Network Competition and Merchant Discount Fees

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Abstract

Pricing in two-sided markets has not been fully understood yet. Especially, investigations of how competition in these markets affects the price structure or levels are still underway. This paper takes the payment card industry as an example of two-sided markets and examines whether two networks' competition lowers one of the prices in the industry, merchant discount fees, and if it does, how much it lowers equilibrium merchant fees compared with the fee set by a monopoly network. If some cardholders hold only one card and the other cardholders hold two different cards, whether network competition lowers the fees and by how much the fees will be lowered depend on various factors, such as the share of multihoming cardholders in the total cardholder base, the merchants' transactional benefit, each network's net transactional benefit to its card users, the difference in the two networks' cardholder bases, and the share of cardholders in the total customer base. Numerical examples with various parameter values suggest that typically, if the share of multihoming cardholders is less than 20 percent, networks can act as if they are monopolies; and if the share is around 50 percent, the average equilibrium merchant fee is reduced from the monopolistic merchant fee by as much as 25 percent. Numerical examples also suggest that a competing network has an incentive to set its cardholder fee lower than its rival's cardholder fee.

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1. Introduction

Costs of accepting credit and debit cards for merchants have been increasing recently. In some countries, government regulations or agreements between government and involved entities restrict merchant fee levels to contain those costs.[2] In the United States, a different approach—encouraging competition among payment card networks—has been taken, rather than directly regulating fees. Recently, the U.S. court ruled that two major credit card networks, MasterCard and Visa, must allow their member financial institutions to issue their competitor networks' credit cards, American Express and Discover. In another U.S. case that was settled out of court, MasterCard and Visa agreed to revoke their rules that had required merchants to honor both credit and signature-based debit cards. It may be too soon to evaluate these changes; however, since then, merchant fee levels have not declined and some networks charge merchants even higher fees.

This paper examines whether network competition decreases merchant fees, and if it does how much it lowers equilibrium merchant fees compared with the fee set by a monopoly network. Some industry experts suspected that network competition in the United States actually *raises* merchant fees to compensate for lower (higher) cardholder fees (rebates) to card issuers. They view that networks compete for cardholders or their issuers rather than for merchants.[3] How networks attract consumers or card issuers is an interesting and important topic, but this paper does not directly analyze it. Instead, the paper seeks the highest merchant fees that competing networks would charge, given cardholder bases and cardholder fees. This approach eliminates the complication of modeling issuers' network joining behavior and consumers' cardholding behavior, together with the model of merchants' card accepting behavior and networks'

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[2] Those countries are including Australia, EU cross-border, Mexico, and Spain.
[3] See, for example, *ATM&Debit News*, and *Card International*.

merchant fee setting; yet it allows us to see the effects of the changes in cardholder bases and/or cardholder fees on equilibrium merchant fees. This approach, however, is relevant only if the markets to which a single interchange fee applies are small enough so that the merchants' card acceptance does not affect consumers' cardholding. In the United States, typically interchange fees (and thus merchant fees) vary by industry. For instance, MasterCard and Visa set industry-specific credit card interchange fees, such as general retail, hotel and car rental, restaurant, fuel dispenser, supermarket, warehouse club, and so on.[4] An industry-specific interchange fee, say a supermarket interchange fee, is less likely to be set by accounting for the effects of the supermarkets' card acceptance on consumer cardholding. In most other countries, on the other hand, typically interchange fees do not vary by industry.[5] The network's single interchange fee determines how many merchants in a nation accept its cards, which may greatly influence consumer cardholding. Therefore, the approach taken by this paper is relevant for U.S. markets but not for other countries' markets.

Several models of payment card markets have been developed to analyze the effect of network competition on price structure and/or price level. Some of the models, however, do not necessarily fit well with U.S. markets with respect to two important features. First, some models assume either that consumers hold at most one card, or that merchants accept at most one branded card, or both (Maneti and Somma (2002), Chakravorti and Roson (2006)). Many U.S. consumers hold more than one card and many U.S. merchants accept more than one branded card.[6,7] Second, some models assume that merchants do not have a strategic motive to accept

[4] Visa USA and MasterCard International.
[5] For example, in Australia each credit card network sets two interchange rates. Interchange fees vary by how the transaction is processed.
[6] According to the BIS, the number of debit cards and credit cards issued in the United States in 2002 were 260.4 million and 709 million, respectively. The U.S. population in the same year was 288.2 million.
[7] See, for example, the 2004 National Retail Census of Credit Cards.

cards (Rochet and Tirole (2003), Chakravorti and Roson (2006)). However, U.S. industries are competitive and many merchants claim that they are afraid of losing customers by rejecting cards the customers prefer.[8] Rochet and Tirole (2002) and Guthrie and Wright (2003, 2006) satisfy these two important features—they assume that some cardholders and some merchants are *multihoming* and that merchants accept cards for strategic reasons. A main difference between them is that while consumer cardholding is exogenously given in Rochet and Tirole, it is endogenized in Guthrie and Wright. They found that if all cardholders hold at most one card and merchants accept cards for strategic reasons, network competition does not result in lower interchange fees (and thus merchant fees), and that if some cardholders hold more than one card, network competition may lower interchange fees.[9]

The model in this paper is built upon the model of Rochet and Tirole (2002). Because the paper focuses on analyzing U.S. markets, where interchange fees are set in a detailed manner according to industry category, the assumption of exogenously given consumer cardholding likely fits better than the assumption of endogenously determined consumer cardholding. Unlike Rochet and Tirole, which did not formally analyze the case where some cardholders hold more than one card, this paper analyzes that case in detail. This paper numerically calculates equilibrium merchant fees under various parameter values, compares equilibrium merchant fees with the fees set by monopolistic networks, and investigates what factors are critical for the difference between equilibrium merchant fees and monopolistically set fees. Four different cases are considered in turn: i) two networks' cardholder bases and cardholder fees are symmetric; ii) two networks' cardholder bases are asymmetric but their cardholder fees are symmetric; iii) two

[8] See, for example, a recent merchant survey conducted by the Association for Financial Professionals.
[9] Guthrie and Wright (2006) also showed the cases where network competition may *raise* interchange fees.

networks' cardholder bases are symmetric but their cardholder fees are asymmetric; and iv) two networks' cardholder bases and cardholder fees are asymmetric.

Whether two competing networks lower merchant fees depends on several factors. Networks are less likely to decline merchant fees as i) the share of multihoming cardholders among the total cardholders gets smaller, ii) a cardholder's net benefit gets larger, iii) a merchant's gross benefit gets smaller, and iv) the share of cardholding customers in the total customer base gets larger. Whether the two networks' cardholder bases and/or cardholder fees are symmetric also affects the equilibrium merchant fees. Generally, when multihoming cardholders are relatively scarce, competition between symmetric networks results in higher merchant fees than competition between asymmetric networks. When multihoming cardholders are relatively abundant, competition between asymmetric networks that have different cardholder fees may result in higher merchant fees.

Numerical examples also allow us to conduct some experiments to see if a competing network has an incentive to set the cardholder fee lower. The results suggest that a network has an incentive to set its cardholder fee lower than its rival's cardholder fee regardless of whether the network has the larger cardholder base, the smaller cardholder base, or the same cardholder base as its rival's. How much lower the network's cardholder fee should be depends on several factors.

The rest of the paper is organized as follows. Section 2 develops the model. In Section 3 equilibrium merchant fees of four different cases are presented in turn. Section 4 conducts some experiments and section 5 concludes.

2. The model

In the model, only two payment instruments are available—cash and card. Card payments are provided by two competing networks: Network 1 and Network 2. Both networks' cards, Card 1 and Card 2, provide the same transactional benefits to the card users and the merchants who accept those cards; the transactional benefit to card users is to reduce their transactional costs associated with a cash transaction, t_c, to zero and the transactional benefit to merchants is to reduce their transactional costs associated with a cash transaction, t_m, to zero. These transactional costs associated with a cash transaction do not vary by each individual consumer or merchant but vary by industry.[10] A card transaction does not create other benefits for either merchants or card users.[11] Each network *i* charges a universal cardholder fee to the card user, f_i, and an industry-specific merchant fee to the merchant, m_i, per transaction.[12] For consumers, the true cost of purchasing a good or service is $p+t_c$ with cash and $p+f_i$ with Card *i*, where p is the product price charged by the merchant. For merchants, the true cost of selling a good or service is $d+t_m$ with cash and $d+m_i$ with Card *i*, where d is the cost of selling a product regardless of the payment methods used for the transaction. To simplify the analysis, d is assumed to be zero.

The model assumes that cardholder bases are exogenously given to the networks. This also implies that the merchants' card acceptance in a given industry does not affect their customers' cardholding behavior. Therefore, a fraction of customers, α_i, hold Card *i* in a given industry. Some consumers (a fraction of $\sigma \geq 0$) are assumed to hold both cards (multihoming).

[10] Rationale for this assumption, see Hayashi (2006).

[11] A credit card may create benefits other than transactional benefits to both card users and merchants. However, the paper focuses on industries where a credit card's revolving function is less important. Those industries may include grocery stores, drug stores, gas stations, and quick service food restaurants.

[12] Obviously, m_i vary by industry.

By definition, the total cardholding consumers in a given industry, α , must satisfy $\alpha = \alpha_1 + \alpha_2 - \sigma$, and the number of multihoming cardholders must be less than both the number of Card 1 holders and the number of Card 2 holders, i.e., $\sigma \le \alpha_1, \alpha_2$.

Given the cardholder bases, each network sets industry-specific merchant fees and a universal cardholder fees. Each network determines its cardholder fee first, and then determines industry-specific merchant fees. Thus, when determining an industry-specific merchant fee for a given industry, the network treats cardholder fees of its own and of its rival's as given. A network is assumed to maximize its revenue from merchant fees.[13]

The paper focuses on markets where merchants are competing against each other so that those merchants have strategic motives to accept cards. We assume that aggregate consumer demand is price inelastic and two merchants, Merchant A and Merchant B, are competing according to the Hotelling model. Consumers (mass 1) are uniformly distributed on the interval of [0,1], which is independent of their cardholding. Merchant A is located at point 0, and Merchant B is located at point 1. For the consumer located at point x, where $0 \le x \le 1$, the transportation cost to Merchant A is tx, and the transportation cost to Merchant B is $t(1-x)$. Merchants are required to set the same product price for both card users and cash users.[14]

A merchant decides its card acceptance behavior from four choices: accept none, accept Card 1 only, accept Card 2 only, or accept both. If a merchant accepts both Card 1 and Card 2, multihoming cardholders use the card that gives them the higher net benefit (i.e., they use the card with the lower (higher) cardholder fee (rebate)). If a merchant accepts both cards, and if

[13] Equilibrium merchant fees under this assumption are likely lower than equilibrium merchant fees under the assumptions of profit maximizing. This is true if the cost per card transaction is higher than the cardholder fee, which is likely.

[14] This is due to the no surcharge rule imposed by card networks.

both cards have the same cardholder fee (rebate), multihoming cardholders are assumed to randomly choose to use either card, thus half of them use Card 1 and half of them use Card 2.

The timing of the game is as follows:

(I) Given cardholder fees, each payment card network sets industry-specific merchant fees.

(II) Each merchant decides whether to accept cards (neither, Card 1 only, Card 2 only, or both) and determines its product price.

(III) A consumer decides from which merchant he or she makes purchases and which payment method he or she uses (if a cardholder).

Starting with stage (III), a cardholder is willing to use her card if the cardholder fee she pays to the network, f_1 or f_2, does not exceed transactional costs associated with cash, t_c, since the merchant sets a unique product price for all of its customers. If the merchant accepts both cards, and if the consumer holds both cards, then she will use the card with the lower cardholder fee.

Suppose $t_c > f_1, f_2$. At stage (II), the merchants decide whether to accept cards and determine the product prices. Suppose that both cards have been accepted in the industry for a long time. In such an industry, when a merchant decides its card acceptance behavior, it is likely that the merchant expects its rival will accept both cards.[15] Suppose that one of the merchants, say Merchant B, accepts both cards. Merchant A selects its card acceptance behavior from four choices: accepts both, accepts Card 1 only, accepts Card 2 only, or accepts neither. First, let us consider the case where Merchant A accepts both cards. Given Merchant B's product price p_B, Merchant A's profit function is defined as:

[15] See Hayashi (2006) for detailed discussion.

(1) $\pi_A(p_A) = \{(p_A - t_m)(1-\alpha) + (p_A - m_1)(\alpha_1 - \rho\sigma) + (p_A - m_2)(\alpha_2 - (1-\rho)\sigma)\}\dfrac{t + p_B - p_A}{2t}$,

where ρ depends on f_1 and f_2. When $f_1 = f_2$, $\rho = 0.5$; when $f_1 > f_2$, $\rho = 1$; and when $f_1 < f_2$, $\rho = 0$. Similarly, Merchant B's profit function is defined. Equilibrium product prices are:

(2) $p_A = p_B = t + (1-\alpha)t_m + (\alpha_1 - \rho\sigma)m_1 + (\alpha_2 - (1-\rho)\sigma)m_2$.

Merchant A's profit is:

(3) $\pi_A(A:\text{both}; B:\text{both}) = \dfrac{t}{2}$.

Second let us consider the case where Merchant A accepts neither card. Merchant A's profit function is defined as:

(4) $\pi_A(p_A) = (p_A - t_m)\{\dfrac{t + p_B - p_A}{2t} - (\alpha_1 - \rho\sigma)\dfrac{t_c - f_1}{2t} - (\alpha_2 - (1-\rho)\sigma)\dfrac{t_c - f_2}{2t}\}$,

and Merchant B's profit function is defined as:

(5)
$$\pi_B(p_B) = \{(p_B - t_m)(1-\alpha) + (p_B - m_1)(\alpha_1 - \rho\sigma) + (p_B - m_2)(\alpha_2 - (1-\rho)\sigma)\}\frac{t + p_A - p_B}{2t}$$
$$+ (p_B - m_1)(\alpha_1 - \rho\sigma)\frac{t_c - f_1}{2t} + (p_B - m_2)(\alpha_2 - (1-\rho)\sigma)\frac{t_c - f_2}{2t}.$$

Equilibrium product prices are:

(6) $p_A = t + (1 - \dfrac{\alpha}{3})t_m + \dfrac{\alpha_1 - \rho\sigma}{3}(m_1 - (t_c - f_1)) + \dfrac{\alpha_2 - (1-\rho)\sigma}{3}(m_2 - (t_c - f_2))$,

(7) $p_B = t + (1 - \dfrac{2\alpha}{3})t_m + \dfrac{\alpha_1 - \rho\sigma}{3}(2m_1 + (t_c - f_1)) + \dfrac{\alpha_2 - (1-\rho)\sigma}{3}(2m_2 + (t_c - f_2))$.

Merchant A's profit is:

(8) $\pi_A(A:\text{neither}; B:\text{both}) = \dfrac{1}{2t}\{t - \dfrac{\alpha_1 - \rho\sigma}{3}(m_1^m - m_1) - \dfrac{\alpha_2 - (1-\rho)\sigma}{3}(m_2^m - m_2)\}^2$,

where m_1^m $(= t_m + t_c - f_1)$ and m_2^m $(= t_m + t_c - f_2)$ are the merchant fees if each of the networks sets its merchant fee monopolistically. From equations 3 and 8, if Merchant B accepts both cards, Merchant A is better off by accepting both cards than by rejecting both cards, as long as each of the networks sets its merchant fee lower than the fee set by a monopoly network.

Lastly, let us consider the case where Merchant A accepts either Card 1 or Card 2. Merchant A's profit function by accepting only Card *i* (*i*=1 or 2) depends on f_i and f_j ($j \neq i$). If $f_i \leq f_j$, Merchant A's profit function is defined as:

$$(9)\quad \pi_A(p_A) = \{(p_A - t_m)(1-\alpha_i) + (p_A - m_i)\alpha_i\}\frac{t + p_B - p_A}{2t} - (p_A - t_m)(\alpha_j - \sigma)\frac{t_c - f_j}{2t};$$

and if $f_i > f_j$, Merchant A's profit function is:

$$(10)\quad \begin{aligned} \pi_A(p_A) = {} & \{(p_A - t_m)(1-\alpha_i) + (p_A - m_i)\alpha_i\}\frac{t + p_B - p_A}{2t} - (p_A - m_i)\sigma\frac{f_i - f_j}{2t} \\ & - (p_A - t_m)(\alpha_j - \sigma)\frac{t_c - f_j}{2t}. \end{aligned}$$

Merchant B's profit function also depends on f_i and f_j. When $f_i < f_j$,

$$(11)\quad \begin{aligned} \pi_B(p_B) = {} & \{(p_B - t_m)(1-\alpha) + (p_B - m_i)\alpha_i + (p_B - m_j)(\alpha_j - \sigma)\}\frac{t + p_A - p_B}{2t} \\ & + (p_B - m_j)(\alpha_j - \sigma)\frac{t_c - f_j}{2t}; \end{aligned}$$

when $f_i = f_j$,

$$(12)\quad \begin{aligned} \pi_B(p_B) = {} & \{(p_B - t_m)(1-\alpha) + (p_B - m_i)(\alpha_i - \frac{\sigma}{2}) + (p_B - m_j)(\alpha_j - \frac{\sigma}{2})\}\frac{t + p_A - p_B}{2t} \\ & + (p_B - m_j)(\alpha_j - \sigma)\frac{t_c - f_j}{2t}; \end{aligned}$$

and when $f_i > f_j$,

(13)
$$\pi_B(p_B) = \{(p_B - t_m)(1-\alpha) + (p_B - m_i)(\alpha_i - \sigma) + (p_B - m_j)\alpha_j\}\frac{t + p_A - p_B}{2t}$$
$$+ (p_B - m_j)(\alpha_j - \sigma)\frac{t_c - f_j}{2t}.$$

Equilibrium prices are given when $f_i < f_j$

(14) $p_A = t + (1 - \alpha_i - \frac{\alpha_j - \sigma}{3})t_m + \alpha_i m_i + \frac{\alpha_j - \sigma}{3} m_j - \frac{\alpha_j - \sigma}{3}(t_c - f_j)$,

(15) $p_B = t + (1 - \alpha_i - \frac{2(\alpha_j - \sigma)}{3})t_m + \alpha_i m_i + \frac{2(\alpha_j - \sigma)}{3} m_j + \frac{\alpha_j - \sigma}{3}(t_c - f_j)$;

when $f_i = f_j$,

(16) $p_A = t + (1 - \alpha_i - \frac{\alpha_j - \sigma}{3})t_m + (\alpha_i - \frac{\sigma}{6})m_i + \frac{2\alpha_j - \sigma}{6} m_j - \frac{\alpha_j - \sigma}{3}(t_c - f_j)$,

(17) $p_B = t + (1 - \alpha_i - \frac{2(\alpha_j - \sigma)}{3})t_m + (\alpha_i - \frac{\sigma}{3})m_i + \frac{2\alpha_j - \sigma}{3} m_j + \frac{\alpha_j - \sigma}{3}(t_c - f_j)$;

and when $f_i > f_j$,

(18) $p_A = t + (1 - \alpha_i - \frac{\alpha_j - \sigma}{3})t_m + (\alpha_i - \frac{\sigma}{3})m_i + \frac{\alpha_j}{3} m_j - \frac{\alpha_j - \sigma}{3}(t_c - f_j) - \frac{\sigma}{3}(f_i - f_j)$,

(19) $p_B = t + (1 - \alpha_i - \frac{2(\alpha_j - \sigma)}{3})t_m + (\alpha_i - \frac{2\sigma}{3})m_i + \frac{2\alpha_j}{3} m_j + \frac{\alpha_j - \sigma}{3}(t_c - f_j) + \frac{\sigma}{3}(f_i - f_j)$.

Merchant A's profit is therefore given when $f_i < f_j$,

(20) $\pi_A(A:\text{Card } i; B:\text{both}) = \frac{1}{2t}[\{t - \frac{\alpha_j - \sigma}{3}(m_j^m - m_j)\}^2 - \alpha_i(\alpha_j - \sigma)(t_c - f_j)(m_i - t_m)]$;

when $f_i = f_j$,

(21)
$$\pi_A(A:\text{Card } i; B:\text{both})$$
$$= \frac{1}{2t}[\{t - \frac{\alpha_j - \sigma}{3}(m_j^m - m_j) + \frac{\sigma}{6}(m_j - m_i)\}^2 - \alpha_i(\alpha_j - \sigma)(t_c - f_j)(m_i - t_m)];$$

and when $f_i > f_j$,

$$\begin{aligned}(22)\quad \pi_A(A:\text{Card } i; B:\text{both}) = \frac{1}{2t}[\{t - \frac{\alpha_j}{3}(m_j^m - m_j) + \frac{\sigma}{3}(m_i^m - m_i)\}^2 \\ - \{\alpha_i(\alpha_j - \sigma)(t_c - f_j) - (1-\alpha_i)\sigma(f_i - f_j)\}(m_i - t_m)].\end{aligned}$$

Suppose both networks set their merchant fees lower than the monopoly fees (i.e., $m_1 \le m_1^m$ and $m_2 \le m_2^m$). Given that Merchant B accepts both cards, Merchant A accepts only one card if and only if:

$$(23)\quad \text{Max}\{\pi_A(A:\text{Card 1}; B:\text{both}), \pi_A(A:\text{Card 2}; B:\text{both})\} > \pi_A(A:\text{both}; B:\text{both}) = \frac{t}{2}.$$

At stage (I), each network sets its merchant fee, given its rival network's merchant fee, and both networks' cardholder bases and cardholder fees. Given Network 2's merchant fee, m_2, Network 1 has two strategies: 1) "undercuts" and 2) prevents Network 2 from "undercutting."[16] Network 1's "undercut" achieves if one of the two merchants accepts Card 1 only. By undercutting, Network 1 may be able to increase its market share in terms of the number of transactions. Denote G_1 as the Network 1's reaction function when Network 1 undercuts given m_2, i.e., $\underline{m}_1 = G_1(m_2)$, and denote g_1 as the Network 1's reaction function when Network 1 prevents Network 2 from undercutting given m_2, i.e., $\overline{m}_1 = g_1(m_2)$. Similarly, Network 2 has two strategies. Denote G_2 and g_2 as Network 2's reaction functions.

Equilibrium merchant fees (m_1^*, m_2^*) are defined as follows: First, neither network can earn more by undercutting its rival network. This condition is described in equation 24 below.

$$(24)\quad E_i(m_i^*, m_j^*) \ge E_i(G_i(m_j^*), m_j^*),$$

[16] Actually, there is another strategy for Network 1: it can allow Network 2 to undercut at the merchant fee of m_2. However, this strategy is always inferior to the strategy that prevents Network 2 from undercutting.

where E_i is the earning function of Network *i* (*i*=1, 2). Second, given its rival's merchant fee, m_j^*, Network *i* (*i*=1 or 2 or both) may be able to earn more by setting a merchant fee, $g_i(m_j^*)$, that prevents its rival network from undercutting at m_j^*. However, if that is the case, its rival network should set its merchant fee at $G_j(g_i(m_j^*))$ to undercut and as a result Network *i*'s, earning should be lower than the equilibrium earning. This implies that if equation 25 holds:

(25) $E_i(g_i(m_j^*), m_j^*) \geq E_i(m_i^*, m_j^*)$,

then, equations 26 and 27 must hold.

(26) $E_j(G_j(g_i(m_j^*)), g_i(m_j^*)) \geq E_j(m_j^*, g_i(m_j^*))$,

(27) $E_i(g_i(m_j^*), G_j(g_i(m_j^*))) \leq E_i(m_i^*, m_j^*)$.

3. Competition between two card networks

Due to the complexity of the model developed in the previous section, general analytical results cannot be easily obtained. This section, therefore, presents numerical examples in order to answer the following two questions: 1) for what parameter values do competing networks set their merchant fees lower than the monopolistic level of fees?; and 2) if they set lower merchant fees, how much lower are equilibrium merchant fees? Numerical examples are grouped into four cases; case (i) two networks' cardholder bases and cardholder fees are symmetric; case (ii) two networks' cardholder bases are asymmetric but their cardholder fees are symmetric; case (iii) two networks' cardholder bases are symmetric but their cardholder fees are asymmetric; and case (iv) two networks' cardholder bases and cardholder fees are asymmetric.

In the numerical examples, the following variables are treated as parameters.

α : share of cardholding customers in the total customer base,

σ/α: share of multihoming cardholders in the total cardholding customer base,

t_m: a merchant's transactional benefit relative to t, (merchant's markup per transaction),

$t_c - f_i$: Network *i*'s (*i*=1, 2) card user's net transactional benefit relative to t.

3.1 Symmetric in both cardholder bases and cardholder fees

This subsection considers the cases where both networks' cardholder bases are the same ($\alpha_1 = \alpha_2$) and cardholder fees are the same ($f_1 = f_2 = f$). In these cases, equilibrium merchant fees are symmetric ($m_1^* = m_2^* = m^*$), and at equilibrium both merchants accept both cards.

To answer the first question, chart 1 shows parameter values for which card network competition *does not* lower merchant fees. In the chart, given $t_c - f$ and α, for any combinations of t_m and σ/α which fall into the colored areas, competing networks set merchant fees as if they were monopolies. The three panels are different levels of $t_c - f$ (Panel 1: $t_c - f$ =0.1, Panel 2: $t_c - f$ =0.5, Panel 3: $t_c - f$ =1), and each panel shows different levels of α (=0.5, 0.75, and 1).

All four parameters, σ/α, t_m, $t_c - f$, and α, influence equilibrium merchant fees. As Rochet and Tirole (2002) found, when all cardholders are singlehoming ($\sigma/\alpha = 0$) competing networks *do not* lower merchant fees from the monopolistic fee, and when all cardholders are multihoming ($\sigma/\alpha = 1$) competing networks *do* lower merchant fees, regardless of the other parameter values. When some cardholders are singlehoming and some are multihoming, whether competing networks set lower merchant fees depends on the other three parameters ($t_m, t_c - f$, and α).

Given $t_c - f$ and α, as a merchant transactional benefit (t_m) increases, the threshold σ/α at which competing networks start setting lower merchant fees declines. For example, when $t_c - f$ =0.5 and α =0.5, the threshold σ / α is about 0.4 when t_m =0 and the threshold σ / α declines to 0.1 as t_m increases to 2. Given $t_c - f$ and t_m, as the share of cardholding customers in the total customer base (α) increases, the threshold σ / α increases. For instance, when $t_c - f$ =1 and t_m =1, the threshold σ / α increases from 0.33, 0.38 to 0.41 as α increases from 0.5, 0.75 to 1. Given α and t_m, as a card user's net transactional benefit ($t_c - f$) increases, the threshold σ / α increases. For example, when t_m =1 and α =0.75, the threshold σ / α increases from 0.05, 0.22 to 0.38 as $t_c - f$ increases from 0.1, 0.5 to 1.

With a greater t_m, a smaller $t_c - f$, and a smaller α, a relatively smaller share of multihoming cardholders among the total cardholders makes competing networks set merchant fees lower than the fee set by a monopoly. When t_m is greater, a monopoly network can charge a higher merchant fee because the greater the merchant transactional benefit from a card payment (t_m), the higher the merchant's willingness to pay for the card payment. A competing network, on the other hand, has an incentive to set the merchant fee lower than the monopolistic level of fee. By doing so, it may increase the market share of the network in terms of the transaction volume if at least one merchant rejects the other network's card. Although lowering the merchant fee reduces the network's per transaction markup, the increased market share compensates for the loss from reduced markups. When a card user's net transactional benefit from a card payment ($t_c - f$) is smaller, a merchant is more likely to reject one of the two cards. In order to retain as many customers as possible who hold only one card that is rejected by the merchant, the merchant needs to lower its price to compensate those card customers for their benefit losses. Because $t_c - f$ is small, a relatively small decrease in price set by the merchant is enough to compensate for the card customers' losses. For a given share of multihoming cardholders among the total cardholders (σ/α), the smaller the share of cardholding customers in the total customer base (α), the more likely the merchant is to reject the one brand of cards with the higher merchant fee. This is because the customer base the merchant will lose by rejecting the cards is relatively small. However, compared with the other parameters, the effect of α is not very significant.

Next, equilibrium merchant fees (m^*) are shown in charts 2, 3, and 4. Charts 2 and 3 show the effects of t_m and $t_c - f$ on the equilibrium merchant fee and chart 4 shows the effects of α. From these charts, one can see that for any combinations of t_m, $t_c - f$, and α, the equilibrium merchant fees decline monotonically as σ/α, the share of multihoming cardholders among the total cardholders, increases. When all cardholders are singlehoming ($\sigma/\alpha = 0$), the equilibrium merchant fee (m^*) is the same as the fee set by a monopoly network (m^m) regardless of the other parameter values. When all cardholders hold both cards ($\sigma/\alpha = 1$), both networks set merchant fees as low as possible. Since each network is assumed to maximize its revenue from the merchants, the lowest merchant fee it would charge is zero. Thus, $m^* = 0$ at $\sigma/\alpha = 1$.

When some cardholders are multihoming ($0 < \sigma/\alpha < 1$), equilibrium merchant fees depend on all four parameters. Chart 2 shows the effects of t_m (panels 1 and 2), and of $t_c - f$ (panels 3 and 4) on the actual level of the merchant fee. From panels 1 and 2, given $t_c - f$, α, and σ/α, a smaller transactional benefit to the merchant (t_m) likely makes equilibrium merchant fee lower. From panels 3 and 4, given t_m, α, and σ/α, a smaller net transactional benefit to the card user ($t_c - f$) makes equilibrium merchant fee lower.

Because a smaller t_m or a smaller $t_c - f$ also makes the monopolistic merchant fee lower, the lower equilibrium merchant fee resulted from a smaller t_m or a smaller $t_c - f$ does not necessarily imply that competing networks reduce their fees by a large amount. Chart 3 shows the equilibrium merchant fee as a percentage of the monopolistic merchant fee. Panels 1 through 4 in chart 3 correspond to panels 1 through 4 in chart 2, respectively. From panels 1 and 2, with a smaller t_m, the ratio of the equilibrium merchant fee to the monopolistic merchant fee tends to be higher (or at least as high) for all ranges of σ / α. Interestingly, a smaller merchant transactional benefit from a card payment makes the equilibrium merchant fee *itself* lower, but it makes the *ratio* of the equilibrium merchant fee to the monopolistic fee tend to be higher. In contrast with t_m, the effects of $t_c - f$ on the ratio of the equilibrium merchant fee to the monopolistic merchant fee is not very clear. From panels 3 and 4, for a relatively smaller σ / α ($0 < \sigma / \alpha < 0.2$), the smaller the card user's net transactional benefit ($t_c - f$), the smaller the ratio is; however this is changed around σ / α =0.5; and for a relatively greater σ / α ($0.6 < \sigma / \alpha < 1$), the smaller the $t_c - f$, the greater the ratio is.

Although there are some variations, for most parameter values, when the share of multihoming cardholders in the total cardholder base is around 50 percent the equilibrium merchant fees will be reduced by as much as 25% of the merchant fee set by a monopoly network. When the share of multihoming cardholders increases to 70 percent the equilibrium merchant fees will be reduced by as much as 50%.

Chart 4 shows the effects of α, the share of cardholding customers in the total customer base. As panel 1 shows, α has no effects on equilibrium merchant fees (m^*) when $t_c - f$ =0. For $t_c - f > 0$, a greater α makes m^* higher when t_m is close to zero (panel 2). However, when

$t_c - f > 0$ and t_m is large enough, a greater α makes m^* higher for a small σ/α but a greater α likely makes m^* lower for a large σ/α (panel 3).

Observations (Symmetric cardholder bases and cardholder fees):

(a) With a greater share of multihoming cardholders among the total cardholders (σ/α), a greater transactional benefit to the merchant (t_m), a smaller net transactional benefit to the card user ($t_c - f$), and a smaller share of cardholding customers in the total customer base (α), competing networks are more likely to set their merchant fees lower than the fee set by a monopoly network.

(b) The equilibrium merchant fee set by the competing networks is likely lower with a greater σ/α, a smaller t_m, and a smaller $t_c - f$.

3.2 Asymmetric in cardholder bases and symmetric in cardholder fees

In this subsection, we consider the cases where the two networks' cardholder bases are different ($\alpha_1 \neq \alpha_2$), but their cardholder fees are the same ($f_1 = f_2 = f$). Without loss of generality, we assume that Network 1's cardholder base is greater than Network 2's ($\alpha_1 > \alpha_2$). Define c as the ratio of Network 2's cardholder base to Network 1's cardholder base ($\alpha_2 = c\alpha_1$, where $0 < c < 1$). By definition, the networks' cardholder bases are $\alpha_1 = \frac{\alpha + \sigma}{1 + c}$ and $\alpha_2 = \frac{c(\alpha + \sigma)}{1 + c}$, respectively. Because multihoming cardholders cannot exceed the smaller network's cardholder base, ($\sigma \leq \alpha_2$), the share of multihoming cardholders in the total cardholder base (σ/α) should be equal to or less than c. At equilibrium, both merchants accept both cards, but in most cases the equilibrium merchant fees are not the same ($m_1^* \neq m_2^*$).

From chart 5, one can see that whether network competition differs equilibrium merchant fees from a monopoly-set merchant fee depends on c . Colored areas in chart 5 are combinations of t_m and σ/α for which equilibrium merchant fees are the same as monopolistic fees, given a combination of c , α , and $t_c - f$. The three panels are different levels of $t_c - f$ (Panel 1: $t_c - f$ =0.1, Panel 2: $t_c - f$ =0.5, and Panel 3: $t_c - f$ =1) and each panel shows different level of c (=0.5, 0.7, and 1). For all three panels, α is assumed to be 0.75. As c gets smaller, colored areas shrink. This means that as the two networks' cardholder bases diverge, either one or both of the networks are more likely to set their merchant fees lower than the fee set by a monopoly. The difference in c is more influential as the card user's net transactional benefit ($t_c - f$) increases.

Because of the asymmetry in cardholder bases, the equilibrium merchant fees set by Networks 1 and 2 are likely different. When the share of multihoming cardholders among the total cardholders (σ/α) is large enough, the larger network (Network 1) sets a higher merchant fee than the smaller network i.e., $m_1^* > m_2^*$. When σ/α is small enough, both networks do not have an incentive to undercut, and therefore both networks set merchant fees at the monopolistic fee level. In this case, the equilibrium merchant fees set by Networks 1 and 2 are the same ($m_1^* = m_2^* = m^m$). When σ/α is in the middle range, the smaller network sets a *higher* merchant fee than the larger network i.e., $m_1^* < m_2^*$. In this range of σ/α, the larger network has no incentive to lower merchant fees while the smaller network has an incentive to do so. Then, the larger network sets a lower merchant fee to prevent its smaller counterpart from undercutting. Given the lower merchant fee set by the larger network, the smaller network chooses not to undercut.

Chart 6 shows the average equilibrium merchant fees. Given σ / α, the average equilibrium merchant fee under competition between two networks whose cardholder bases are different (c =0.5, 0.7) is typically lower than the equilibrium merchant fee under competition between two symmetric networks (c =1). As the two networks' cardholder bases diverge (c gets smaller), the average equilibrium merchant fees are likely lower.

Although asymmetry in the networks' cardholder bases makes average equilibrium merchant fees lower, the upper limit of σ / α created by the asymmetry keeps the minimum possible merchant fees high. For example, when t_m=1, $t_c - f$ =1, and α=0.75 (panel 1 of chart 6), the minimum possible (average) merchant fee in the case of c=1 is 0, but 0.92 or 1.32 in the case of c=0.7 or 0.5.

Observations (Asymmetric cardholder bases and symmetric cardholder fees):

(c) As the two competing networks' cardholder bases diverge, either one or both of the networks are more likely to set their merchant fees lower than the fee set by a monopoly network.

(d) Given a combination of parameters, σ / α, t_m, $t_c - f$, and α, the average equilibrium merchant fee set by the competing networks with asymmetric cardholder bases is likely lower than that set by the competing networks with symmetric cardholder bases.

(e) The minimum possible average equilibrium merchant fee becomes higher as the two competing networks' cardholder bases diverge.

3.3 Symmetric in cardholder bases and asymmetric in cardholder fees

In this subsection, we consider the cases where the two networks' cardholder bases are the same ($\alpha_1 = \alpha_2$), but their cardholder fees are different ($f_1 \neq f_2$). Without loss of generality, we assume that the Network 1's cardholder fee is lower than the Network 2's cardholder fee ($f_1 < f_2$).

By assumption, multihoming cardholders use Card 2, only when the merchant they choose accepts only Card 2. Network 1, therefore, has no incentive to undercut because even if one of the two merchants accepts only Card 1 while the other merchant accept both cards, Network 1's market share in terms of number of transactions does not increase. Network 2, on the other hand, can increase its market share by undercutting. If increased market share can compensate for the reduced margin per transaction, Network 2 will undercut. For most parameter values, when at least one of the two merchants rejects Card 1 and accepts Card 2, the other merchant rejects Card 1. If that is the case, Network 1 will lose all of its transactions. To avoid that, Network 1 sets the merchant fee so that it can prevent Network 2 from undercutting. As a result, Network 2 does not undercut, rather it sets its merchant fee so that no merchants reject Card 2. For some parameter values, however, when one of the two merchants accepts only Card 2, the other merchant still accepts Card 1. In such cases, Network 1 has two strategies to take—one is to prevent Network 2 from undercutting and the other is to let Network 2 undercut. Although Network 1 can set a higher merchant fee when it lets Network 2 undercut, its revenue is always higher when it prevents Network 2 from undercutting. Thus, Network 1 always sets its merchant fee that discourages Network 2 to undercut.

Unlike the previous two cases, one of the two networks (Network 1) has no incentive to undercut. Nevertheless, like the previous two cases, a unique equilibrium, at which both merchants accept both cards, exists for all parameter values. The equilibrium merchant fees are asymmetric ($m_1^* \neq m_2^*$).

Chart 7 shows equilibrium merchant fees. Panels 1 and 2 show the merchant fee set by Network 1 when its card user's net transactional benefit ($t_c - f_1$) is 0.5 and 1, respectively. Panels 3 and 4 show the merchant fee set by Network 2 when its card user's net transactional benefit ($t_c - f_2$) is 0.5 and 0.1, respectively. The merchant fee set by Network 1 depends on the net transactional benefit of Network 2's card users ($t_c - f_2$). Similar to the merchant fee set by Network 1, Network 2's merchant fee also depends on the net transactional benefit of Network 1's card users. In each panel, a thick line represents the equilibrium merchant fees set under competition between two completely symmetric networks.

As panels 1 and 2 show, for a given combination of t_m, α, $t_c - f_1$, and $t_c - f_2$, the merchant fee set by Network 1 (m_1^*) declines as the share of multihoming cardholders among the total cardholders (σ / α) increases. When σ / α is relatively small, Network 1 sets its merchant fee lower than the fee set under symmetric competition, while when σ / α is relatively large, Network 1 sets its merchant fee higher than the fee set under symmetric competition. When σ / α is small, the lower the net transactional benefit provided by Network 2 ($t_c - f_2$), the lower the merchant fee set by Network 1 likely is. As σ / α increases, however, the order changes; when σ / α=1, the lower the $t_c - f_2$, the higher the m_1^* is.

From panels 3 and 4, for a relatively smaller σ / α, Network 2 raises its merchant fee (m_2^*) as σ / α increases; after σ / α exceeds a certain level, Network 2 reduces m_2^* as σ / α increases. The merchant fee set by Network 2 is at least as high as the fee set under symmetric competition. For most range of σ / α, the higher the card user's net transactional benefit provided by Network 1 ($t_c - f_1$), the higher the equilibrium merchant fee set by Network 2 is.

Charts 8 and 9 also show equilibrium merchant fees. In contrast with chart 7, in these two charts, both m_1^* and m_2^* are presented in the same panel. From chart 8, one can see the effects of t_m and the effects of the difference between $t_c - f_1$ and $t_c - f_2$ on the equilibrium merchant fees. The effects of α on the equilibrium merchant fees can be seen in chart 9.

It may be somewhat counterintuitive that, under some circumstances, the merchant fee set by Network 2, whose net transactional benefit to its card users is lower than Network 1, is higher than the merchant fee set by Network 1. As explained above, Network 1 cannot set its merchant fee to one that induces Network 2 to undercut. Since Network 1 wants to set its merchant fee as high as possible, Network 1 sets m_1^* at this upper limit. Network 2, then sets its merchant fee at m_2^*, given m_1^*, so that no merchants reject its cards. As a result, for some parameter values, m_2^* exceeds m_1^*. Even when $m_2^* > m_1^*$, Network 2's revenue is always lower than Network 1's revenue.

It is more likely that m_2^* is higher than m_1^* when the share of multihoming cardholders among the total cardholders is higher. By comparing panels 1 and 2 in chart 8, one can find that the higher the merchant's transactional benefit from a card payment (t_m), the more likely the Network 2's merchant fee (m_2^*) exceeds the Network 1's merchant fee (m_1^*). Panels 1, 3 and 4 in chart 8 demonstrate that as the difference between $t_c - f_1$ and $t_c - f_2$ increases, the range of σ / α that makes $m_2^* > m_1^*$ shrinks. When $t_c - f_1$ and $t_c - f_2$ are close (panel 3), $m_2^* > m_1^*$ for $\sigma / \alpha > 0.2$, while when $t_c - f_1$ is much higher than $t_c - f_2$ (panel 4), m_2^* does not exceed m_1^* for the entire range of σ / α. Chart 9 reveals that, as the share of cardholding customers in the total customer base (α) increases, m_2^* is more likely to exceed m_1^*.

Chart 10 shows the average equilibrium merchant fees. Compared with the average equilibrium merchant fee when the two networks set the same cardholder fees (i.e., $f_1 = f_2 = f$), even when Network 2 sets its cardholder fee higher (i.e., $f_2 > f_1 = f$), the average equilibrium merchant fee is higher for a large σ/α. This means that when many cardholders are multihoming, if one of the two networks sets its cardholder fee higher than the other network, both the average equilibrium merchant fee and the average cardholder fee are higher. The more the two networks' cardholder fees diverge, the higher the average equilibrium merchant fee will likely be for a large σ/α.

Observations (Symmetric cardholder bases and asymmetric cardholder fees):

(f) As the two competing networks' cardholder fees diverge, the network with the lower cardholder fee is more likely to set its merchant fee lower than the fee set by a monopoly network with the same cardholder fee.

(g) The equilibrium merchant fee set by the network with the lower cardholder fee is more likely to be higher than that set by the network with the higher cardholder fee, if the share of multihoming cardholders among the total cardholders (σ/α) is smaller, the merchant's transactional benefit (t_m) is smaller, the difference between two network's net transactional benefit to their card users ($t_c - f_1$ and $t_c - f_2$) is greater, and the share of cardholding customers in the total customer base (α) is smaller.

(h) The average equilibrium merchant fee with asymmetric cardholder fees tends to be higher than that with symmetric cardholder fees when the share of multihoming cardholders among the total cardholders (σ/α) is large.

3.4 Asymmetric in both cardholder bases and cardholder fees

Finally, this subsection considers the cases where the two networks' cardholder bases are different ($\alpha_1 \neq \alpha_2$) and cardholder fees are also different ($f_1 \neq f_2$). Without loss of generality, Network 1's cardholder fee is assumed to be lower than Network 2's ($f_1 < f_2$). Both cases where Network 1's cardholder base is greater ($\alpha_1 > \alpha_2$) and where Network 2's cardholder base is greater ($\alpha_1 < \alpha_2$) are considered.

Like the previous three cases, a unique equilibrium exists for all parameter values. At equilibrium, both merchants accept both cards. As explained in subsection 3.3, Network 1 sets the merchant fee so that it can prevent Network 2 from undercutting, and given the merchant fee set by Network 1, Network 2 sets its merchant fee so that no merchants reject Card 2, in the case of asymmetric cardholder bases as well as asymmetric cardholder fees.

Chart 11 shows equilibrium merchant fees. For a given combination of parameters, t_m, α, $t_c - f_1$, and $t_c - f_2$, panel 1 shows the case where the two networks' cardholder bases are symmetric ($\alpha_1 = \alpha_2$), panel 2 shows the case where the network with the lower cardholder fee (Network 1) has a greater cardholder base ($\alpha_1 > \alpha_2 = 0.5\alpha_1$), and panel 3 shows the case where the network with the lower cardholder fee has a smaller cardholder base ($\alpha_1 < \alpha_2 = 2\alpha_1$). The effects of the difference in cardholder bases on each network's merchant fee are not very clear. However, the range of σ / α, which gives a merchant fee set by Network 1 that is higher than that by Network 2, expands, as the Network 1's cardholder base gets smaller.

Charts 12, 13 and 14 compare the average equilibrium merchant fee in the case where the two networks have asymmetric cardholder bases and asymmetric cardholder fees with the average equilibrium merchant fee in the other three cases—1) symmetric cardholder bases and asymmetric cardholder fees, 2) asymmetric cardholder bases and symmetric cardholder fees, and 3) symmetric cardholder bases and symmetric cardholder fees.

The effects of the difference in cardholder bases on the average equilibrium merchant fee can be seen in chart 12. Panel 1 shows the cases where Network 1 whose cardholder fee is the lower has the smaller cardholder base and panel 2 shows the cases where Network 1 has the greater cardholder base. In each panel, a thick line represents the average equilibrium merchant fee where two networks have the same cardholder bases. Compared with the case where the two networks' cardholder bases are identical, when Network 1's cardholder base is smaller, the average equilibrium merchant fee is lower if the share of multihoming cardholders in the total cardholding customer base is small (σ / α<0.5) but it may be higher if the share of multihoming cardholder is large (σ / α>0.5). When Network 1's cardholder base is greater, on the other hand, the average equilibrium merchant fee is higher for relatively small shares of multihoming cardholders (σ / α<0.3) , but it is lower for a relatively large σ / α.

Chart 13 demonstrates the effects of the difference in cardholder fees on the average equilibrium merchant fee. Panels 1 and 2 are the case where the two networks' net transactional benefits to their card users are close ($t_c - f_1 = 0.8$ and $t_c - f_2 = 0.7$) and panels 3 and 4 are the case where $t_c - f_1$ and $t_c - f_2$ are quite different ($t_c - f_1 = 0.8$ and $t_c - f_2 = 0.1$). A thick line in each panel represents the average equilibrium merchant fee where the two networks set the same lower cardholder fee (i.e., $t_c - f_2 = t_c - f_1 = 0.8$). In the former case (panels 1 and 2), the average merchant fee set by the networks with asymmetric cardholder fees is likely lower than that set by the networks with symmetric cardholder fees. Only when Network 1's cardholder base is the smaller, can the average merchant fee be higher with asymmetric cardholder fees than with symmetric cardholder fee for large σ / α ($\sigma / \alpha \geq 0.5$). In the latter case (panels 3 and 4), the average merchant fee can be higher with asymmetric cardholder fees for a large σ / α regardless of which network's cardholder base is the smaller.

Chart 14 compares the average equilibrium merchant fee in the case where the two networks are asymmetric in cardholder bases and cardholder fees with that in the case where the two networks are symmetric in cardholder bases and cardholder fees. Again, panels 1 and 2 are the case where the two networks' net transactional benefits to their card users are close ($t_c - f_1 = 0.8$ and $t_c - f_2 = 0.7$) and panels 3 and 4 are the case where $t_c - f_1$ and $t_c - f_2$ are quite different ($t_c - f_1 = 0.8$ and $t_c - f_2 = 0.1$). A thick line in each panel represents the equilibrium merchant fee set by the two networks with symmetric cardholder bases and cardholder fees. The average merchant fee set by the networks with asymmetric cardholder bases and cardholder fees can be higher than that set by the networks with symmetric cardholder bases and fees only when the share of multihoming cardholders in the total cardholder base (σ / α) is large enough. However, the minimum possible average equilibrium merchant fee set by the two asymmetric networks is always higher than the minimum possible equilibrium merchant fee set by the two symmetric networks.

Observations (Asymmetric cardholder bases and cardholder fees):

(i) The equilibrium merchant fee set by the network with the lower cardholder fee is more likely to be higher than that set by the network with the higher cardholder fee, if the network with the lower cardholder fee has the smaller cardholder base.

(j) With some exceptions, the average equilibrium merchant fee set by the networks with asymmetric cardholder bases and asymmetric cardholder fees are likely lower than the average equilibrium merchant fee set by the networks with symmetric cardholder bases and/or symmetric cardholder fees.

4. The network's cardholder fee setting—some experiments

This section carries out some experiments to examine whether the network has an incentive to set a lower cardholder fee by using the results obtained in the previous section. As mentioned before, some industry experts suspected that network competition in the United States actually raises merchant fees to compensate for lower cardholder fees (even negative) to card issuers. Since the model assumes that the networks are the card issuers, we examine if the network's setting a lower cardholder fee generates enough revenue from merchant fees to compensate for the loss of revenue from the cardholder fee. Although changing the network's cardholder fee likely affects the network's cardholder base, such effects will appear rather slowly. Instead, it likely has an immediate effect on existing cardholder's transactions—multihoming cardholders use the network's card exclusively. Therefore, during the experiments, it is assumed that cardholder fees do not affect current cardholder bases.

In this section, we do not seek to find equilibrium cardholder fees; instead, we calculate one of the two network's net revenues in a given industry—revenue from the merchant fee minus loss from the decreased cardholder fee—given the other network's cardholder fee and both networks' cardholder bases. The other network's cardholder fee is used as the base cardholder fee of the network. That means if the network sets the same cardholder fee as the other network's, the loss from the cardholder fee is zero; if the network sets the cardholder fee lower than the other network's, the difference between the two cardholder fees times the number of transactions used by the network cards is the loss; if the network sets the cardholder fee higher than the other network's, the difference times the number of transactions used by the network cards is seen as the gain.

First, let us consider the case where the two networks' cardholder bases are the same. Table 1 reports Network 1's net revenues when Network 2 sets its cardholder fee so that Network 2's card users' net transactional benefit ($t_c - f_2$) is 0.5. Three panels in the table present the results under different parameter values of α, the share of cardholding customers in the total customer base, and t_m, a merchant's transactional benefit from a card payment, because it is considered that these parameters greatly vary by industry. Panel 1 shows the case where α=0.75 and t_m=0.5, panel 2 shows the case where α=0.75 and t_m=1, and panel 3 shows the case where α=1 and t_m=0.5.

Whenever singlehoming and multihoming cardholders coexist ($0 < \sigma / \alpha < 1$), Network 1 can increase its net revenue by setting its cardholder fee lower than Network 2's cardholder fee. However, any lower fees do not always increase the net revenue, compared with the net revenue when Network 1 sets the same cardholder fee as Network 2's. For example, in panel 1, when σ / α=0.8, if Network 1 sets its cardholder fees so that its card user's net transactional benefit ($t_c - f_1$) becomes 1, 0.9, or 0.6, then the network's net revenue increases; if instead the network sets its cardholder fee so that $t_c - f_1$=0.7 or 0.8, then its net revenue decreases. Therefore, how much lower Network 1's cardholder fee should be depends on the parameter values. Obviously Network 1 has no incentive to set its cardholder fee higher than Network 2's cardholder fee.

Next, let us consider the case where Network 1's cardholder base is smaller than Network 2's. Table 2 presents Network 1's net revenue given a card user's net transactional benefit from Card 2 ($t_c - f_2$) is 0.5, the share of cardholding customer base (α) is 0.75, and a merchant transactional benefit from a card payment (t_m) is 0.5. Panels 1, 2 and 3 show the cases where the ratio of Network 1's cardholder base to Network 2's cardholder base are 0.9, 0.7, and 0.5, respectively. Similar to symmetric cardholder bases, the network with the smaller cardholder base would set a lower cardholder fee than its rival's cardholder fee. Again, how much lower the cardholder fee should be depends on parameter values.

Finally, let us consider the case where Network 1's cardholder base is larger than Network 2's. Table 3 presents the results under the same parameter values as table 2 ($t_c - f_2$=0.5, α=0.75, t_m=0.5), except for the ratio of Network 1's cardholder base to Network 2's. Panels 1, 2 and 3 show the cases where the ratio of Network 1's cardholder base to Network 2's cardholder base are 1/0.9, 1/0.7, and 1/0.5, respectively. In contrast with the previous two cases, when Network 1's cardholder base is the larger, Network 1 can increase its net revenue by setting its cardholder fee *higher* than Network 2's cardholder fee. For example, see in panel 2, when the share of multihoming cardholders among the total cardholders (σ / α) is 70 percent (that is, all Card 2 holders are multihoming). By setting its cardholder fee higher so that its card user's net transactional benefit ($t_c - f_1$) becomes 0.1 or 0.2, Network 1's net revenue is higher than it would be by setting its cardholder fee lower. However, such cases are rare and for most parameter values, Network 1 can increase its net revenue by setting the cardholder fee lower than Network 2's. The network with the larger cardholder base will unlikely set its cardholder fee higher than its rival's cardholder fee, even when its revenue increases by doing so. Setting a higher cardholder fee will not change the network's cardholder base immediately, but it may eventually affect the network's cardholder base negatively.

The experiments in this section suggest that a network has an incentive to set its cardholder fee lower than its rival's cardholder fee regardless of whether the network has the larger cardholder base, the smaller cardholder base, or the same cardholder base as its rival's.

5. Conclusion

This paper examined the effects of network competition on equilibrium merchant fees in detail. Previous literature suggested that if all cardholders hold at most one card then network competition does not lower merchant fees, while if some cardholders are multihoming then network competition likely lowers merchant fees. By using numerical examples with various parameter values, the paper explored what percentage of cardholders need to be multihoming so that competing networks lower merchant fees, and if they were to lower the fees then by how much the fees would be lowered. This study analyzed not only competition between symmetric networks but also asymmetric networks in terms of cardholder bases and cardholder fees.

The results suggest that network competition does not necessarily lower merchant fees when merchants accept cards for strategic reasons. The share of multihoming cardholders among the total cardholders need to be large enough so that competing networks set lower merchant fees than the monopolistic merchant fee. For most parameter values, if the share of multihoming cardholders is less than 20 percent, networks can act as if they are monopolies. When the share of multihoming cardholders is around 50 percent, networks set lower merchant fees but the ratio of the equilibrium merchant fee to the monopolistic merchant fee is likely 0.75 or above.

Asymmetric cardholder bases likely lower the average equilibrium merchant fees compared with those under competition between symmetric networks; however the upper limit of the share of multihoming cardholders in the total cardholder base is also created by the difference in the two networks' cardholder bases, which keeps the minimum possible merchant fees high. Asymmetric cardholder fees typically make the average equilibrium merchant fees lower compared with symmetric cardholder fees when the share of multihoming cardholders is less than 50 percent, but those may make the average equilibrium merchant fees higher when the share of multihoming cardholders is greater than 50 percent. If, in the real world, competing networks' cardholder bases are different significantly, the average equilibrium merchant fees cannot be much lower than the monopolistic merchant fee. If, instead, their cardholder bases are quite similar and the share of multihoming cardholders in the total cardholder base is large, but if their cardholder fees are different significantly, the average equilibrium merchant fees could be quite high.

This paper also examined whether a competing network has an incentive to set a lower cardholder fee. The results suggest that regardless of whether the network has the larger cardholder base, the smaller cardholder base, or the same cardholder base as its rival's, the network can increase its net revenue by setting the cardholder fee lower than its rival's cardholder fee. Since lower cardholder fees likely make equilibrium merchant fees higher, the results may emphasize that network competition does not necessarily lower merchant fees.

In the United States, more and more consumers hold payment cards. If this implies an increase in singlehoming cardholders, networks would not reduce their merchant fees. If, instead, this implies an increase in multihoming cardholders, if everything else has been the same, networks would lower their merchant fees. However, other parameters, such as the merchants' transactional benefit and the card users' net transactional benefit, have likely changed. It is difficult to measure the change in the merchants' transactional benefit from a card, but if the benefit has declined then networks would be less likely to reduce their merchant fees from the monopolistic fee level. The card users' net transactional benefit from a payment card has likely increased, which may allow networks to raise their merchant fees. Moreover, many card issuers offer rebates to their customers in order to make their cards be the most preferred cards. As a result, some cardholders act like singlehoming cardholders even though they actually hold multiple cards.

The results obtained in this paper suggest that policies that simply encourage network competition may or may not lower merchant fees, depending on various factors, such as the merchants' transactional benefit, each network's net transactional benefit to its card users, the share of cardholders in the total customer base, the share of multihoming cardholders among the total cardholders, and each network's cardholder base. More empirical research is necessary to evaluate the effectiveness of such policies.

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Chart 1: Parameter values for which network competition *does not* lower merchant fees

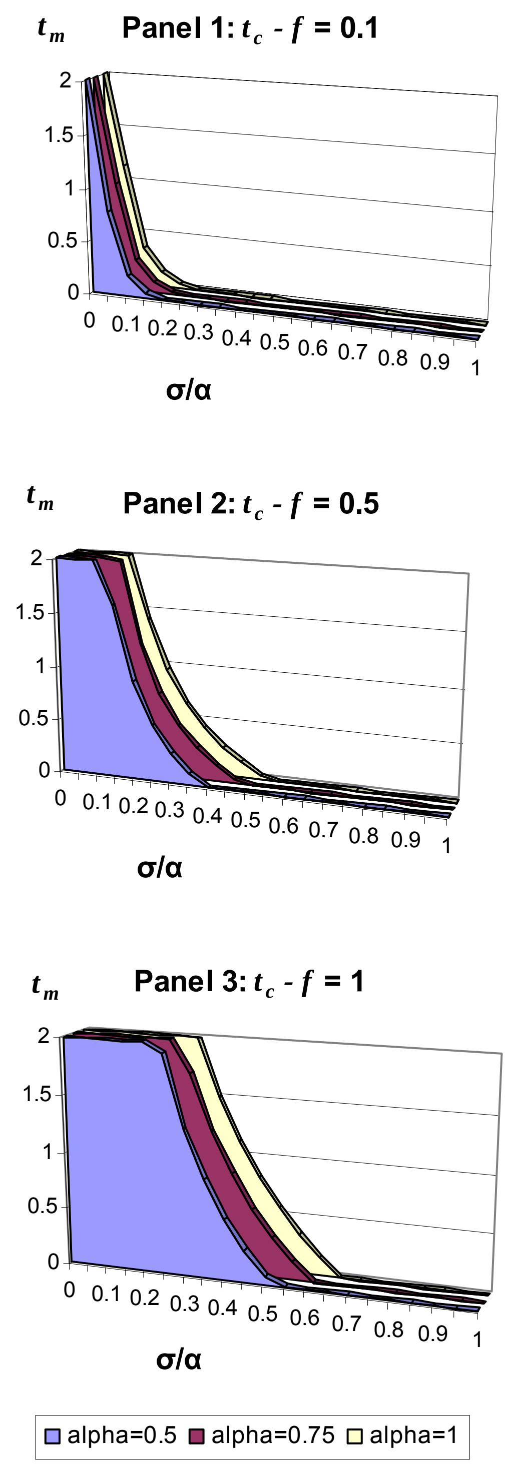


Chart 2: Equilibrium merchant fees—symmetric cardholder bases and fees (α=0.75)

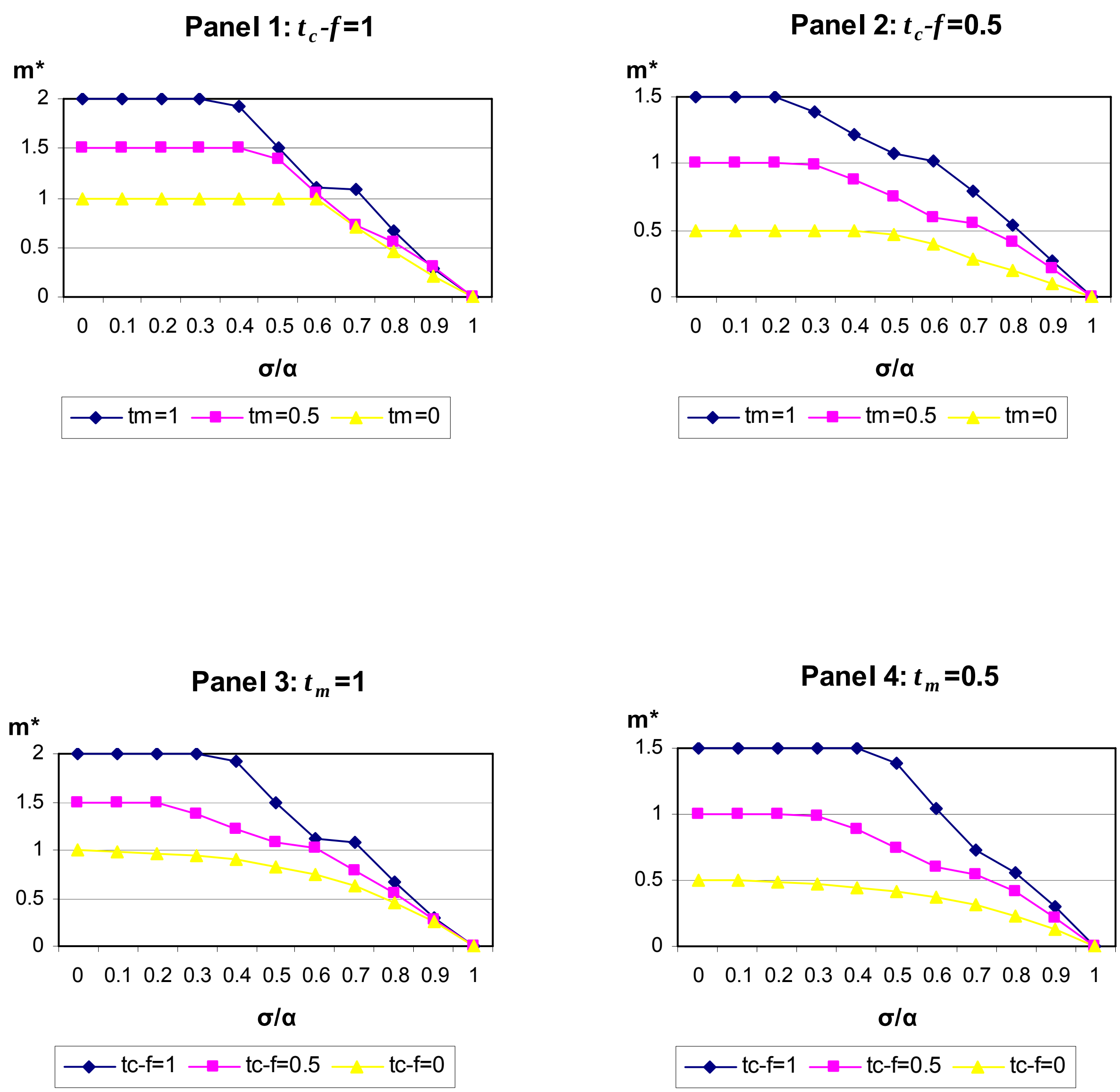
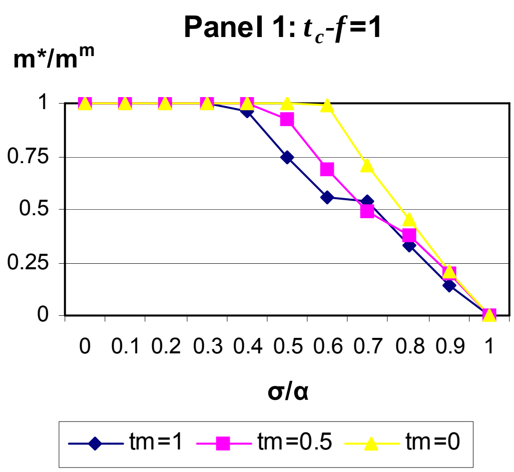
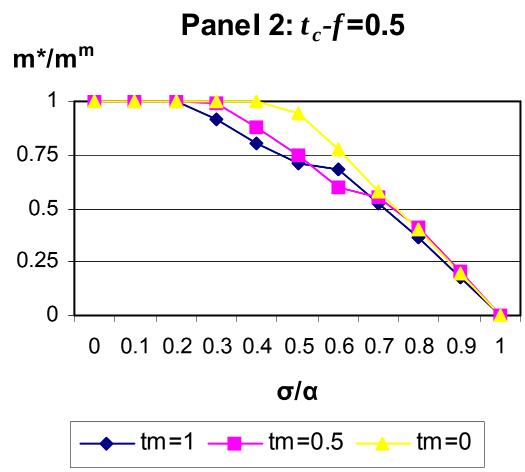
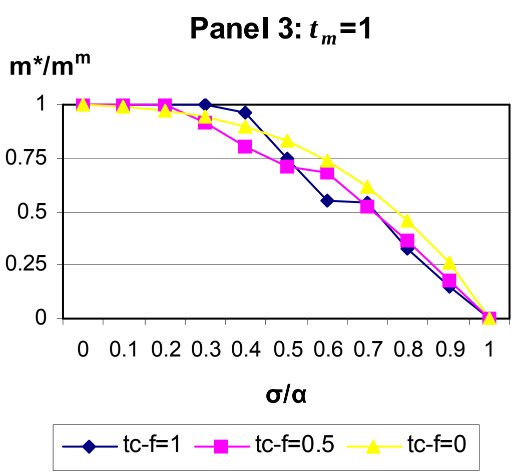


Chart 3: Equilibrium merchant fees—symmetric cardholder bases and fees:

As a percent of the merchant fee set by a monopoly (α=0.75)







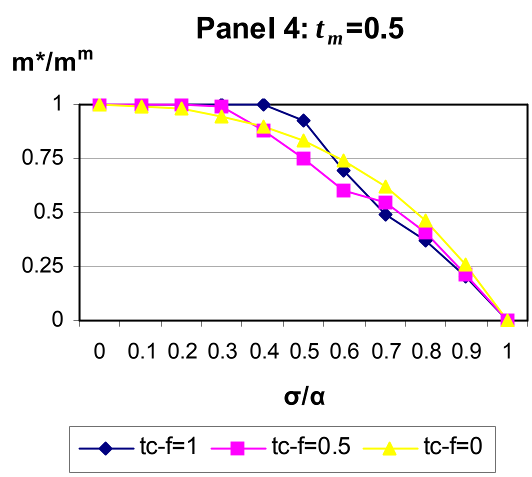


Chart 4: Equilibrium merchant fees: Effects of α

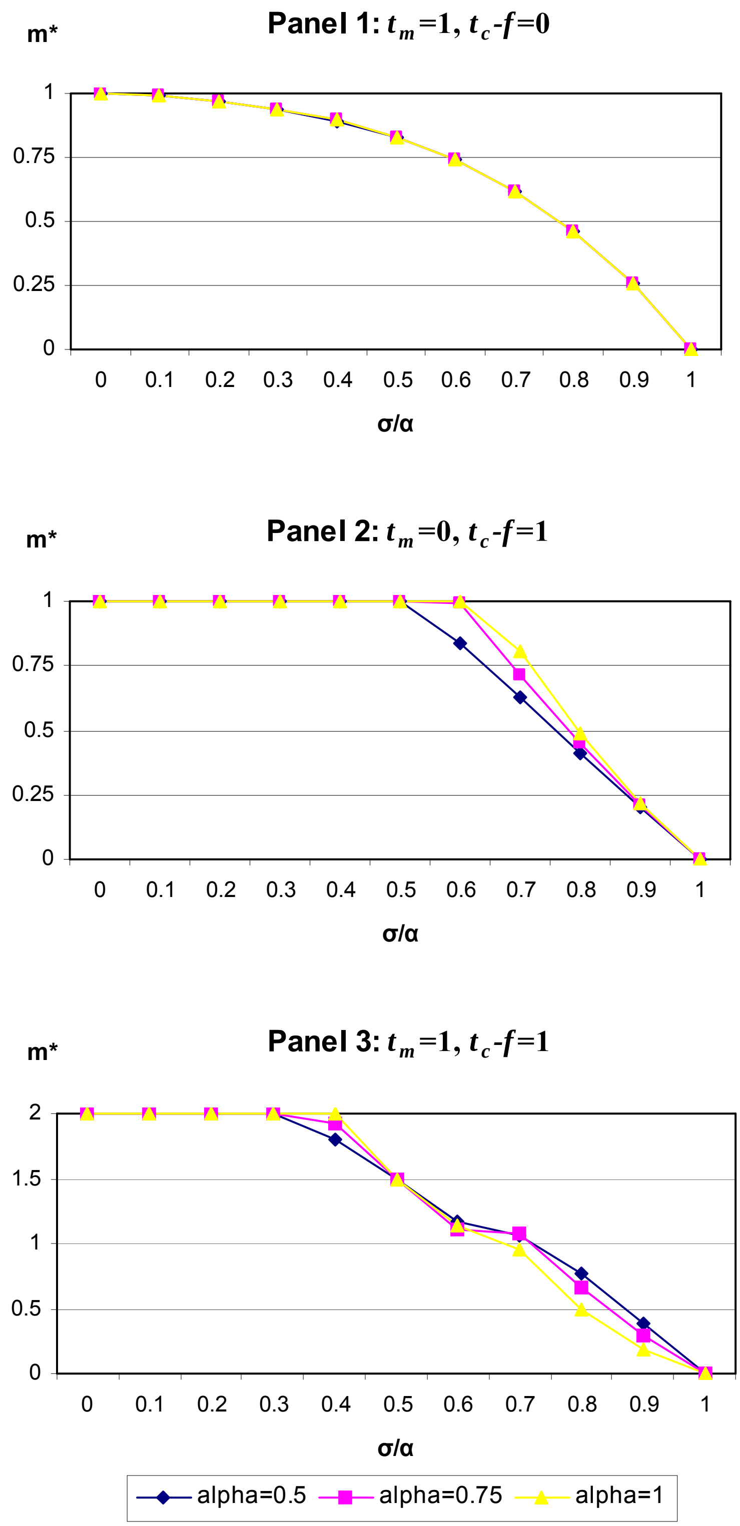


Chart 5: Parameter values for which network competition *does not* lower merchant fees:

Effects of *c* (α=0.75)

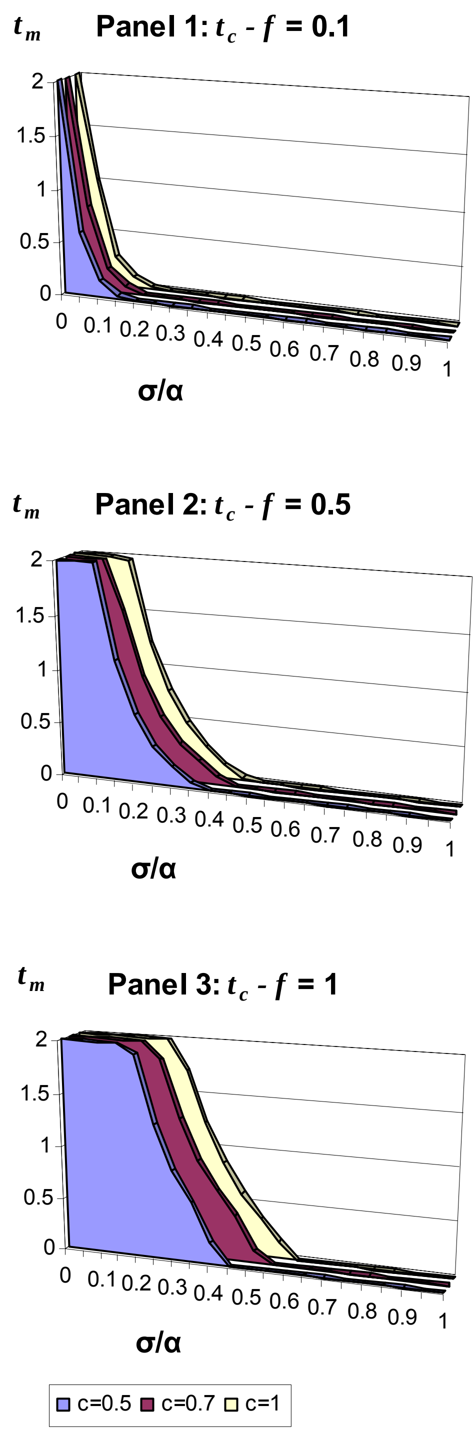


Chart 6: Average equilibrium merchant fees—asymmetric cardholder bases: Effects of c (α=0.75)

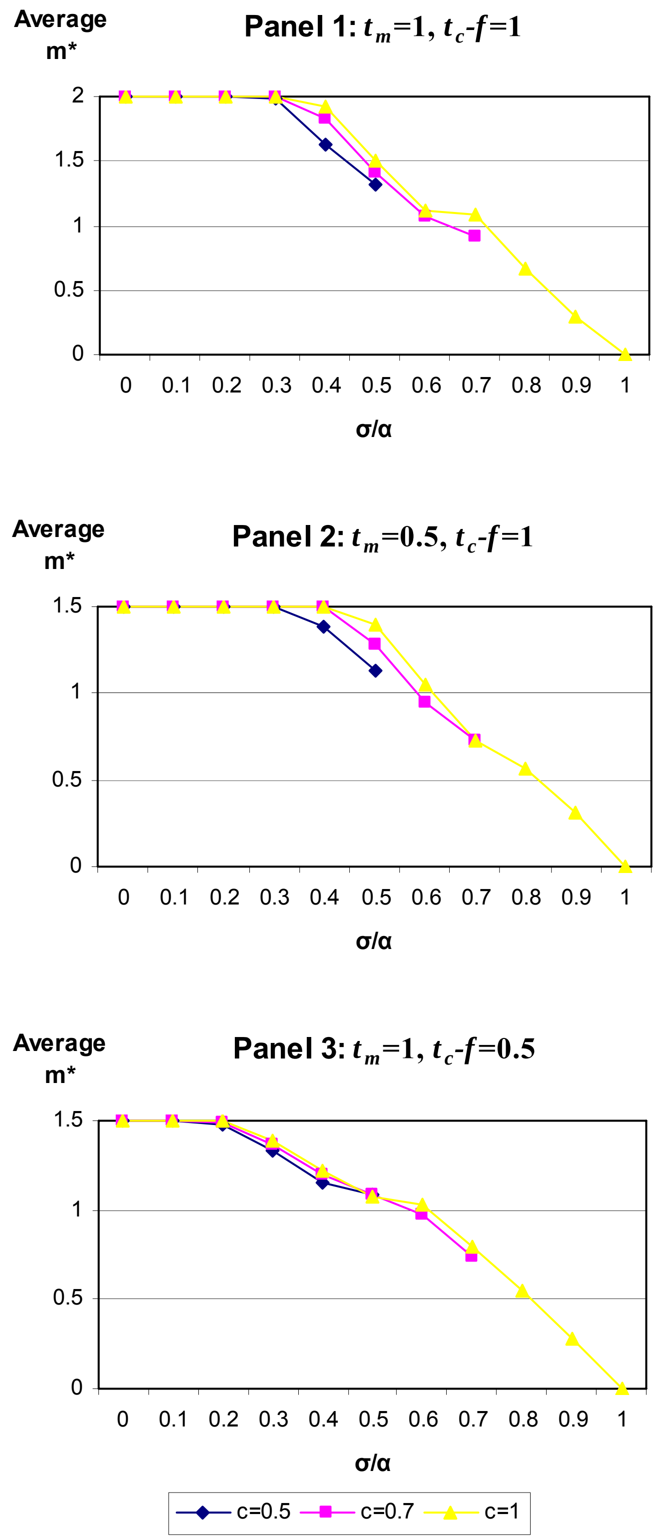


Chart 7: Equilibrium merchant fees—asymmetric cardholder fees
(α=0.75, t_m=0.5)

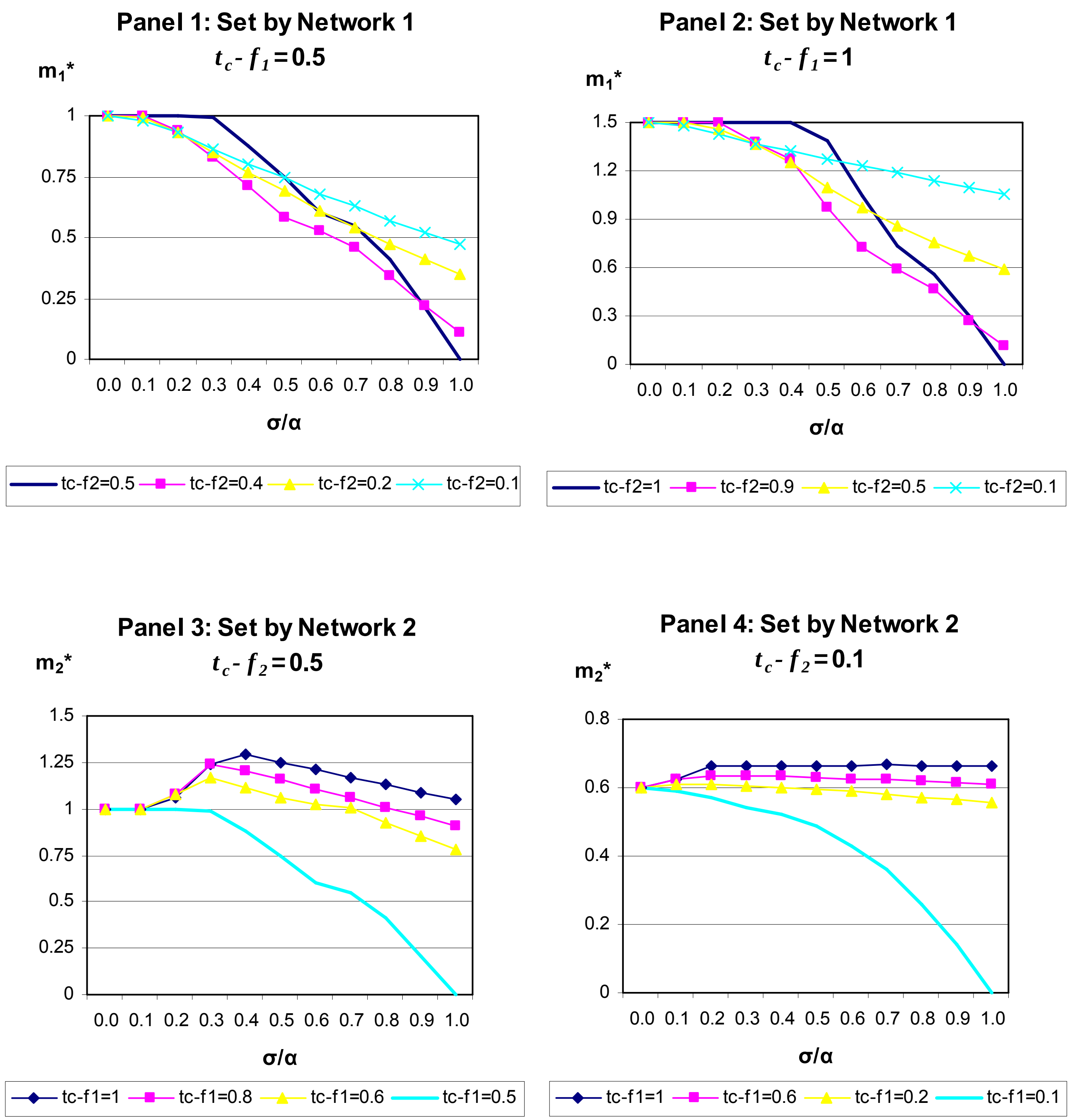


Chart 8: Equilibrium merchant fees—asymmetric cardholder fees: Effects of t_m and difference between t_c-f_1 and t_c-f_2 (α=0.75)

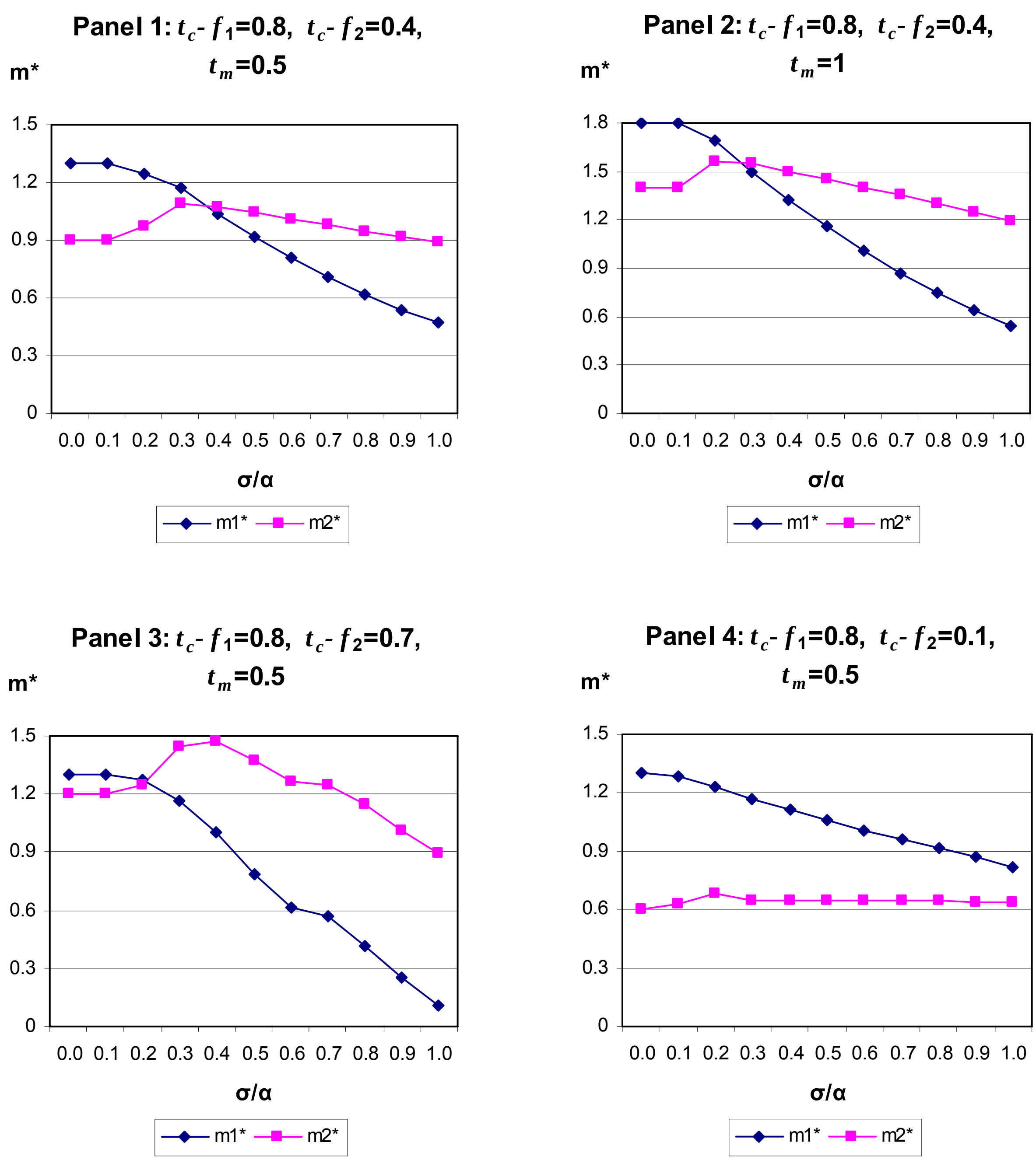


Chart 9: Equilibrium merchant fees—asymmetric cardholder fees: Effects of α (t_m=0.5)

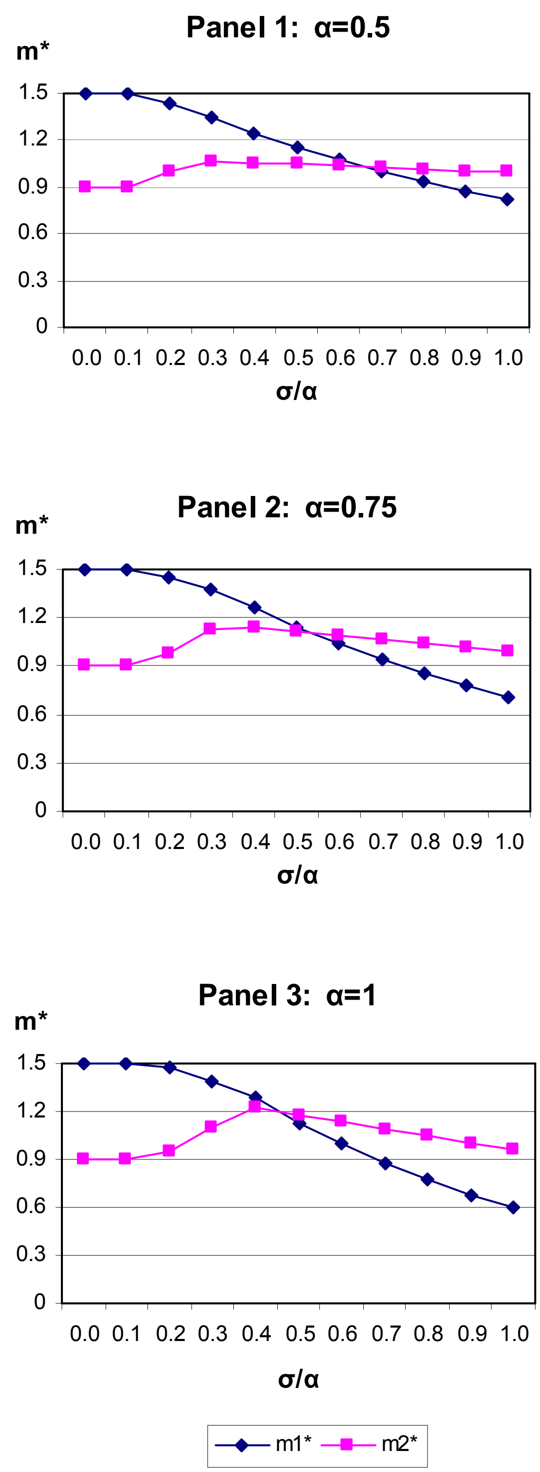


Chart 10: Average equilibrium merchant fees—asymmetric cardholder fees: (α=0.75, t_m=0.5)

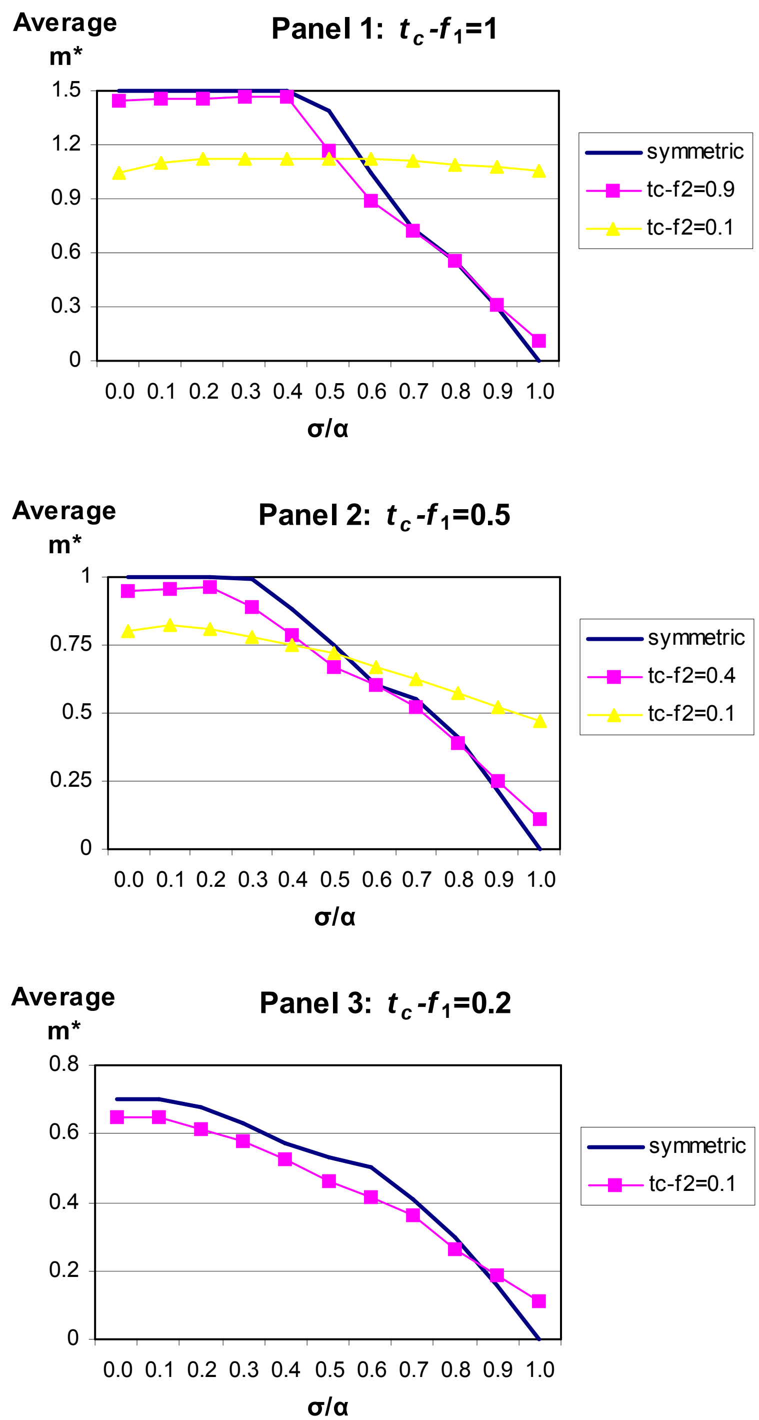


Chart 11: Equilibrium merchant fees—asymmetric cardholder bases and fees: (α=0.75, t_m=0.5, t_c-f_1=0.8, t_c-f_2=0.4)

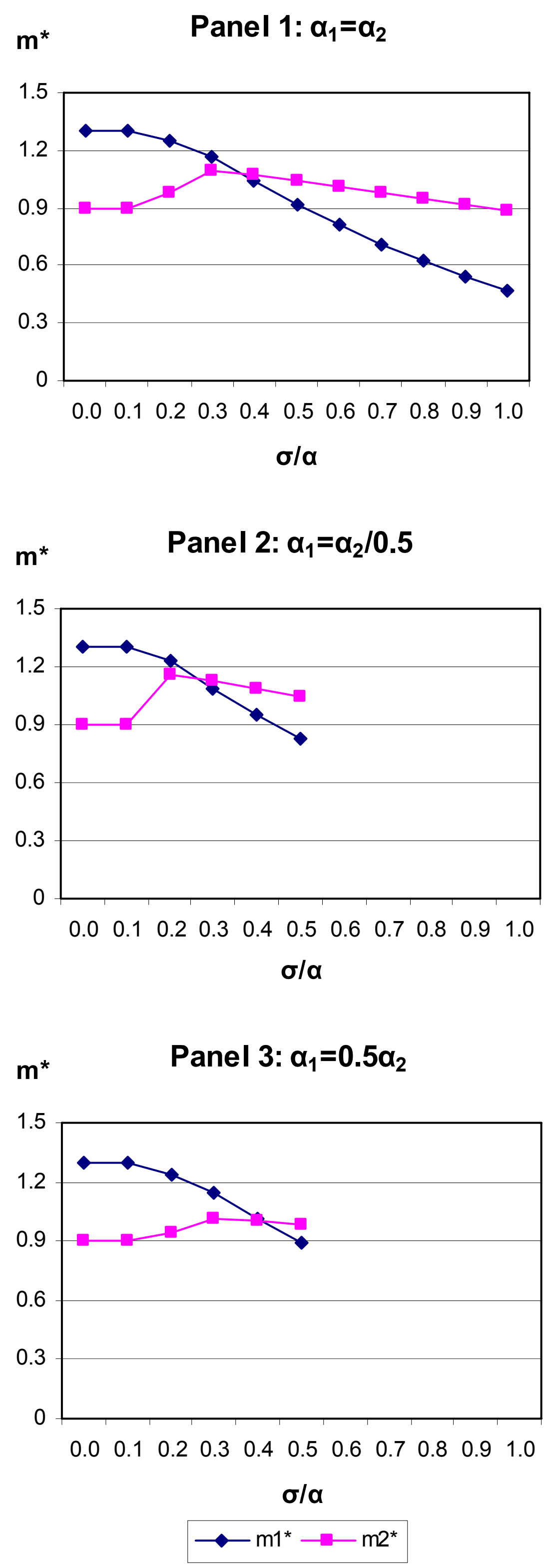


Chart 12: Average equilibrium merchant fees—asymmetric cardholder bases and fees: Effects of difference in cardholder bases
(α=0.75, t_m=0.5, t_c-f_1=0.8, t_c-f_2=0.4)

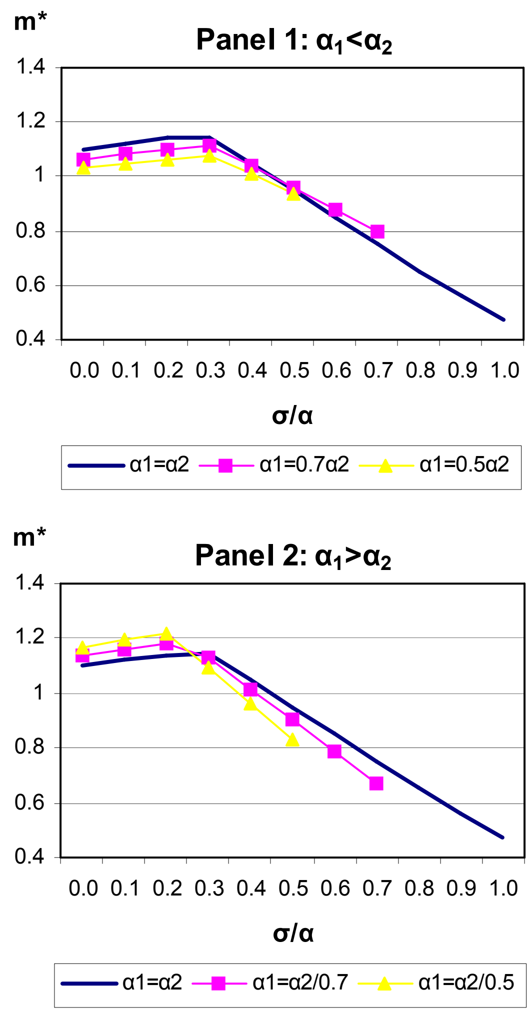


Chart 13: Average equilibrium merchant fees—asymmetric cardholder bases and fees: Effects of difference in cardholder fees
(α=0.75, t_m=0.5, t_c-f_1=0.8)

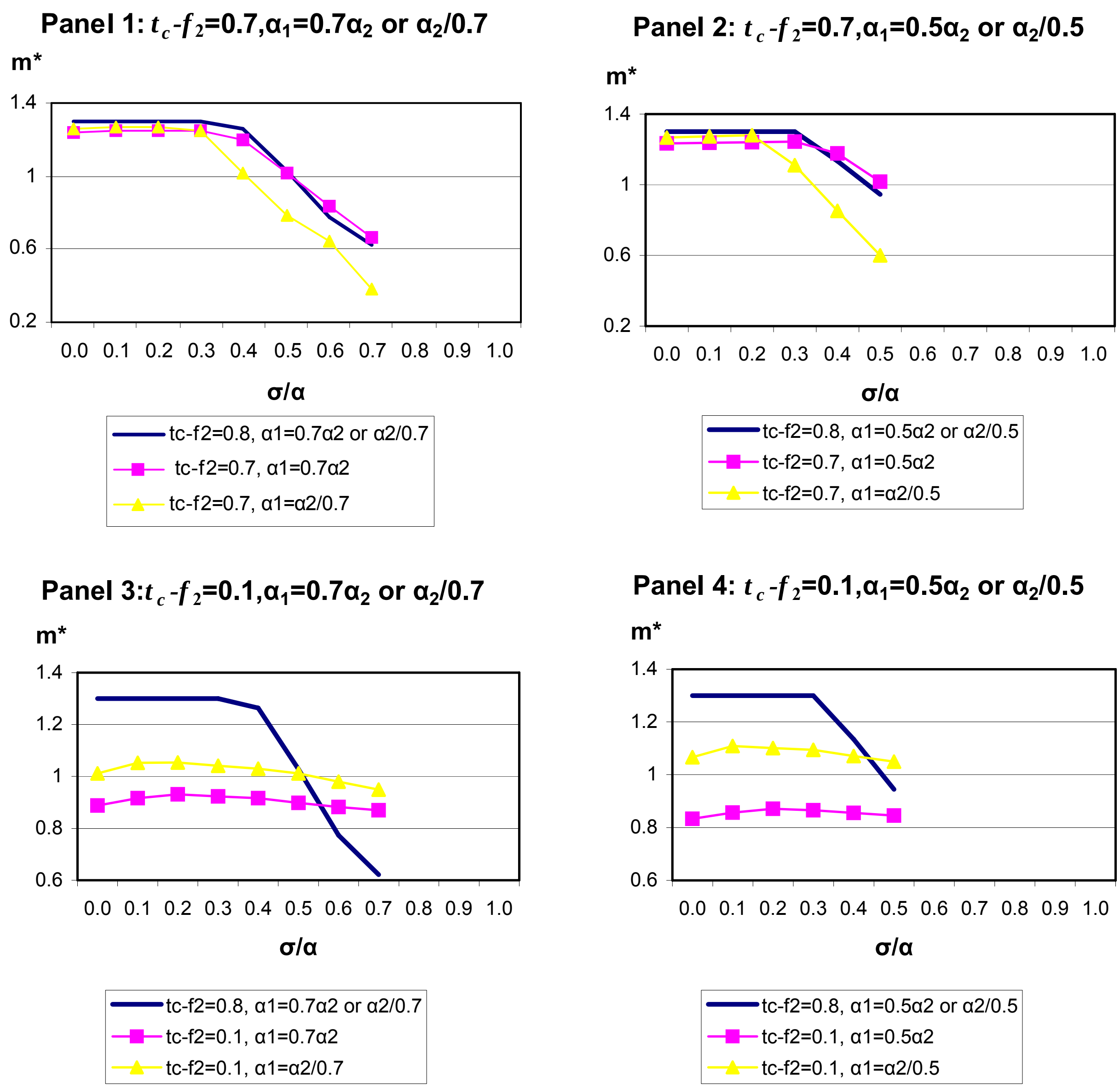


Chart 14: Average equilibrium merchant fees—asymmetric cardholder bases and fees: Effects of difference in cardholder bases and difference in cardholder fees (α=0.75, t_m=0.5, t_c-f_1=0.8)

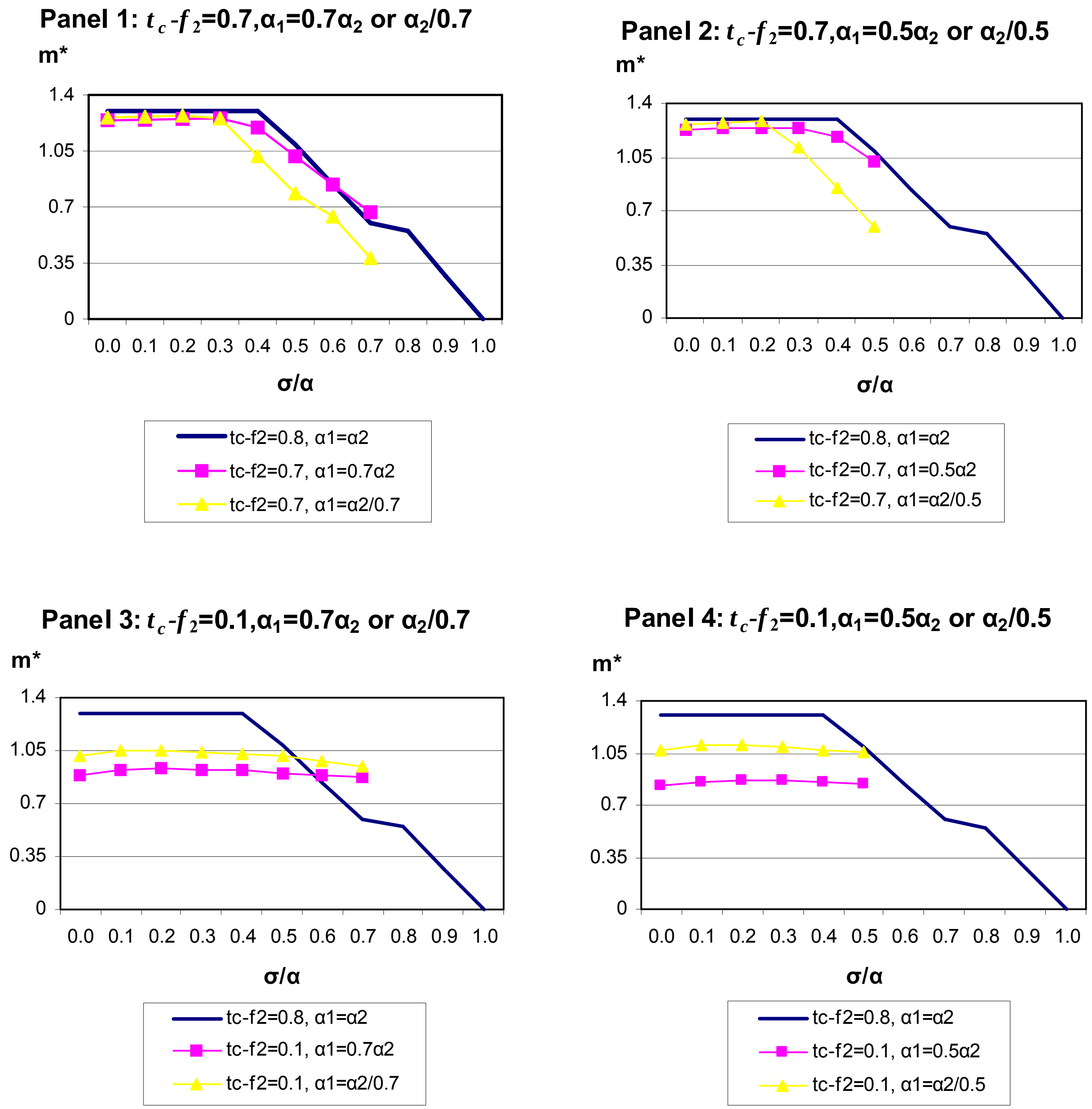


Table 1: Network 1's net revenue—symmetric cardholder bases ($t_c - f_2$=0.5)

Panel 1: α=0.75, t_m=0.5

		Share of multihoming cardholders in the total cardholding customer base										
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	1	.375	.413	.432	.424	.394	.338	.282	.230	.176	.121	.068
	0.9	.375	.413	.432	.424	.383	.332	.276	.217	.162	.107	.053
Lower	0.8	.375	.413	.428	.424	.378	.326	.264	.210	.149	.093	.038
	0.7	.375	.413	.428	.419	.373	.315	.258	.198	.135	.078	.023
	0.6	.375	.413	.428	.414	.362	.309	.270	.261	.176	.093	.008
Same	0.5	.375	.375	.375	.371	.330	.281	.225	.206	.154	.079	.000
	0.4	.375	.338	.327	.288	.240	.193	.152	.111	.070	.033	.000
Higher	0.3	.375	.338	.327	.282	.238	.194	.152	.111	.072	.035	.000
	0.2	.375	.342	.317	.276	.235	.194	.153	.113	.075	.037	.000
	0.1	.375	.346	.309	.269	.230	.191	.152	.114	.076	.038	.000

Panel 2: α=0.75, t_m=1

		Share of multihoming cardholders in the total cardholding customer base										
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	1	.563	.619	.626	.600	.536	.467	.402	.332	.263	.200	.135
	0.9	.563	.619	.626	.595	.525	.456	.384	.312	.243	.171	.105
Lower	0.8	.563	.619	.626	.585	.520	.444	.372	.293	.223	.150	.082
	0.7	.563	.619	.626	.580	.509	.456	.468	.383	.270	.164	.053
	0.6	.563	.619	.626	.570	.515	.540	.450	.351	.243	.135	.023
Same	0.5	.563	.563	.563	.518	.454	.401	.383	.296	.203	.101	.000
	0.4	.563	.510	.479	.407	.341	.281	.215	.153	.096	.045	.000
Higher	0.3	.563	.519	.471	.405	.339	.277	.220	.160	.103	.049	.000
	0.2	.563	.523	.464	.402	.340	.280	.220	.163	.106	.052	.000
	0.1	.563	.516	.457	.398	.340	.282	.224	.167	.110	.055	.000

Panel 3: α=1, t_m=0.5

		Share of multihoming cardholders in the total cardholding customer base										
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	1	.500	.550	.588	.579	.560	.458	.360	.264	.171	.076	.000
	0.9	.500	.550	.588	.579	.546	.443	.344	.255	.162	.124	.000
Lower	0.8	.500	.550	.582	.572	.525	.435	.336	.272	.243	.114	.000
	0.7	.500	.550	.582	.572	.511	.420	.352	.349	.225	.105	.000
	0.6	.500	.550	.576	.572	.497	.405	.424	.323	.216	.105	.000
Same	0.5	.500	.500	.500	.500	.450	.375	.295	.280	.195	.095	.000
	0.4	.500	.450	.430	.397	.326	.262	.207	.145	.090	.041	.000
Higher	0.3	.500	.450	.436	.386	.322	.260	.204	.151	.096	.046	.000
	0.2	.500	.455	.432	.374	.316	.259	.204	.150	.098	.048	.000
	0.1	.500	.461	.415	.362	.309	.256	.203	.151	.100	.050	.000

Table 2: Network 1's net revenue—the smaller cardholder base

($t_c - f_2$=0.5, α=0.75, t_m=0.5)

Panel 1: c=0.9

		Share of multihoming cardholders in the total cardholding customer base									
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Lower	1	.355	.391	.409	.402	.378	.325	.273	.223	.173	.122
	0.9	.355	.391	.409	.402	.368	.320	.267	.211	.160	.108
	0.8	.355	.391	.409	.402	.363	.309	.256	.199	.147	.095
	0.7	.355	.391	.405	.402	.353	.304	.244	.187	.134	.081
	0.6	.355	.391	.405	.393	.348	.293	.239	.236	.192	.068
Same	0.5	.355	.353	.351	.346	.306	.256	.203	.171	.129	.057
Higher	0.4	.355	.316	.305	.261	.210	.162	.121	.077	.036	.000
	0.3	.355	.316	.302	.255	.209	.163	.120	.078	.038	.000
	0.2	.355	.320	.293	.250	.206	.163	.121	.080	.039	.000
	0.1	.355	.324	.285	.243	.202	.161	.120	.080	.040	.000

Panel 2: c=0.7

		Share of multihoming cardholders in the total cardholding customer base							
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
Lower	1	.309	.340	.359	.349	.329	.283	.237	.194
	0.9	.309	.340	.356	.349	.320	.278	.232	.184
	0.8	.309	.340	.356	.345	.316	.269	.222	.173
	0.7	.309	.340	.356	.345	.311	.264	.212	.163
	0.6	.309	.340	.352	.345	.303	.255	.203	.152
Same	0.5	.309	.302	.296	.283	.246	.204	.167	.152
Higher	0.4	.309	.265	.251	.195	.141	.092	.044	.000
	0.3	.309	.270	.243	.191	.140	.091	.045	.000
	0.2	.309	.274	.235	.187	.138	.091	.045	.000
	0.1	.309	.274	.228	.182	.136	.090	.045	.000

Panel 3: c=0.5

		Share of multihoming cardholders in the total cardholding customer base					
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5
Lower	1	.250	.275	.288	.273	.249	.210
	0.9	.250	.275	.288	.273	.245	.206
	0.8	.250	.275	.285	.273	.242	.203
	0.7	.250	.275	.285	.273	.238	.195
	0.6	.250	.275	.285	.273	.235	.191
Same	0.5	.250	.238	.225	.202	.152	.116
Higher	0.4	.250	.206	.172	.111	.053	.000
	0.3	.250	.211	.166	.108	.053	.000
	0.2	.250	.211	.161	.106	.052	.000
	0.1	.250	.208	.156	.103	.051	.000

Table 3: Network 1's net revenue—the larger cardholder base

($t_c - f_2$=0.5, α=0.75, t_m=0.5)

Panel 1: c=1/0.9

		Share of multihoming cardholders in the total cardholding customer base									
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Lower	1	.395	.434	.455	.446	.409	.349	.291	.235	.171	.113
	0.9	.395	.434	.450	.446	.398	.343	.284	.221	.163	.105
	0.8	.395	.434	.450	.446	.392	.332	.272	.208	.149	.090
	0.7	.395	.434	.450	.436	.387	.326	.265	.208	.171	.075
	0.6	.395	.434	.450	.431	.376	.320	.303	.248	.156	.068
Same	0.5	.395	.397	.399	.397	.358	.308	.252	.229	.177	.099
Higher	0.4	.395	.359	.349	.315	.268	.223	.182	.144	.105	.066
	0.3	.395	.359	.349	.308	.266	.224	.183	.144	.106	.070
	0.2	.395	.363	.341	.302	.263	.224	.185	.147	.110	.074
	0.1	.395	.367	.333	.296	.258	.221	.184	.148	.111	.075

Panel 2: c=1/0.7

		Share of multihoming cardholders in the total cardholding customer base							
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
Lower	1	.441	.485	.498	.493	.426	.364	.296	.225
	0.9	.441	.485	.498	.488	.420	.357	.282	.218
	0.8	.441	.485	.498	.476	.414	.344	.275	.210
	0.7	.441	.485	.498	.470	.408	.338	.304	.195
	0.6	.441	.485	.498	.465	.401	.357	.296	.188
Same	0.5	.441	.448	.454	.456	.398	.323	.250	.219
Higher	0.4	.441	.410	.402	.377	.335	.294	.254	.215
	0.3	.441	.410	.402	.370	.332	.295	.258	.222
	0.2	.441	.414	.398	.363	.329	.294	.260	.226
	0.1	.441	.417	.398	.356	.324	.292	.259	.227

Panel 3: c=1/0.5

		Share of multihoming cardholders in the total cardholding customer base					
Fee	Net benefit	0	0.1	0.2	0.3	0.4	0.5
Lower	1	.500	.550	.558	.514	.434	.353
	0.9	.500	.550	.558	.507	.427	.345
	0.8	.500	.550	.558	.501	.420	.338
	0.7	.500	.550	.558	.494	.413	.330
	0.6	.500	.550	.552	.488	.420	.323
Same	0.5	.500	.513	.525	.505	.457	.405
Higher	0.4	.500	.475	.468	.451	.416	.379
	0.3	.500	.475	.471	.445	.414	.382
	0.2	.500	.478	.467	.439	.410	.382
	0.1	.500	.483	.459	.432	.406	.380