Card User Rebates: Vertical Control by a Payment Network. *Review of Network Economics*, *5*(1). https://doi.org/10.2202/1446-9022.1090

Schwartz, M., & Vincent, D. R. (2020). Platform Competition With Cash-Back Rebates Under No Surcharge Rules. *The Journal of Industrial Economics*, *68*(2), 298–327. https://doi.org/10.1111/joie.12210

Teh, T.-H., Liu, C., Wright, J., & Zhou, J. (2023). Multihoming and Oligopolistic Platform Competition. *American Economic Journal: Microeconomics*, *15*(4), 68–113. https://doi.org/10.1257/mic.20210324

van der Cruijsen, C., & van der Horst, F. (2016). Payment Behaviour: The Role of Socio-Psychological Factors. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2867462

Verdier, M. (2011). Interchange Fees in Payment Card Systems: A Survey of the Literature. *Journal of Economic Surveys*, *25*(2), 273–297. https://doi.org/10.1111/j.1467-6419.2009.00607.x

Wang, L. (2025). Regulating Competing Payment Networks. https://doi.org/10.2139/ssrn.5262161

White, A., & Weyl, E. G. (2016). Insulated Platform Competition. https://doi.org/10.2139/ssrn.1694317

Worldpay. (2024). The Global Payments Report 2024.

Wright, J. (2004). The Determinants of Optimal Interchange Fees in Payment Systems. *The Journal of Industrial Economics*, *52*(1), 1–26.

A. Appendix

A. *Proof of Proposition 1*

Proof. Suppose that card network E does not enter and I can set a monopolistic rebate. Note that the profit of card network I is given by:

$$\Pi_I = (f_{m,I} - R_{c,I})n_{c,I}n_{m,I} - C_I$$

where $f_{m,I} = \alpha_c + \alpha_m + rR_{c,I} - \frac{M_{m,I}+C_m}{n_{c,I}}$ as given by equation (11), $n_{m,I} = 1$ as given by equation (6), $n_{c,I} = \frac{\alpha_c - C_c + R_{c,I}}{s}$ as given by equation (13). Note that demand is maximized if $n_{c,I} = 1$, which holds if $R_{c,I} \geq s - \alpha_c + C_c$. The FOC for card network I, with respect to $R_{c,I}$ is given by:

$$\frac{\partial \Pi_I}{\partial R_{c,I}} = \frac{\alpha_c + \alpha_m - (1-r)2R_{c,I} - (1-r)(\alpha_c - C_c)}{s} = 0$$
$$\implies \frac{\alpha_m + r\alpha_c + (1-r)C_c}{2(1-r)} = R_{c,I} < s - \alpha_c + C_c$$

If we solve this last inequality, it follows that the inequality holds (and there is an interior solution without a covered market) if and only if

$$s > \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2} \tag{32}$$

where $r \in (0, 1)$. In this case, the switching costs parameter s to issue a card is too high for some clients. If s is lower than the threshold given by equation (32), then there is a covered market in a monopolistic setting. A monopolist then sets the rebate at the minimum level at which all issuers still issue cards.

In total we have the following monopolistic rebate:

$$R^M_{c,I} = \begin{cases} \dfrac{\alpha_m + r\alpha_c}{2(1-r)} + \dfrac{C_c}{2} & \text{if } s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}, \\ s - \alpha_c + C_c & \text{if } s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}. \end{cases}$$

This is the rebate stated in equation (16).

Given the profit function given by equation (9), the merchant fee as given by equation (11), merchant demand $n_{m,k} = 1$ as given by equation (6) and consumer demand given by equation (14), the FOC for card network k, with respect to $R_{c,k}$ is given by:

$$\frac{\partial \Pi_k}{\partial R_{c,k}} = \frac{\alpha_c + \alpha_m - (2R_{c,k} - R_{c,l} + s)(1-r)}{2s} = 0, k \neq l,$$
$$\implies \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{R_{c,l} - s}{2} = R_{c,k}.$$

We have the entrant's best response function as given by equation (17) and we fill in $R_{c,I}^M$ to get the level of rebates that the entrant would set if it were to enter:

$$R_{c,E}^M = \begin{cases} \dfrac{3(\alpha_c + \alpha_m)}{4(1-r)} + \dfrac{C_c - \alpha_c - 2s}{4} & \text{if } s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}, \\ \dfrac{\alpha_m + r\alpha_c}{2(1-r)} + \dfrac{C_c}{2} & \text{if } s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}. \end{cases} \tag{33}$$

The number of consumers that the entrant can attract is given by equation (14) and we fill in $R_{c,I}^M$ and $R_{c,E}^M$ as given above:

$$n_{c,E}^B = \begin{cases} \dfrac{\alpha_m + \alpha_c(2-r)}{8s(1-r)} - \dfrac{C_c - 2s}{8s} & \text{if } s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}, \\ \dfrac{\alpha_m + \alpha_c(2-r)}{4s(1-r)} - \dfrac{C_c}{4s} & \text{if } s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}. \end{cases} \tag{34}$$

First suppose there is a covered market, i.e. $s \leq \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c - C_c}{2}$:

$$\begin{aligned} f_{m,E} - R_{c,E}^M &= \alpha_c + \alpha_m + (r-1)\left(\frac{\alpha_m + r\alpha_c}{2(1-r)} + \frac{C_c}{2}\right) - \frac{M_{m,E} + C_m}{n_{c,E}^B} \\ &= \frac{1}{2}\left(\alpha_m + (2-r)\alpha_c - (1-r)C_c\right) - \frac{M_{m,E} + C_m}{n_{c,E}^B} \end{aligned} \tag{35}$$

where $n_{c,E}^B$ is given by equation (34). Entry is blockaded if the entrant cannot make a profit, which is the case if:

$$\begin{aligned} C_E^B &= \left(\frac{1}{2}\left(\alpha_m + (2-r)\alpha_c - (1-r)C_c\right)\right) n_{c,E}^B - M_{m,E} - C_m \\ &= \left(\frac{1}{2}\left(\alpha_m + (2-r)\alpha_c - (1-r)C_c\right)\right) \\ &\qquad \left(\frac{\alpha_m + (2-r)\alpha_c}{4s(1-r)} - \frac{C_c}{4s}\right) - M_{m,E} - C_m \\ &= \frac{(\alpha_m + \alpha_c + (1-r)(\alpha_c - C_c))^2}{(1-r)8s} - M_{m,E} - C_m \end{aligned} \tag{36}$$

Second suppose there is **not** a covered market, i.e. $s > \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{\alpha_c-C_c}{2}$:

$$\begin{aligned} f_{m,E} - R^M_{c,E} &= \alpha_c + \alpha_m + (r-1)\left(\frac{3(\alpha_c+\alpha_m)}{4(1-r)} + \frac{C_c-\alpha_c-2s}{4}\right) - \frac{M_{m,E}+C_m}{n^B_{c,E}} \\ &= \frac{1}{4}\left(\alpha_m + (2-r)\alpha_c - (1-r)(C_c-2s)\right) - \frac{M_{m,E}+C_m}{n^B_{c,E}} \end{aligned} \tag{37}$$

where $n^B_{c,E}$ is given by equation (34). Entry is blockaded if the entrant cannot make a profit, which is the case if:

$$\begin{aligned} C^B_E &= \left(\frac{1}{4}\left(\alpha_m + (2-r)\alpha_c - (1-r)(C_c-2s)\right)\right) n^B_{c,E} - M_{m,E} - C_m \\ &= \left(\frac{1}{4}\left(\alpha_m + (2-r)\alpha_c - (1-r)(C_c-2s)\right)\right) \\ &\qquad \left(\frac{\alpha_m+\alpha_c(2-r)}{8s(1-r)} - \frac{C_c-2s}{8s}\right) - M_{m,E} - C_m \\ &= \frac{(\alpha_m+\alpha_c+(1-r)(\alpha_c-C_c+2s))^2}{(1-r)32s} - M_{m,E} - C_m \end{aligned} \tag{38}$$

Now we have proven the first bullet.

To prove the second bullet for a covered market, we take the derivative of equation (36) with respect to α_c and α_m and note that these have a clear relationship with equation (34):

$$\begin{aligned} \frac{\partial C^B_E}{\partial \alpha_c} &= \frac{(\alpha_m + (2-r)\alpha_c - (1-r)C_c)(2-r)}{(1-r)4s} = (2-r)n^B_{c,E} \\ \frac{\partial C^B_E}{\partial \alpha_m} &= \frac{\alpha_m + (2-r)\alpha_c - (1-r)C_c}{(1-r)4s} = n^B_{c,E} \end{aligned}$$

Note that $r \in (0,1)$ and $n^B_{c,E} \geq 0$.

To prove the second bullet when there is not a covered market, we take the derivative of equation (38) with respect to α_c and α_m and note that these have a clear relationship with equation (34):

$$\begin{aligned} \frac{\partial C^B_E}{\partial \alpha_c} &= \frac{(\alpha_m + (2-r)\alpha_c - (1-r)(C_c-2s))(2-r)}{(1-r)16s} = \frac{1}{2}(2-r)n^B_{c,E} \\ \frac{\partial C^B_E}{\partial \alpha_m} &= \frac{\alpha_m + (2-r)\alpha_c - (1-r)(C_c-2s)}{(1-r)16s} = \frac{1}{2}n^B_{c,E} \end{aligned}$$

Note that $r \in (0,1)$ and $n^B_{c,E} \geq 0$.

To prove the third bullet, we take the derivative of equation (36) with respect to s and

r:

$$\frac{\partial C_E^B}{\partial s} = -\frac{(\alpha_m + (2-r)\alpha_c - (1-r)C_c)^2}{(1-r)8s^2} < 0$$
$$\frac{\partial C_E^B}{\partial r} = \frac{(\alpha_m + (2-r)\alpha_c - (1-r)C_c)(\alpha_m + r\alpha_c + (1-r)C_c)}{(1-r)^2 8s} > 0$$

Note that $r \in (0,1)$ and $s > 0$. The last inequality holds as entry is only profitable if:

$$f_{m,E} - R_{c,E}^M = \frac{1}{2}(\alpha_m + (2-r)\alpha_c - (1-r)C_c) - \frac{M_{m,E} + C_m}{n_{c,E}} \geq 0$$
$$\implies \alpha_m + (2-r)\alpha_c - (1-r)C_c > 0$$

Q.E.D. ■

B. *Proof of Proposition 2*

Proof. Note that the profit of card network I is given by:

$$\Pi_I = (f_{m,I} - R_{c,I})n_{c,I}n_{m,I} - C_I$$

where $f_{m,I} = \alpha_c + \alpha_m + rR_{c,I} - \frac{M_{m,I}+C_m}{n_{c,I}}$ as given by equation (11), $n_{m,I} = 1$ as given by equation (6), $n_{c,I} = \frac{1}{2} + \frac{R_{c,E}-R_{c,I}}{2s}$ as given by equation (14) and $R_{c,E} = \frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{R_{c,I}-s}{2}$ as given by equation (17). The FOC for card network I, with respect to $R_{c,I}$ is given by:

$$\frac{\partial \Pi_I}{\partial R_{c,I}} = \frac{2\alpha_c + 2\alpha_m + (2R_{c,I} + 3s)(r-1)}{4s} = 0$$
$$\implies \frac{\alpha_m + \alpha_c}{(1-r)} - \frac{3s}{2} = R_{c,I}$$

We have the entry accommodation rebate stated in equation (21). Now the entrant's rebate follows from filling in equation (21) into equation (17):

$$R_{c,E}^* = \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{(\frac{\alpha_m+\alpha_c}{(1-r)} - \frac{3s}{2}) - s}{2}$$
$$\implies R_{c,E}^A = \frac{\alpha_m + \alpha_c}{(1-r)} - \frac{5s}{4}.$$

The first bullet follows as

$$R^A_{c,E} - R^A_{c,I} = \frac{\alpha_m + \alpha_c}{(1-r)} - \frac{5s}{4} - \frac{\alpha_m - \alpha_c}{(1-r)} + \frac{3s}{2} = \frac{s}{4} > 0, \tag{39}$$

where $s > 0$.

In a duopolistic equilibrium, the incumbent does not integrate the best response function of the entrant, but instead its best response is derived in the same way as the FOC of the entrant above in equation (17). The FOC for card network I, with respect to $R_{c,I}$ is given by:

$$\frac{\partial \Pi_I}{\partial R_{c,I}} = \frac{\alpha_c + \alpha_m - (2R_{c,I} - R_{c,E} + s)(1-r)}{2s} = 0$$
$$\implies \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{R_{c,E} - s}{2} = R_{c,I}$$

Now when we solve these two best response functions we get the rebate as given by equation (19):

$$R^S_{c,k} = \frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{\left(\frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{R_{c,k}-s}{2}\right) - s}{2}$$
$$\implies R^S_{c,k} = \frac{\alpha_m + \alpha_c}{(1-r)} - s.$$

We fill in this level of rebates in the demand and profit function. The number of consumers with the incumbent and entrant in the duopolistic equilibrium is given by equation (14) and we fill in the rebates given by equation (19):

$$n^S_{c,k} = \frac{1}{2} + \frac{\frac{\alpha_m+\alpha_c}{(1-r)} - s - \frac{\alpha_m+\alpha_c}{(1-r)} + s}{2s} = \frac{1}{2}. \tag{40}$$

If we fill in the number of consumers that join each card network given by equation (40) and the rebates given by equation (19), we obtain the closed form solution of the profit of each card network in the duopolistic equilibrium:

$$\begin{aligned}\Pi^S_k &= \left(f_{m,k} - R^S_{c,k}\right) n^S_{c,k} - C_k \\ &= (\alpha_c + \alpha_m - (1-r)R^S_{c,k})n^S_{c,k} - M_{m,k} - C_m - C_k \\ &= \left(\alpha_c + \alpha_m - (1-r)\left(\frac{\alpha_m + \alpha_c}{(1-r)} - s\right)\right)\frac{1}{2} - M_{m,k} - C_m - C_k \\ &= \frac{(1-r)s}{2} - M_{m,k} - C_m - C_k. \end{aligned} \tag{41}$$

To show that profits are higher for the incumbent in the collusive equilibrium compared to the duopolistic equilibrium, we solve the profits in the collusive equilibrium. The number of consumers with the incumbent in the collusive equilibrium is given by equation (14) and we fill in the rebates in the entry accommodation given by equation (21) and equation (22):

$$n_{c,I}^{A} = \frac{1}{2} + \frac{\frac{\alpha_m+\alpha_c}{(1-r)} - \frac{3s}{2} - \frac{\alpha_m+\alpha_c}{(1-r)} + \frac{5s}{4}}{2s} = \frac{3}{8} \tag{42}$$

If we fill in the number of consumers that join the incumbent given by equation (42) and the incumbent's entry accommodation rebate given by equation (21) we obtain the closed form solution of the incumbent's profit in the collusive equilibrium:

$$\begin{aligned}
\Pi_I^A &= (f_{m,I} - R_{c,I}^A)n_{c,I}^A - C_I \\
&= (\alpha_c + \alpha_m - (1-r)R_{c,I}^A)n_{c,I}^A - M_{m,I} - C_m - C_I \\
&= \left(\alpha_c + \alpha_m - (1-r)\left(\frac{\alpha_m + \alpha_c}{(1-r)} - \frac{3s}{2}\right)\right)\frac{3}{8} - M_{m,I} - C_m - C_I \\
&= \frac{(1-r)9s}{16} - M_{m,I} - C_m - C_I
\end{aligned} \tag{43}$$

To prove equation (23), we deduct the profit obtained in the duopolistic equilibrium in equation (41) from that obtained in the collusive equilibrium in equation (43):

$$\Pi_I^A - \Pi_I^S = \frac{(1-r)s}{16} > 0.$$

Let $\alpha_t = \alpha_c + \alpha_m$. The second bullet follows because:

$$= \frac{\partial R_{c,I}^A}{\partial \alpha_t} = \frac{\partial R_{c,E}^A}{\partial \alpha_t} = \frac{1}{1-r} > 1, \tag{44}$$

where $r \in (0,1)$.

A second-mover advantage means that the entrant's profit is higher than the incumbent's profits given equal cost. We first derive the entrant's profit. The number of consumers with the entrant in the collusive equilibrium is given by equation (14) and we fill in equation (21) and equation (22):

$$n_{c,E}^{A} = \frac{1}{2} + \frac{\frac{\alpha_m+\alpha_c}{(1-r)} - \frac{5s}{4} - \frac{\alpha_m+\alpha_c}{(1-r)} + \frac{3s}{2}}{2s} = \frac{5}{8} \tag{45}$$

If we fill in the number of consumers that join the entrant given by equation (45) and the entrant's entry accommodation rebate given by equation (22) we obtain the closed form solution of the entrant's profit in the collusive equilibrium:

$$\begin{aligned}
\Pi_E^A &= (f_{m,E} - R_{c,E}^A) n_{c,E}^A - C_E \\
&= (\alpha_c + \alpha_m - (1-r) R_{c,E}^A) n_{c,E}^A - M_{m,E} - C_m - C_E \\
&= \left(\alpha_c + \alpha_m - (1-r) \left(\frac{\alpha_m + \alpha_c}{(1-r)} - \frac{5s}{4} \right) \right) \frac{5}{8} - M_{m,E} - C_m - C_E \\
&= \frac{(1-r)25s}{32} - M_{m,E} - C_m - C_E \qquad (46)
\end{aligned}$$

Let $C_E = C_I$. The entrant's second-mover advantage is proven as we deduct the incumbent's profit given by equation (43) from the entrant's profit given by equation (46):

$$\Pi_E^A - \Pi_I^A = \frac{(1-r)7s}{32} > 0.$$

We take the derivatives with respect to s and r:

$$\begin{aligned}
\frac{\partial(\Pi_E^A - \Pi_I^A)}{\partial s} &= \frac{(1-r)7}{32} > 0 \\
\frac{\partial(\Pi_E^A - \Pi_I^A)}{\partial r} &= \frac{-7s}{32} < 0
\end{aligned}$$

where $s > 0$ and $r \in (0,1)$. Q.E.D.

■

C. *Proof of Proposition 3*

Proof. The consumer market share of the entrant is given by equation (14) and we fill in $R_{c,E}^*(R_{c,I})$ given by equation (17) to solve the number of consumers that will join the entrant:

$$\begin{aligned}
n_{c,E}^D &= \frac{1}{2} + \frac{\frac{\alpha_c + \alpha_m}{2(1-r)} + \frac{R_{c,I} - s}{2} - R_{c,I}}{2s} \\
&= \frac{1}{2} + \frac{\alpha_c + \alpha_m - (1-r)(R_{c,I} + s)}{4s(1-r)} \qquad (47)
\end{aligned}$$

The entrant's profit is given by equation (9) where the entrant's acquiring transaction fee $f_{m,E}$ is given by equation (11), $n_{m,E} = 1$ and $n_{c,E}$ is given by equation (47):

$$
\begin{aligned}
\Pi_E^D &= (\alpha_c + \alpha_m - (1-r)R^*_{c,E}(R_{c,I}))n^D_{c,E} - M_{m,E} - C_m - C_E \\
&= \left(\alpha_c + \alpha_m - (1-r)\left(\frac{\alpha_c+\alpha_m}{2(1-r)} + \frac{R_{c,I}-s}{2}\right)\right) n^D_{c,E} - M_{m,E} - C_m - C_E \\
&= (\alpha_c + \alpha_m - (1-r)(R_{c,I}-s)) \frac{n^D_{c,E}}{2} - M_{m,E} - C_m - C_E \\
&= (\alpha_c + \alpha_m - (1-r)(R_{c,I}-s)) \left(\frac{1}{4} + \frac{\alpha_c + \alpha_m - (1-r)(R_{c,I}+s)}{8s(1-r)}\right) - M_{m,E} - C_m - C_E \\
&= \frac{(\alpha_c + \alpha_m - (R_{c,I}-s)(1-r))^2}{8s(1-r)} - M_{m,E} - C_m - C_E
\end{aligned}
$$

This proves equation (26). Subsequently we solve for $R_{c,I}$:

$$
\begin{aligned}
&\frac{(\alpha_c + \alpha_m - (R_{c,I}-s)(1-r))^2}{8s(1-r)} \leq M_{m,E} + C_m + C_E \\
\implies &\begin{cases} R_{c,I} \geq \dfrac{\alpha_c+\alpha_m}{1-r} + s - \sqrt{\dfrac{(M_{m,E}+C_m+C_E)8s}{1-r}} & \text{Option 1} \\ R_{c,I} \geq \dfrac{\alpha_c+\alpha_m}{1-r} + s + \sqrt{\dfrac{(M_{m,E}+C_m+C_E)8s}{1-r}} & \text{Option 2} \end{cases}
\end{aligned}
$$

Option 2 implies that the required deterrence rebate increases in entry costs, contradicting the entrant's zero-profit condition. We have proven equation (27).

The incumbent's profit in the contestable equilibrium is solved by filling in equation (9) where the incumbent's acquiring transaction fee $f_{m,I}$ is given by equation (11) and $n_{m,I} = n_{c,I} = 1$:

$$
\Pi_I^D = \alpha_c + \alpha_m - (1-r)R^D_{c,I} - M_{m,I} - C_m - C_I \tag{48}
$$

The incumbent's profit in the collusive equilibrium is given by equation (43) in section B.

If we solve for $R_{c,I}$ under which entry deterrence is profitable in the entry deterrence condition given by equation (28) we derive the maximum rebate under which entry deterrence is profitable:

$$
\begin{aligned}
&\Pi_I^A \leq \Pi_I^D \\
\implies &\frac{(1-r)9s}{16} - M_{m,I} - C_m - C_I \leq \alpha_c + \alpha_m - (1-r)R_{c,I} - M_{m,I} - C_m - C_I \\
&R_{c,I} \leq \frac{\alpha_c+\alpha_m}{1-r} - \frac{9s}{16}
\end{aligned}
$$

This proves equation (29).

If we fill in the required rebate as given by equation (27) into equation (48) we obtain the closed form solution of the entry deterrence profit:

$$\Pi_I^D = \alpha_c + \alpha_m - (1-r)\left(\frac{\alpha_c + \alpha_m}{(1-r)} + s - \sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}}\right) - M_{m,I} - C_m - C_I$$
$$= (1-r)\sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}} - s(1-r) - M_{m,I} - C_m - C_I. \tag{49}$$

We solve for C_E under which entry deterrence is profitable according to the entry deterrence condition given by equation (28) by filling in equation (49) and equation (43). This gives the condition under which the incumbent deters entry:

$$\Pi_I^D \geq \Pi_I^A$$
$$\implies (1-r)\sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}} - s(1-r) \geq \frac{(1-r)9s}{16}$$
$$\implies C_E \geq \frac{(1-r)625s}{2048} - M_{m,E} - C_m$$

This proves equation (30).

To prove the second bullet, we take the derivative of equation (30) w.r.t. r and s:

$$\frac{\partial C_E^D}{\partial r} = -\frac{625s}{2048} < 0,$$
$$\frac{\partial C_E^D}{\partial s} = \frac{625(1-r)}{2048} > 0,$$

where $s > 0$ and $r \in (0,1)$.

To prove the last bullet, note that the duopolistic rebate is given by equation (19) (recall that this rebate is higher than either of the entry accommodation rebates). It has to hold that $R_{c,k}^S \leq R_{c,I}^D$, because otherwise it follows from equation (27) that entry is deterred as the entrant's profit is negative.

If we deduct the merchant transaction fee with this duopolistic rebate from the merchant transaction fee with the entry deterrence rebate given by equation (27):

$$
\begin{aligned}
&p^D_{m,I} - p^S_{m,I} = \\
&\alpha_c + \alpha_m + r\left(\frac{\alpha_c + \alpha_m}{(1-r)} + s - \sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}}\right) - \alpha_c - \alpha_m - r\left(\frac{\alpha_m + \alpha_c}{(1-r)} - s\right) \\
&\implies p^D_{m,I} \geq p^S_{m,I} \Leftrightarrow \sqrt{\frac{8s(C_E + M_{m,E} + C_m)}{(1-r)}} \leq 2s \\
&\implies p^D_{m,I} \geq p^S_{m,I} \Leftrightarrow C_E + M_{m,E} + C_m \leq \frac{s(1-r)}{2} \qquad (50)
\end{aligned}
$$

where $s > 0$ and $r \in (0, 1)$. This last inequality has to hold for a duopolistic equilibrium to exist, because it follows from the profit function in a duopolistic equilibrium given by equation (41) that profits are negative if $C_E + M_{m,E} + C_m > \frac{s(1-r)}{2}$, so in this case the entrant will not enter.

Q.E.D.

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