THE ECONOMICS OF PAYMENT CARD FEE STRUCTURE: POLICY CONSIDERATIONS OF PAYMENT CARD REWARDS

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October, 2008

Abstract

This paper considers possible public policies that could improve efficiency and welfare distribution in the U.S. retail payments industry. Mainly, four options, i) encouraging competition; ii) allowing merchants to surcharge; iii) regulating merchant fees; and iv) regulating payment card rewards, are discussed, but each option has advantages and disadvantages. Any single option may not achieve the policymakers' objective; rather, combining several policy options may be required.

1. Introduction

In many countries, public authorities have intervened with the payment card industry in general and the payment card fee structure in particular.[2] Some public policy interventions have directly regulated the level of the fees paid by merchants and other interventions have abolished network rules and/or encouraged competition among card networks, aiming to reduce the level of fees paid by merchants. In the United States, public authorities and legislatures have not taken actions regarding the payment card fee structure until very recently. In 2008, the U.S. legislature has introduced two bills in the Congress, which are aiming to change the balance between the merchant fee and the cardholder fee (or rewards).

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[2] Bradford and Hayashi (2008).

Policymakers should consider three key questions, when considering public policies. First, what is the optimal balance between the merchant fee and cardholder fee (or payment card rewards)? Second, if the market cannot reach the optimal balance, what market forces cause the equilibrium fee structure to deviate from the optimal fee structure? And third, what are policy options? This paper is the last of a series of three papers. The first paper examined the optimal balance between the merchant fee and the cardholder fee from both efficiency and equity perspectives.[3] The results and available empirical evidence suggest that providing rewards may not be the most efficient; nevertheless, the rewards are prevalent in the United States. The second paper investigated what market forces drive payment card rewards.[4] The results suggest that there are three potential market forces that altogether may drive payment card rewards, and that encouraging competition among card networks—the policy commonly used in a typical one-sided market—may not work to improve efficiency and/or welfare distribution; rather, the policy may potentially deteriorate those. These results should be utilized to consider the public policies—knowing these results may reduce the risk of implementing policies that may bring unwanted outcomes for policymakers. This paper considers potential public policies that could improve efficiency and welfare distributions in the U.S. retail payment industry.

There are several viable options that would change the current balance between the merchant fee and the cardholder fee to a more desirable balance from both efficiency and equity points of view. More specifically, reducing the merchant fee and payment card rewards would likely enhance social welfare and improve its distribution. This paper discusses some of those options and addresses advantages and disadvantages of each option. Any single option might not be able to achieve the policy goal; instead, combining several options may be required. In some

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[3] Hayashi (2008a).
[4] Hayashi (2008b).

instances, theory and available empirical evidence give a clear policy implication. In other instances, insufficient theory or a lack of evidence makes it hard to evaluate some policy options. In these cases, this paper points to the theory and data that would be required. How to design more suitable (combinations of) policies is very challenging, yet it may not be infeasible.

The rest of the paper is organized as follows. Section 2 recaps the results in the first and the second papers—the optimal balance between the merchant fee and the cardholder fee, and equilibrium fee structures and their welfare consequences. Section 3 considers policy options and their advantages and disadvantages. Section 4 concludes.

2. Recap—Optimal Fee Structures and Equilibrium Fee Structures

2.1 Recap—Optimal Fee Structure

Efficiency and equity are two commonly used criteria to consider the "optimal" fee structures or price levels. Efficiency is often measured by social welfare, which consists of welfares of all parties involved in the market. The most efficient card fee structure, therefore, can be defined as the fee structure that maximizes social welfare of all parties involved in the payment card market. Equity considers the distribution of social welfare among different parties. In contrast to efficiency, there is no clear way to measure equity. Because equity and efficiency do not necessarily coincide, political decision is required to define the "optimal" fee structure. Therefore, one approach to consider the "optimal" fee structure is to examine the most efficient card fee structure and its effects on welfare distribution among different parties.

Although it is not always the case, in most cases the most efficient cardholder fee is the difference between the card network's costs for a card transaction and the merchant transactional benefit from the card transaction. Therefore, in most cases, providing rewards to card-using consumers is the most efficient only when the merchant transactional benefit from a card transaction exceeds the card network's costs of processing it. In some cases, the product price and the merchant fee also affect social welfare, while in other cases, they do not.

The most efficient fee structure and product price do not necessarily make all parties involved in the payment card market better off, compared with the economy where no card products are available. Especially, consumers who use the alternative payment method, such as cash and checks, would likely be worse off, if the product price they face is higher due to the introduction of the cards. Since the product price is generally positively correlated with the merchant fee, the higher the merchant fee, the worse off these consumers are. Furthermore, not all card-using consumers are better off even when the fee structure and product price are the most efficient. Card-using consumers whose transactional benefit from cards is relatively small would likely be worse off due to the higher product price. In contrast, card-using consumers whose transactional benefit from cards is relatively high would likely be better off because their transactional benefit from cards would likely exceed the welfare losses due to the higher product price.

If merchants are allowed to set different prices according to their customers' payment method and if they actually practice such pricing, then the maximum social welfare would not be lower than that when merchants are not allowed to do so. In some cases, the merchant's ability to price discriminate their customers would increase the maximum social welfare, while in other cases, it would not affect the maximum social welfare. In either case, the merchant's practicing discriminatory pricing would likely affect welfare distribution. The most efficient card fee structure and product price would be less likely to negatively affect the surplus of a consumer who uses the alternative payment method. And all card-using consumers would likely be better off compared with the case where no card products are available. Because of the incentive compatibility constraints, the merchants and card networks would not incur losses under the most efficient fee structure and product price regardless of whether the merchants set different prices across payment methods or not.

Whether the most efficient cardholder fee is positive or negative is an empirical question. Available existing cost studies, which used relatively old information on merchant costs, suggest that the most efficient cardholder fee may likely be positive.[5] This implies providing rewards may not be the most efficient. In order for policymakers to accurately evaluate whether currently provided payment card rewards are efficient or not, collecting comprehensive and updated information on costs and benefits of various parties is required.

2.2 Recap—Equilibrium Fee Structure

The second paper investigated what market forces drive payment card rewards, when providing rewards may not be the most efficient. The paper identified three factors that altogether may explain the prevalence of rewards programs in the United State today. They are oligopolistic merchants, output-maximizing card networks, and the merchant's inability to set different prices across payment methods. It is quite plausible that these three factors co-exist in the U.S. payment card market.

Arguably, some merchants may be monopolistic at least locally. Having rewards at equilibrium with monopolistic merchants is possible but in rather limited circumstances. When consumers make a fixed number of transactions (say, all consumers make an X number of transactions a year), providing rewards is unlikely to be at equilibrium. In this case, monopolistic merchants would not accept cards if the merchant fee exceeds their transactional benefit, and thus card networks cannot provide rewards without incurring losses. When a consumer's demand

[5] Hayashi (forthcoming 2009) calculates the most efficient cardholder fees using available empirical evidence.

function for goods is downward-sloping, which implies the number of transactions the consumer makes increases as the product price decreases (or the cardholder fee decreases in the case of card users), the equilibrium cardholder fee may potentially be negative. In this case, monopolistic merchants would accept the cards even when the merchant fee exceeds their transactional benefit because accepting the cards may induce a consumer demand curve shift upwards. In contrast, oligopolistic merchants are more likely to accept cards even when the merchant fee exceeds their transactional benefit, because of their strategic motives. The higher merchant fee allows the card networks to provide rewards without incurring losses.

It may be quite intuitive that output-maximizing networks are more likely to provide rewards than profit-maximizing networks, aiming for more consumers to use the cards instead of using the alternative payment method. When merchants are oligopolistic, a profit-maximizing monopoly network would set the most efficient cardholder fees, and thus, it would not provide rewards when providing rewards is not the most efficient. The idea is that the profit-maximizing monopoly network uses the cardholder fee to increase social welfare as much as possible and uses the merchant fee to absorb the welfare gains as much as possible. This implies that the cardholder fee set by an output-maximizing network is likely lower than the most efficient cardholder fee. We should note that the fee structure set by the profit-maximizing monopoly network is not generally the most efficient; although the cardholder fee coincides with the most efficient one, the merchant fee is generally higher than the most efficient merchant fee.

When merchants set different prices for card-using consumers and for consumers who use the alternative payment method, if per transaction costs and fees are fixed, then the fee structure does not affect the number of card transactions; rather, the sum of the cardholder fee and merchant fee affects the number of card transactions.[6] In this case, although the card networks may provide rewards, the effect of rewards would be offset by the difference in the product prices for card-using and for non-card-using consumers. Thus, the card networks would not have an incentive to provide rewards. If per transaction costs and fees are proportional to the transaction value, then even when merchants set different prices, the card fee structure still affects the number of card transactions. Nevertheless, the merchants' ability to set different prices allows the merchants to reject the cards when the merchant fee exceeds their transactional benefits. Thus, the card networks would set the merchant fee at most as high as the merchant transactional benefit. This implies that unless the most efficient cardholder fee is negative, card networks would not provide rewards at equilibrium.

The results of the theoretical models also suggest that whether per transaction costs and fees are fixed or proportional to the transaction value would significantly influence the equilibrium fee structure, especially when card networks are competing. When per transaction costs and fees are fixed (as many theoretical models assume), the equilibrium cardholder fees would converge to the most efficient cardholder fee as more cardholding consumers become multihoming. A multihoming cardholder is indifferent among cards: if the merchant accepts all (branded) cards, then his choice of which card to use is solely dependent on the cardholder fees of the cards—he chooses the card with the lowest (highest) cardholder fee (level of rewards). In contrast, when per transaction costs and fees are proportional to the transaction value, even if all cardholders are multihoming, the equilibrium cardholder fee set by competing card networks would unlikely be the most efficient; rather it would be less efficient than the cardholder fee set by a monopoly network. This implies that competition among card networks potentially deteriorates social welfare. In fact, the results suggest that when per transaction costs and fees

[6] This is consistent with the results of previous literature, which suggested the "neutrality" of interchange fees.

are proportional to the transaction value, the equilibrium social welfare would not just be lower than the maximum social welfare, but would also potentially be lower than the social welfare without cards at all. Consumers as a whole and merchants would be worse off, compared with the economy without cards. This may warrant public policy interventions.

3. Policy Considerations

This section considers possible public policies that could improve efficiency and welfare distribution in the U.S. retail payments industry. This section mainly discusses four options: i) encouraging competition; ii) allowing merchants to surcharge; iii) regulating merchant fees; and iv) regulating payment card rewards. However, this does not necessarily imply these options are better than any other options. In fact, each option has advantages and disadvantages. And any single option may not be able to achieve the policymakers' goal. Instead, combining several options may be required.

Encouraging card network competition alone may not be a good option

To achieve the efficient allocation, encouraging competition is a commonly used policy option in a typical one-sided market. However, how encouraging competition in a two-sided market affects efficiency has not been fully understood. Because of the two-sidedness, encouraging competition in one or both sides—the consumer side and merchant side—of the market may significantly affect efficiency. As credit card networks claim, they may already be quite competitive in the consumer side of the market. Card issuers (including the three-party scheme card networks) compete for card users by providing generous rewards to entice them to use the issuers' cards. The four-party scheme networks set higher interchange fees to entice card issuers to issue cards of their brands. As more issuers provide more generous rewards and differentiate their card products to compete for cardholders, more cardholders may become singlehoming, meaning they strongly prefer to use one card as much as possible. This cardholder's behavior allows for card networks to set a monopolistic merchant fee, even though they are competing in the consumer side of the market.[7] Therefore, encouraging competition in the merchant side of the market may be required to reduce the levels of merchant fees and rewards toward more efficient levels.

Several options are proposed to enhance card networks' competition in the merchant side of the market. Abolishing network rules, such as honor-all-cards rule[8] and single entity rule[9], and mandating a single card to carry multiple card networks may allow merchants to influence their customers' payment choice toward less expensive payment methods for the merchants. However, how influential merchants can be is a question. Merchants may be reluctant to reject any issuers' cards if some of their customers strongly prefer those cards to use. As long as consumers have a strong preference for which card network to process the transaction, merchants may have little influence even if the card carries multiple card networks.[10]

Merchants can be the most influential for their customers' payment choice when all cardholders are multihoming. As mentioned before, multihoming cardholders hold multiple cards and are indifferent among cards: their choice of which payment card to use solely depends on the cardholder fees as long as the merchant accepts all cards they hold. Even if all cardholders are multihoming, the equilibrium fee structure may not be the most efficient. As shown in the second paper (Hayashi 2008b), whether the equilibrium fee structure is the most

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[7] See Guthrie and Wright (2007) and Hayashi (2008b).

[8] A merchant that accepts a network's credit (or debit) card must accept all of the network's credit (or debit) cards regardless of the card issuer or specific card programs, such as consumer credit vs. corporate credit cards or no-reward consumer credit vs. reward consumer credit cards.

[9] A merchant that accepts a network's card is required to accept it at every retail location.

[10] Currently, a typical debit card in the United States carries both PIN- and signature-based debits. Some consumers strongly prefer signature debit while other consumers prefer PIN debit or are indifferent between the two. Merchants generally prefer PIN-debits due to their lower fees. There are mixed views about how influential merchants are when consumers choose between PIN- and signature-debit. Some merchants may have been successful in steering their customers toward PIN-debit, however other merchants may not.

efficient or not depends on the nature of per transaction costs and fees of the payment methods. When per transaction costs and fees are fixed amounts regardless of the transaction value, then as more cardholders become multihoming, the equilibrium fee structure converges to the most efficient fee structure. In contrast, when per transaction costs and fees are proportional to the transaction value, then even when all cardholders are multihoming, the equilibrium fee structure may not be efficient. In fact, the equilibrium fee structure in this case is less efficient than in the case where all cardholders are singlehoming. Thus, encouraging card networks' competition in the merchant side of the market may potentially deteriorate social welfare.

Because the current payment card fees are generally proportional to the transaction value, policymakers should be careful about this policy option. One thing policymakers can do before giving up this policy option is to investigate whether payment card fees need to be proportional to the transaction value or not. If the card networks' costs of a card transaction, the merchants' transaction costs and fees for the alternative payment methods, and consumers' transactional benefit from cards are not proportional to the transaction value, then encouraging the card networks' competition in the merchant side of the market, combined with making payment card fees fixed, may be a viable policy option. If these costs, fees and benefits are actually proportional to the transaction value, then encouraging the card networks' competition alone may not be a good policy option.

Abolishing no-surcharge rule may not be enough

Many card networks have a rule that restricts merchants to set different prices based on their customers' payment methods (the so-called no-surcharge rule or no-discriminatory rule). In several countries, regulatory interventions abolished this rule and merchants are now allowed to price discriminate their customers based on their payment methods. Those countries include Australia, Netherlands, Switzerland, and the United Kingdom.

Theoretically, merchants' practicing discriminatory pricing is welfare enhancing unless either card networks or merchants are monopolistic. When per transaction costs and fees are fixed, the merchants' setting of different prices across payment methods changes the payment card market from two-sided to one-sided. That is, the fee structure does not affect the number of card transactions any more; rather, the sum of the two fees, the merchant fee and the cardholder fee, affects the number of card transactions. In a one-sided market, conventional competition policies—encouraging competition among card networks—may improve efficiency. When per transaction costs and fees are proportional to the transaction value, the fee structure still affects the equilibrium card transaction volume even if merchants set different prices across payment methods. Nevertheless, the equilibrium fee structure would likely become more efficient if neither card networks nor merchants are monopolistic. Therefore, allowing merchants to price discriminate their customers would potentially improve social welfare if it is used with competition policies.

However, whether merchants actually practice such pricing is a question. Although the threat of setting different prices could induce card networks to lower the merchant fees, if practicing such pricing cannot be wide spread among merchants for various reasons, then this policy would not be very effective. Empirical evidence from other countries, such as Netherlands and Sweden,[11] suggests that although merchants are allowed to set different prices to their customers, many of them do not do so.[12] According to the Reserve Bank of Australia, practicing surcharging card customers is becoming more common among merchants, but larger merchants

[11] Today, surcharging is not allowed in Sweden.
[12] See IMA Market Development AB (2000) and ITM Research (2002).

are more likely to practice surcharging than their smaller counterparts.[13] Experience in these countries may imply that setting different prices across payment methods is costly for merchants.

There may be another reason why such pricing is difficult for merchants, especially in the United States, even if they were allowed to do so. To effectively set different prices, merchants need to know the exact level of merchant fees as well as cardholder fees. However, in reality, the U.S. merchants typically do not know their own fee level of a particular transaction due to the complex interchange/merchant fee structures. Furthermore, merchants do not know their customers' cardholder fees. Even the "average" cardholder fees in the industry as a whole are difficult to obtain.

Thus, if policymakers would want merchants to set different prices based on the payment methods, other policies that eliminate the obstacles to doing so may also be needed. For example, simplifying the card networks' fees would make it easier for the merchants to determine the price levels for card-using consumes and non-card-using consumers.

Again, policymakers should be careful about the option of combining two policies—allowing merchants to price discriminate customers and encouraging competition among card networks and merchants. If either one of the two policies is not effective, the equilibrium outcome after the policy intervention would likely be worse than that before the intervention. As discussed above, if merchants are reluctant to set different prices based on the payment methods, encouraging competition among card networks may potentially lower social welfare. If either the merchants set a monopolistic product price or the card networks set a monopolistic merchant fee, then the merchants' practicing discriminatory pricing may potentially lower social welfare.

[13] See Graph 2 in Reserve Bank of Australia (2008).

Regulating the merchant fees, rather than the interchange fees, may be more reasonable but it would require measuring costs and benefits of a card transaction accurately

Direct regulations on interchange fees and/or merchant fees have been taken in many countries.[14] The regulatory authorities determine the regulated level or cap of interchange fees or merchant fees. In some of these countries, public authorities regulate interchange fees of four-party scheme networks and do not regulate merchant fees of three-party scheme networks. The same policy—regulating four-party scheme interchange fees only—may not work well in the United States for two reasons. First, three-party scheme networks, such as American Express and Discover, have relatively large market shares in the United States; and although these three-party scheme networks do not have explicit interchange fees, their organizational form is now close to the four-party scheme: their cards are now issued by financial institutions (such as Citibank and Bank of America), and their merchant acquiring services are also provided by third-parties (such as Fifth Third Bank), besides the card networks themselves. Therefore, regulating the four-party scheme interchange fees gives a competitive advantage to the three-party scheme networks, and card issuing financial institutions would likely switch their card brands from the four-party to the three-party schemes. Second, regulating interchange fees alone allows card networks to find the other ways to transfer funds from merchants to card issuers. For instance, card networks may lower association dues for card issuing members and raise them for acquiring members, which are ultimately paid by merchants. Because the policymakers' ultimate goal is to set the appropriate balance between the fees paid by merchants and the fees paid (or rewards received) by consumers, this policy would require policymakers to monitor other fees as well.

Some regulators require interchange fees or merchant fees to be set based on the cost-based benchmarks. If the U.S. policymakers would regulate the merchant fees based on the cost-based

[14] See Bradford and Hayashi (2008).

benchmark, they need to determine which costs should be included in the cost-based benchmarks. Typically, the merchants and the card networks (and their card issuers) have different views on which costs should be covered by the fees paid by merchants. Although the cost categories that are allowed to be included in the cost-based benchmark vary by country and payment card type (credit or debit), there are mainly three cost categories considered that issuers can recover from the fees paid by merchants: One is the costs of processing a transaction, which includes both authorization and clearing/settlement processes. Two is the costs for fraud losses (including payment guarantee to the merchants) and fraud prevention. And three is the costs of free-funding period.

We should note that providing rewards is not considered as the cost of issuers in the countries that regulate the interchange fees or merchant fees. To some extent, this view is shared with the theoretical literature on the payment card industry. In the theoretical models, providing rewards is not included in the card network's costs or the joint costs of the acquirer and the issuer for a card transaction; rather, rewards are considered as negative cardholder fees. However, this does not necessarily justify regulating the interchange fees or merchant fees based on the cost-based benchmark.

Setting the level (or cap) of the merchant fees at the cost-based benchmarks would be welfare enhancing if the most efficient cardholder fee—the card network's costs (or the joint costs of the acquirer, the issuer and the card network) for a card transaction minus the merchant's transactional benefit from a card transaction—is positive but the market equilibrium cardholder fee is negative (i.e., rewards are provided). The resulting cardholder fees due to this regulation are likely to be still lower than the most efficient cardholder fee, but they are likely to be closer to the most efficient cardholder fee than the pre-regulation equilibrium cardholder fees.

In contrast, if the most efficient cardholder fee is negative (i.e., providing rewards at a certain level is the most efficient), the same policy may either improve or worsen social welfare.[15] The resulted cardholder fees due to the regulation are likely to be higher than the most efficient cardholder fee, while the market equilibrium cardholder fees are likely to be lower than the most efficient cardholder fee. Thus, whether the regulation improves or worsens social welfare depends on the difference between the cardholder fees under the regulation and the most efficient cardholder fee and the difference between the equilibrium cardholder fees and the most efficient cardholder fee. If the former is greater than the latter (i.e., the resulted cardholder fees are much higher than the most efficient cardholder fee), then the cost-based merchant fee would likely worsen social welfare. On the other hand, if the latter is greater than the former (i.e., the current rewards at the market are too generous compared with the most efficient rewards level), then the regulated merchant fee would likely improve social welfare.

The potential negative effects of this policy option on social welfare would be diminished if policymakers use this option with policies that encourage competition among card networks and among merchants. Except for some special cases (when per transaction costs and fees for the payment methods are fixed and consumers make a fixed number of transactions regardless of the price of the goods), the product prices affect social welfare, and generally, social welfare increases as the product prices are lowered. Thus, encouraging competition among merchants to reduce the product prices would positively affect social welfare. And encouraging competition among card networks (especially when card networks are profit-maximizing) would reduce the risk that the resulted cardholder fees due to the regulation become too high compared with the most efficient cardholder fee.

[15] Although the available empirical evidence in the United States suggests that the most efficient cardholder fee is likely positive.

Nevertheless, setting the merchant fees based on the cost-based benchmarks may still negatively impact social welfare, and therefore, policymakers should be careful about this policy option. It would be safer for policymakers to implement this policy option if it is certain that the most efficient cardholder fee is positive or it is negative but close enough to zero.

Another downside of this policy option is that it requires accurately measuring the joint costs of the acquirer, the issuer, and the card network for a card transaction (if three-party scheme, then simply the card network's costs) and it also requires policymakers to determine which *level* of the costs should be used to set the merchant fees. According to several industry studies, the issuer's costs vary by issuer: larger card issuers tend to have lower costs than their smaller counterparts.[16] Policymakers need to decide whether the highest, the average, or the lowest costs among issuers should be used to determine the level (or the cap) of the merchant fees. If policymakers choose the cost level that is lower than the highest, then the highest cost issuers may need to exit the market. But if policymakers choose the highest costs, then some issuers, presumably larger issuers, might still be able to provide too generous rewards to their customers.

Ideally, policymakers would want to set the merchant fees at the most appropriate level, instead of setting the merchant fees at the cost-based benchmarks. However, depending on the market environment, such as competition among card networks and their objective and competition among merchants, the regulated merchant fees would not necessarily result in the appropriate levels of cardholder fees and product prices. If card networks are output-maximizing and merchants are quite competitive, then setting the merchant fees at the merchant's transactional benefit from a card would make the cardholder fees and the product prices close to

[16] According to various industry sources. For instance, Star Network's *POS Debit Issuer Cost Studies (2006, 2007)* and Visa's *Credit Card Issuer Functional Cost studies*.

the most efficient levels. Therefore, setting the merchant fees at the most appropriate level is more effective if it is used with policies encouraging competition among card networks and among merchants.

Setting the merchant fees at the merchant transactional benefit from cards does not require accurately measuring the joint costs of the acquirer, the issuer, and the card network; however, it requires accurately measuring the merchant's transactional benefit from a card, which may be more challenging. Merchants may have an incentive to underreport their transactional benefit from a card in order to reduce the merchant fee. Therefore, policymakers need to obtain the merchants' transactional benefit from the other sources (for example, comprehensive studies on merchant's costs and benefits that can also be used to set fees for the alternative payment methods, such as cash and checks, or the merchant tax information that reflects the costs of alternative payment method).

Although regulating the merchant fees may not be infeasible and may potentially improve social welfare, this option requires policymakers to accurately measure the card network's costs or the merchant's transactional benefit from cards. Policymakers may need to periodically revise this information on costs/benefits. The administration costs of this policy option might not be negligible.

Regulating the rewards with abolishing no-surcharge rule and encouraging competition may work

As an alternative to directly regulating the merchant fees, policymakers have an option of directly regulating payment card rewards. They could cap the reward level at either zero or the difference between the merchant transactional benefit from cards and the card network's cost for a card transaction (whichever is higher). This would improve social welfare when the equilibrium payment card rewards are much more generous than the most efficient level. An advantage of this option is that the rewards level is always at or closer to the most efficient level, regardless of the market environment, such as the card networks' competition and the merchants' competition. However, a downside is that policymakers need to know both the card network's costs (or the joint costs of the acquirer, the issuer, and the card network) and the merchant's transactional benefit from a card. As discussed earlier, accurately measuring the card network's costs and the merchant's transactional benefit is very challenging.

Another way to regulate the payment card rewards is setting the rewards level at zero. This does not require policymakers to measure either the card network's costs or the merchant's transactional benefits. Obviously, this option alone may negatively impact social welfare if providing rewards is the most efficient. However, if this option is used with competition policies and abolishing no-surcharge rules, then social welfare would likely be improved. Consider the case where the most efficient cardholder fee is negative (i.e., providing rewards is the most efficient). Competitive card networks may want to maximize their output, the number of card transactions, but they now need to do so by *reducing* the merchant fees. The lowest merchant fee they can set is at their cost of a card transaction (otherwise they make losses). Since the most efficient cardholder fee is negative, this implies that the merchant transactional benefit from a card is greater than the card network's costs of a card transaction. The merchants would save more if their customers use the cards instead of using the alternative payment methods. Thus, if they are allowed to price discriminate their customers, they would set a *lower* product price for card-using customers and a *higher* product price for customers who use the alternative payment methods, such as cash and checks. The card networks may want to encourage the merchants to set different prices for card-using consumers and non-card-using consumers: they may simplify their fee schedule so that the merchants can easily determine the product prices by payment method. In order for product prices to effectively reflect the merchant's benefit from a card, merchants need to be quite competitive. Thus, policymakers need to encourage competition among merchants.

If, on the other hand, the most efficient cardholder fee is positive, setting payment card rewards level at zero alone would improve social welfare, although it would not be the most efficient. Combining the other two policies—abolishing no-surcharge rule and encouraging competition among card networks and among merchants—to this option would be unlikely to harm social welfare.

A downside of this option may be the unattractiveness of the option for some card-using consumers: This option would be welfare reducing for those consumers whose transactional benefit from cards is relatively high, although the option would be welfare enhancing for consumers as a whole. Even for consumers who would benefit from this policy, it may be difficult to recognize their welfare gains, because they usually do not observe how much product prices are raised and thus how much their welfare is reduced due to higher merchant fees.

Another downside of regulating the payment card rewards level at zero may be its enforcement. Although they may not be as effective as the current generous rewards programs, card issuers may find other ways to reward their customers. For example, extending the warranty of the products purchased with their cards or waiving annual fees of the credit cards or fees of other products the card issuers offer. Thus, this option may potentially require policymakers to monitor card issuers' behavior closely.

4. Conclusion

This paper considered the policy options that are available to the U.S. policymakers. Four main options—encouraging competition among card networks and among merchants, abolishing no-surcharge rule, regulating the merchant fees, and regulating the payment card rewards—were discussed. Since each option has advantages and disadvantages, any single option may not achieve the policymakers' objective—to improve efficiency and welfare distribution among parties involved in the retail payment system. Rather, combining several policy options may potentially work.

Because of the complexity of the payment card markets, the potential effects of any policy interventions may vary by market environments, such as competition among card networks and their objectives, competition among merchants, consumer's demand for goods, and so on. Although the paper tried to consider many different plausible market environments, it may still overlook some key market characteristics that may significantly change the effects of policy interventions. Further theoretical developments as well as comprehensive data gathering may be required to accurately assess the potential effects of policy interventions.

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THE ECONOMICS OF PAYMENT CARD FEE STRUCTURE: WHAT IS THE OPTIMAL BALANCE BETWEEN MERCHANT FEE AND PAYMENT CARD REWARDS?

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October, 2008

Abstract

This paper theoretically considers the optimal balance between the merchant fee and the cardholder fee (rewards) from both efficiency and equity perspectives. First, the paper constructs the models that can be used by the U.S. policymakers, because theoretical results are very sensitive to the assumptions of the models. Second, the most efficient fee structure and product price are considered under the various combinations of the assumptions. And finally, the paper considers welfare consequences of the most efficient fee structure.

1. Introduction

As card payments have become more prevalent, the fee structures of payment cards have been attracting more policy debates and public policy interventions. In many countries, public policy interventions have reduced the level of fees paid by merchants and as a result either payment card rewards received by card users have been reduced or fees paid by card users have been raised. In contrast to the trend in many other countries, the U.S. public authorities and legislature have not taken actions until very recently and both the merchant fees and payment card rewards have continued to increase. In 2008, the U.S. legislature has introduced two bills in the Congress, which are aiming to change the balance between the merchant fee and the cardholder fee (or rewards).

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The views expressed in this article are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Kansas City or the Federal Reserve System.

Although policymakers may be urged to take actions to resolve the heating policy debates between the merchants and the card networks, before taking actions they should consider three key questions, regarding payment card fee structures. First, what is the optimal balance between the merchant fee and cardholder fee (or payment card rewards)? Second, if the market cannot reach the optimal balance, what market forces cause the equilibrium fee structure to deviate from the optimal fee structure? And third, what are policy options? This paper is the first of a series of three papers, each of which addresses each of the three questions above.

Knowing the optimal balance between the merchant fee and cardholder fee is important for policymakers. Policymakers cannot evaluate the current fee structure determined at the market place—whether the current fee structure is close enough to the optimal fee structure—without knowing the optimal fee structure. The optimal fee structure can also be the target of policies that policymakers would potentially implement.

There are two commonly used criteria to consider the "optimal" fee structures or price levels. One is efficiency and the other is equity. Efficiency is often measured by social welfare, which aggregates welfares of all parties involved in the market. The most efficient card fee structure, therefore, can be defined as the fee structure that maximizes social welfare of all parties involved in the payment card market. Equity considers the distribution of social welfare among different parties. In contrast to efficiency, there is no clear way to measure equity. Furthermore, sometimes equity and efficiency contradict: It is possible that the most efficient card fee structure results in a much skewed welfare distribution. With a given card fee structure, if only one entity or party absorbs all welfare gains and the rest incur welfare losses, then the fee structure has a problem from the equity point of view, even if the fee structure maximizes social welfare. Thus, political decision is required to define the "optimal" fee structure. This paper does not define the "optimal" fee structure; rather, the paper examines how the most efficient card fee structure affects welfare distribution among different parties.

The rest of the paper is organized as follows. Section 2 constructs theoretical models, taking into account institutional features of the U.S. payment card market. Section 3 examines the most efficient fee structures. Section 4 examines the welfare distribution under the most efficient fee structure. Section 5 concludes.

2. Models

This section constructs theoretical models that can be used by the U.S. policymakers when considering potential public policies. There is a large body of theoretical literature on payment card fee structure.[2] We have learned that the theoretical results are very sensitive to the assumptions of the models.[3] Therefore, constructing models that reflect the reality of the market is especially important for policymakers who implement actual policies.

There are several models that are used to analyze the most efficient fee structure. Among them, we use the model constructed by Rochet and Tirole (2002) (hereafter RT) as our base model, because the model reflects some of the institutional features in the U.S. market.[4] We extend their model, allowing some of the assumptions to vary. In the first half of this section, we consider key assumptions that reflect the U.S. payment card market. Then, in the second half, we construct our models.

2.1 Assumptions

<u>RT model</u>

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[2] See, for example, Chakravorti (2003).
[3] Hayashi and Weiner (2006).
[4] RT model focuses on payment methods' payment function, and thus it does not consider the benefits/costs of credit card's credit function. This paper also focuses on credit card's payment function, rather than its credit function. In this sense, the model considers credit cards as "charge" cards.

The RT model assumes that the fee structure does not affect the number of merchants who accept the cards. In the model, the consumer's cardholding behavior and card usage behavior are not separated; however, one can interpret the model that all consumers hold a card and their usage decision is affected by the cardholder fee. Consumers ultimately determine which payment method to use: consumers use cards when their transactional benefit exceeds the cardholder fee. Transactional benefit of a card transaction is defined as the saving of opportunity cost of using the alternative payment method, such as cash. Consumers are assumed to be heterogeneous in terms of their transactional benefit from a card transaction, while merchants are assumed to be homogeneous. Merchants are required not to set different prices according to the payment methods their customers choose. In addition, their model (implicitly) assumes that i) consumers make a fixed number of transactions (i.e., they purchase a fixed number of goods regardless of the price) and ii) per transaction costs and fees for the payment methods are fixed regardless of the transaction value.

<u>The U.S. payment card markets are matured</u>

In the RT model, the number of merchants who accept the cards is fixed regardless of the merchant fee level. As mentioned, their model can be interpreted as if all consumers hold a card and their usage is affected by the cardholder fee. In this sense, the model assumes there is usage externality but no membership externality in the market.

Payment card markets potentially have two-types of externalities—membership externality and usage externality. Membership externality (or positive feedback) arises from membership decisions: A consumer's cardholding of a particular network's card depends on how many merchants accept that network's cards. Similarly, a merchant's card acceptance of a particular network's cards depends on how many current and potential customers use that network's cards.

Usage externality arises from usage decision. In a payment market, consumers choose a payment method from a set of payment methods the merchant accepts. The consumer's choice of payment methods affects the merchant benefits/costs. However, the consumer's private incentive typically does not reflect the merchant benefits/costs.

Once the market matured, the positive feedback becomes almost negligible. That means, additional cardholders do not influence merchant card acceptance and additional merchants do not influence consumer cardholding. In contrast, usage externality exists, even after the market matured. Because the U.S. payment card markets can be considered to be matured, it may be appropriate to assume usage externality only.

Consumers

The RT model assumes that consumers are heterogeneous in terms of the transactional benefit from the card and use the card when their transactional benefit from the card exceeds the cardholder fee. A consumer's transactional benefit from cards may consist of three parts. One is resource cost saving by using a card as opposed to using an alternative payment method, such as cash or checks. For example, time spent at the casher may be much shorter if consumers use a card rather than checks. The second part is differences in benefits. Consumers may receive more benefits by using a card, such as record keeping, security, etc., but consumers may lose some benefits, such as anonymity or privacy. The last part is a saving from not paying fees to the banks or payment service providers for the alternative payment methods. How to value resource cost saving or difference in benefits may vary by individual consumers significantly. How the fees paid by consumers affect the consumers' choice of payment methods has not been fully uncovered. However, assuming the cardholder fee affects the consumer's card usage is more flexible than the other way. The model can treat it as a special case if the cardholder fee does not affect the consumer's payment choice.

In the RT model, consumers are assumed to make a fixed number of transactions. This assumption is likely to be true for some products and services but consumer demand for other products may increase as the product prices decrease or the rewards received by card users increase. The rewards received by card users affect the card users' effective price of product. A card-using consumer's effective price is the product price plus the cardholder fee (or minus rewards) minus the transactional benefit from cards, while a non-card-using consumer's effective price is the product price itself. Because there is little empirical evidence about which assumptions are more realistic, this paper considers both cases.

Merchants

Although some merchants are possibly monopolistic, many U.S. merchants are considered to be quite competitive. While monopolistic merchants are likely very sensitive to the merchant fee, competitive or oligopolistic merchants are less sensitive to the merchant fee, because of the strategic motives. Even when the merchant fees are quite high compared with the merchant transactional benefit from cards, competition among merchants may keep the merchants from rejecting the cards, given their rival merchants are accepting the cards.[5] Therefore, the assumption that merchants are less sensitive to the merchant fee may reflect the U.S. merchant behavior well.

A merchant's transactional benefit from cards is assumed to consist of two parts.[6] One is the resource cost saving by a card transaction as opposed to an alternative payment method

[5] Hayashi (2006).

[6] A merchant transactional benefit from a card may include another part. According to a report by Government Accountability Office (2008), accepting cards improves internal operations at merchants.

transaction. The other part is saving from not paying fees to the banks or payment service providers for the alternative payment methods.

As the RT model assumes, this paper also assumes merchants are homogeneous in terms of the transactional benefit from cards and the cost of selling a unit of goods. Although merchants are quite different across industries, they are more homogeneous within an industry, in terms of transactional benefit, costs of selling and markup per unit of goods. Because in the United States, interchange fees (and thus merchant fees) are typically industry specific, this assumption can be justifiable within an industry.

Card networks

Payment card schemes take one of two principal organizational forms. One is four-party schemes: Four-parties are cardholders, merchants, card issuers, and merchant acquirers. Both card issuers and merchant acquirers should be members of a payment card network. In a four-party scheme network, an interchange fee is set by the card network and paid by the merchant acquirer to the card issuer.[7] The merchant pays a merchant (discount) fee to the merchant acquirer. The merchant fee is set by each merchant acquirer, and a typical merchant acquirer entirely passes through the interchange fee to its merchants and charges other fees, such as an acquirer processing fee, association dues, and a switch fee. The cardholder either receives rewards or pays a cardholder fee to its card issuer. Each card issuer sets its own rewards or cardholder fees, and typically rewards are mostly financed by the issuer's interchange fee revenue.[8] The other organizational form is three-party schemes: Three parties are cardholders, merchants and a card network, such as American Express and Discover. In contrast to the four-

[7] In some networks, the interchange fee flows from the card issuer to the merchant acquirers. However, in the United States, the interchange fee flows from the merchant acquirer to the card issuer.
[8] The author obtained this information from industry experts at the "Consumer Behavior and Payment Choice Conference" held at the Federal Reserve Bank of Boston in July, 2006.

party schemes, there is no interchange fee, because the card network acts as card issuer and merchant acquirer. The merchant pays a merchant fee to the card network and the cardholder either receives rewards or pays a cardholder fee to the network. The network sets both merchant fees and cardholder fees.

If transferring funds between the acquirer and the issuer (i.e., interchange fee) is allowed in a four-party scheme network, a three-party scheme network and a four-party scheme network are almost equivalent when social welfare is considered. In a social welfare function, a card network's profit is considered to be the joint profits of the card network and its member acquirers and issuers, in the case of four-party scheme network.

Nature of per transaction costs and fees

As the majority of models assume, the RT model assumes that per transaction costs, fees, and benefits for payment methods are fixed regardless of the transaction value (flat per transaction costs, fees, and benefits). Only a few models assume per transaction costs, fees, and benefits are proportional to the transaction value.[9] According to cost studies in the United States, some of the costs and fees are fixed and some are proportional to the transaction value. Typically, interchange fee structure (thus merchant fee structure) consists of a fixed portion and a proportional portion. For credit cards, a fixed portion is relatively small, while for debit cards, especially for PIN debit cards, the interchange fee is more or less a flat fee—the fee reaches its cap at the average transaction value. A bank's costs of processing a cash or a credit card transaction seem to be proportional to the transaction value, while their costs of processing a debit card or a check transaction seems not to be influenced by the transaction value. A merchant's resource costs seem to be proportional for credit cards and cash and to be flat for debit cards and checks. Some of the consumer's transactional benefits from payment methods,

[9] For example, McAndrews and Wang (2006).

such as book keeping and anonymity might not be influenced by the transaction value, but other benefits might be proportional to transaction value. Thus, two extreme cases can be considered. In one case, all costs and fees (and benefits) per transaction are fixed, and in the other case, all of them are proportional to the transaction value. This paper considers both cases.

Merchant ability to set different prices according to the payment methods

Currently, many card networks have a rule that restricts merchants setting different prices for their customers according to the payment method they use. Although merchants are allowed to offer a cash discount for their customers, many of them do not do so. Therefore, the models assuming that merchants set the same price for both card-using and non-card-using consumers are well aligned with the practice. However, abolishing this rule is often considered to be a viable public policy option. Therefore, this paper considers both cases.

2.2 Models

Base model

The base model is the following. The payment card markets are considered to be matured. All consumers hold at least one card and merchants accept cards as long as the merchant fees are lower than a certain threshold level, which is endogenously determined.

Consumers are heterogeneous in their transactional benefit from cards as opposed to the alternative payments. A consumer's transactional benefit from a card, b_B, consists of three parts. One is a gross benefit minus gross cost from using a card, B_B^C;[10] one is a gross benefit minus gross cost from using the alternative payment method, B_B^A; and one is the consumer fee paid for the alternative payment method, f^A. Thus, the transactional benefit from a card is defined as:

[10] Note that the fees for a card transaction are not included in the cost.

$b_B = B_B^C - B_B^A + f^A$. b_B is assumed to be distributed over the interval $[\underline{b}_B, \overline{b}_B]$ with a density function of $h(b_B)$, and a cumulative distribution function of $H(b_B)$. Consumers pay the cardholder fee of f when they use a card.

Merchants are homogeneous (at least ex-ante) and their transactional benefit from cards, $\hat{b}_S$, is defined as the merchant cost for the alternative payment method, c_S^A, plus the merchant fee paid for the alternative payment method, m^A, minus the merchant cost for a card transaction, c_S^C (i.e., $\hat{b}_S = c_S^A + m^A - c_S^C$). Merchants pay the merchant fee of m when their customers use a card. Merchants also incur a cost of selling one unit of goods, d.

<u>Assumptions that can be varied</u>

The assumptions in the final models vary in terms of three categories: (i) Per transaction costs and fees; (ii) Consumer demand for goods; and (iii) Merchant ability to set different prices according to the payment method. There are two variations in each category. Per transaction costs and fees are either flat or proportional to the transaction value. Consumer demand for goods is either elastic (i.e., a consumer makes a fixed number of transactions) or downward-sloping (i.e., the number of transactions increases as the effective price of goods decreases). And finally, a merchant either sets the same price for all of its customers regardless of the payment method or sets the different prices according to the payment method its customers use.

3. The Most Efficient Fee Structure

The most efficient fee structure is defined as the fee structure that maximizes social welfare. Social welfare is defined as the aggregate surpluses of all parties involved in the payment card markets. Parties involved in the payment card markets are card-using consumers, non-card-using consumers, merchants, card networks, and payment service providers that provide the alternative payment method. Since payment cards are considered to be a substitute for the alternative payment methods, such as cash and checks, the surplus of a consumer who uses an alternative payment method and the surplus of alternative payment method service providers are also counted in social welfare. Payment cards can be provided by four-party scheme networks. Therefore, a card network's surplus can be interpreted as the joint surpluses of the card network and its member acquirers and issuers.

Policymakers should be interested in the most efficient fee structures for two reasons. First, the most efficient fee structure can be used to examine whether the current fee structure is efficient or not. Second, the most efficient fee structure can be the target of policies that policymakers would potentially implement.

Existing theoretical models consider the most efficient fee structures in rather limited circumstances. Most models assume 1) consumers make a fixed number of transactions; 2) costs and fees per transaction do not vary by the transaction value (flat per transaction costs and fees); and 3) merchants are not allowed to set different product prices according to the payment methods. However, as discussed in the previous section, it is possible that a consumer's quantity demanded for goods depends on the effective price the consumer faces and that costs and fees per transaction are proportional to the transaction value. Potential policies may allow merchants to set discriminatory pricing. Thus, it is important to examine how the differences in these assumptions affect the most efficient fee structures.

In the first four subsections, we examine how consumer demand for goods and per transaction costs and fees affect the most efficient payment card fee structures by assuming merchants set the same price for both card-using and non-card-using consumers. In the last subsection, we relax this assumption and examine how merchant's ability to set different prices across payment methods affects the most efficient fee structure.

3.1 Scenario I: Fixed Number of Transactions and Flat Per-Transaction Costs and Fees

Assume that each consumer receives gross benefit, υ , by purchasing one unit of product. Since merchants set the same price for card-using consumers and non-card-using consumers, consumers whose transactional benefit exceeds the cardholder fee (i.e., $f \leq b_B = B_B^C - B_B^A + f^A$) use a card and consumers whose transactional benefit is below the cardholder fee use an alternative payment method. The social welfare function is defined as:

$$
\begin{aligned}
SW = & \int_f^{\bar{b}_B} (\upsilon - p - f + B_B^C) h(b_B) db_B + \int_{\underline{b}_B}^{f} (\upsilon - p - f^A + B_B^A) h(b_B) db_B \\
& + \int_f^{\bar{b}_B} (p - d - m - c_S^C) h(b_B) db_B + \int_{\underline{b}_B}^{f} (p - d - m^A - c_S^A) h(b_B) db_B \\
& + \int_f^{\bar{b}_B} (f + m - c) h(b_B) db_B + \int_{\underline{b}_B}^{f} (f^A + m^A - c^A) h(b_B) db_B
\end{aligned} \tag{1}
$$

The first two terms of equation 1 are the surpluses of card-using consumers and non-card-using consumers, respectively, and the third and fourth terms are the merchants' profits from card-using consumers and from non-card-using consumers, respectively, and the last two terms are the card networks' profits and the (joint) profits of alternative payment method service providers.

This social welfare function is essentially the same as the social welfare function defined in RT. Equation 1 can be rewritten as:

$$
SW = (\upsilon - d + B_B^A - c_S^A - c^A) + \int_f^{\bar{b}_B} \{ b_B + \hat{b}_S - c - (f^A + m^A - c^A) \} h(b_B) db_B \, , \tag{1'}
$$

and the first term is fixed regardless of the payment card fee structure. The most efficient cardholder fee, f^*, satisfies the first-order condition:

$$
f^* = \{ c + (f^A + m^A - c^A) \} - \hat{b}_S \, . \tag{2}
$$

This condition implies that the most efficient cardholder fee is the difference between the payment service providers' (card networks and alternative payment service providers) net costs of processing a card transaction and the merchant transactional benefit from a card. To the extent that allowing the alternative payment method generates profits or losses (i.e., $f^A + m^A - c^A > 0$ or $f^A + m^A - c^A < 0$) to maximize social welfare depends on the policymakers' objectives. To simplify the model, we assume that the alternative payment method generates zero profit hereafter. Note that if payment service providers of the alternative payment method jointly earn zero profit from the alternative payment method, then the most efficient cardholder fee is the difference between the card networks' costs of processing a card transaction and the merchant transactional benefit from a card.

$$f^* = c - \hat{b}_S . \tag{2'}$$

We should note that neither the product price nor merchant fee affects social welfare although they are likely to affect the welfare distribution among different parties.

3.2 Scenario II: Fixed Number of Transactions and Proportional Per-Transaction Costs and Fees

The social welfare function is the same as equation 1 except for the costs, fees, and benefits for payment methods are proportional to the price of the goods.[11]

$$\begin{aligned} SW = & \int_f^{\bar{b}_B} (\upsilon - p - fp + B_B^C p) h(b_B) db_B + \int_{\underline{b}_B}^f (\upsilon - p - f^A p + B_B^A p) h(b_B) db_B \\ & + \int_f^{\bar{b}_B} (p - d - mp - c_S^C p) h(b_B) db_B + \int_{\underline{b}_B}^f (p - d - m^A p - c_S^A p) h(b_B) db_B \\ & + \int_f^{\bar{b}_B} p(f + m - c) h(b_B) db_B . \end{aligned} \tag{3}$$

[11] Note that we assume that payment service providers of the alternative payment method jointly earn zero profit from the alternative payment method.

The first-order condition with respect to the cardholder fee gives the same condition as equation 2'. Thus, the most efficient cardholder fee is the same regardless of whether per transaction costs and fees are flat or proportional to the transaction value when consumers make a fixed number of purchases and transactions.

However, the product price affects the social welfare when costs and fees per transaction are proportional to the transaction value. The first-order condition with respect to the product price is:

$$\frac{\partial SW}{\partial p} = \int_{f^*}^{\bar{b}_B} (B_B^C - c_S^C - c)h(b_B)db_B - \int_{\underline{b}_B}^{f^*} (B_B^A - c_S^A - c^A)h(b_B)db_B, \tag{4}$$

This condition implies that if aggregate surpluses from using a card (the first term) exceed aggregate surpluses from using the alternative payment method (the second term), then the social welfare increases as the product price increases. The highest product price that satisfies all parties' incentive compatibility constraints is the one that makes the marginal card user's surplus from using a card zero.[12] That is $p = \upsilon/(1 + f - B_B^C(i_M))$, where $B_B^C(i_M)$ is the marginal card user i_M 's gross benefit minus gross cost of using a card. If equation 4 is negative, the social welfare increases as the product price decreases. The lowest price can be achieved when merchants set the product price at the marginal cost and card networks set the merchant fee so that they earn zero profit from cards. The lowest price $p = \dfrac{d}{1 - \hat{b}_S - c_S^C}$ can be achieved when the card networks set the merchant fee at $m = \hat{b}_S$.

The summary of the most efficient fee structure and product price is the following:

[12] Marginal card user is defined as the consumer who is indifferent between using a card and the alternative payment method.

When $\int_{f^*}^{\bar{b}_B}(B_B^C - c_S^C - c)h(b_B)db_B - \int_{\underline{b}_B}^{f^*}(B_B^A - c_S^A - c^A)h(b_B)db_B > 0$,

$f^* = c - \hat{b}_S$; $p^* = \upsilon/(1 + f^* - B_B^C(i_M))$; and the merchant fee does not affect social welfare;

When $\int_{f^*}^{\bar{b}_B}(B_B^C - c_S^C - c)h(b_B)db_B - \int_{\underline{b}_B}^{f^*}(B_B^A - c_S^A - c^A)h(b_B)db_B < 0$,

$f^* = c - \hat{b}_S$; $m^* = \hat{b}_S$; $p^* = \dfrac{d}{1 - \hat{b}_S - c_S^C}$; and

When $\int_{f^*}^{\bar{b}_B}(B_B^C - c_S^C - c)h(b_B)db_B - \int_{\underline{b}_B}^{f^*}(B_B^A - c_S^A - c^A)h(b_B)db_B = 0$,

$f^* = c - \hat{b}_S$, and the merchant fee and product price do not affect social welfare.

3.3 Scenario III: Downward-sloping Consumer Demands and Flat Per-Transaction Costs and Fees

There are several variations when the market demand curve is downward sloping. Even though each consumer purchases a fixed number of products, if each consumer i has a different reservation utility, υ_i, then the number of consumers who purchase the product increases as the price of the goods decreases.[13] This section, however, assumes that each consumer has a downward-sloping demand curve for goods.

Assume that the alternative payment method (such as cash) is a “base” payment method for all consumers. That is, when product price is p, the quantity demanded by a consumer who uses the alternative payment method is $D(p) = a - bp$. The quantity demanded by a card user depends not only on the product price but also on the cardholder fee and the transactional benefit from cards. Two extreme cases can be considered. One case is where a consumer purchases goods on one transaction. The other case is where a consumer purchases one unit of goods per

[13] Schuh, Shy, and Stavins (2008).

transaction.[14] In the former case, the effective price of a card-using consumer with transactional benefit of b_B is likely the same as that of a consumer who uses an alternative payment method; however, using a card effectively increases his income by $b_B - f$. In the latter case, the effective price of a card-using consumer with transactional benefit of b_B is $p + f - b_B$. Thus, his quantity demanded becomes $D(p) = a - b(p + f - b_B)$ when he uses a card. This paper focuses on the latter case: because in the former case, the (per transaction) fee structure of payment card and product price alone cannot maximize social welfare without violating some parties' incentive compatibility constraints.

The social welfare function is defined as:[15]

$$\begin{aligned} SW &= \int_f^{\bar{b}_B} \frac{(a - bp - bf + bb_B)^2}{2b} h(b_B) db_B + \int_{\underline{b}_B}^{f} \frac{(a-bp)^2}{2b} h(b_B) db_B \\ &+ \int_f^{\bar{b}_B} (p - d - m - c_S^C)(a - bp - bf + bb_B) h(b_B) db_B + \int_{\underline{b}_B}^{f} (p - d - m^A - c_S^A)(a - bp) h(b_B) db_B \quad (5) \\ &+ \int_f^{\bar{b}_B} (f + m - c)(a - bp - bf + bb_B) h(b_B) db_B . \end{aligned}$$

The first-order conditions with respect to the cardholder fee and with respect to the product price are, respectively:

$$\frac{\partial SW}{\partial f} = -b(p - d + f - c)(1 - H(f)) + (a - bp)(c - \hat{b}_S - f)h(f) = 0 \quad (6)$$

$$\frac{\partial SW}{\partial p} = b\{-p + d + \hat{b}_S - c_S^C + (c - \hat{b}_S - f)(1 - H(f))\} = 0 \quad (7)$$

Equation 7 implies that the product price that maximizes social welfare is:

$$p^* = d + \hat{b}_S - c_S^C + (c - \hat{b}_S - f)(1 - H(f)) \quad (7')$$

[14] Schwartz and Vincent (2006).
[15] Again, we assume that payment service providers of the alternative payment method jointly earn zero profit from the alternative payment method.

We obtain two f 's from equations 6 and 7', but the second-order condition is satisfied only in one of the two, which is: $f^* = c - \hat{b}_S$.

Thus, the most efficient fee structure and product price are: $f^* = c - \hat{b}_S$ and $p^* = d + \hat{b}_S - c_S^C$. To achieve the most efficient product price without violating any parties' incentive compatibility constraints, the merchant fee needs to be set at $m^* = \hat{b}_S$. The most efficient cardholder fee is the same as the previous two scenarios and the most efficient product price can be achieved when merchants practice marginal cost pricing and card networks earn zero profit from the cards.

3.4 Scenario IV: Downward-sloping Consumer Demands and Proportional Per-Transaction Costs and Fees

Assume that each consumer has a downward-sloping demand curve. When per transaction costs and fees are proportional to the transaction value, whether the consumer purchases goods on one transaction or the consumer purchases one unit of goods per transaction does not affect the social welfare function. The social welfare function is defined as:[16]

$$\begin{aligned} SW = & \int_f^{\bar{b}_B} \frac{\{a - bp(1+f-b_B)\}^2}{2b} h(b_B)db_B + \int_{\underline{b}_B}^{f} \frac{(a-bp)^2}{2b} h(b_B)db_B \\ & + \int_f^{\bar{b}_B} \{p(1-m-c_S^C)-d\}\{a-bp(1+f-b_B)\}h(b_B)db_B + \int_{\underline{b}_B}^{f} \{p(1-m^A-c_S^A)-d\}(a-bp)h(b_B)db_B \\ & + \int_f^{\bar{b}_B} p(m+f-c)\{a-bp(1+f-b_B)\}h(b_B)db_B \end{aligned}$$

The first best solution violates merchant and/or card network's incentive compatibility constraints: That means either merchants or card networks or both make losses at the first best

[16] We assume that payment service providers of the alternative payment method jointly earn zero profit from the alternative payment method.

solution. The second best solution is, therefore, to maximize consumer surplus subject to the incentive compatibility constraints of merchants and card networks. The problem is defined as:

$$\text{Max } CS = \int_f^{\bar{b}_B} \frac{\{a - bp(1+f-b_B)\}^2}{2b} h(b_B)db_B + \int_{\underline{b}_B}^{f} \frac{(a-bp)^2}{2b} h(b_B)db_B$$

$$\begin{aligned}\text{s.t. } & \int_f^{\bar{b}_B} \{p(1-m-c_S^C)-d\}\{a-bp(1+f-b_B)\}h(b_B)db_B \\ & \quad + \int_{\underline{b}_B}^{f} \{p(1-m^A-c_S^A)-d\}(a-bp)h(b_B)db_B = 0, \quad \text{and} \\ & m + f - c = 0\end{aligned}$$

The incentive compatibility constraints imply that when $f = c - \hat{b}_S$, $p = \frac{d}{1-\hat{b}_S - c_S^C}$. Although it is difficult to analytically solve the most efficient cardholder fee and product price, we are able to show providing rewards is unlikely the most efficient in this case.[17]

3.5 When Merchants Practice Discriminatory Pricing

The previous subsections examined the most efficient fee structure and product price when merchants are not allowed to price discriminate their customers. This subsection considers how the change in this assumption affects the most efficient fee structure and product price.

In each scenario, the maximum social welfare cannot be lowered when merchants set different prices according to their customers' payment methods, because for social planners the merchants' ability to price discriminate their customers means an additional variable they can control. It is easy to show that the merchant's discriminatory price setting does not affect the maximum social welfare when per transaction costs and fees are fixed (Scenarios I and III). In contrast, when per transaction costs and fees are proportional to the transaction value (Scenarios II and IV), it is likely that the merchant's ability to set different prices increases the maximum

[17] See Appendix A.

social welfare: The maximum social welfare is more likely to be achieved when the product prices for card-using consumers and for non-card-using consumers, respectively, are set at the merchant's marginal costs, and the sum of a cardholder fee and a merchant fee equals the card network's cost. Depending on the relationship between the card network's cost and consumers' transactional benefit from cards ($[\underline{b}_B, \bar{b}_B]$), the marginal card user's transactional benefit from cards may be either higher or lower than $c - \hat{b}_S$, the most efficient marginal card user's transactional benefit from cards when merchants are *not* allowed to set different prices according to the payment methods.[18]

4. Welfare Distribution under the Most Efficient Fee Structure

This section considers how the most efficient card fee structure affects welfare distribution among different parties. Because we were not able to analytically obtain the most efficient card fee structure under Scenario IV, we consider only three Scenarios, I, II and III. First, we consider the case where merchants are not allowed to set different prices across payment methods, and then consider the case where merchants set different prices.

Under Scenario I, where consumers make a fixed number of transactions and per transaction costs and fees are fixed, only the cardholder fee determines social welfare. The product price and the merchant fee do not affect social welfare. To satisfy the card network's incentive compatibility, the merchant fee cannot be lower than the merchant transactional benefit from a card (i.e., $m \geq \hat{b}_S$). When the merchant fee is higher than the merchant transactional benefit from a card, then the product price set by the merchants is likely to be higher, compared with the level of the product price in the economy where no card products are available.[19] As a

[18] The most efficient fee structure and product price under Scenario II are solved in Appendix B.
[19] Unless merchants are monopoly.

result, consumers who use the alternative payment method would likely be worse off, compared with the economy without cards. Some card using consumers, whose transactional benefit from a card is relatively low, would also likely be worse off, due to the higher product price. These consumers' payment choice between the card and the alternative payment method is very sensitive to the cardholder fee, because their transactional benefit from a card is very close to the cardholder fee. Some card-using consumers, whose transactional benefit from a card is relatively high, would likely be better off, because their transactional benefit from cards would likely exceed the welfare loss due to the higher product price. These consumers' payment choice between the card and the alternative payment method is not sensitive to the cardholder fee because their transactional benefit from cards far exceeds the cardholder fee.[20] Thus, under the most efficient card fee structure, some consumers would likely be worse off, even when the surplus of consumers as a whole would increase. As long as merchants practice marginal cost pricing, their profits are not affected by the merchant fee set by the card networks.

Under Scenario II, where consumers make a fixed number of transactions and per transaction costs and fees are proportional to the transaction value, social welfare is affected by the cardholder fee and product price. When the aggregate surpluses from using a card are greater than the aggregate surpluses from using the alternative payment method, the product price set at the highest level maximizes the social welfare. This product price, however, would reduce the welfare of consumers who use the alternative payment method and who use a card but their transactional benefit from a card is relatively lower. If, on the other hand, the aggregate surpluses from using a card are smaller than the aggregate surpluses from using the alternative payment method, the product price set at the lowest level maximizes social welfare. Under this product

[20] However, these consumers' choice among the card products, such as the brand of the card or the issuer of the card, may be very sensitive to the cardholder fees (rewards).

price, consumers who use the alternative payment method would *unlikely* be worse off compared with the economy without cards at all. Depending on the most efficient product price, the most efficient card fee structure would possibly make some consumers worse off even if it would make the surplus of consumers as a whole increase.

Under Scenario III, where a consumer's demand function for goods is downward-sloping and per transaction costs and fees are fixed, the cardholder fee, the merchant fee and the product price, all affect social welfare. Under the most efficient fee structure and product price, the card networks and the merchants earn zero profits. The surplus of a consumer who uses the alternative payment method would not be reduced compared with the economy without cards. All card-using consumers would likely be better off. Unlike the previous two scenarios, under Scenario III, the most efficient fee structure and product price would not make any consumers worse off.

Finally, when the merchants set the different prices according to their customers' payment methods, the most efficient fee structure and product price would be less likely to affect the surplus of a consumer who uses the alternative payment method. Card-using consumers are better off with cards. Thus, the total consumer surpluses would be higher with cards than those without cards. The card networks would earn zero profits and the merchants would likely earn the same profits with and without cards.

5. Conclusion

This paper examined the most efficient fee structure and product price and their effects on the welfare distribution. Although it is not always the case, in most cases the most efficient cardholder fee is the difference between the card network's costs of processing a card transaction and the merchant transactional benefit from a card transaction. Therefore, in most cases, providing rewards to card-using consumers is the most efficient only when the merchant transactional benefit from a card transaction exceeds the card network's costs.

The most efficient fee structure and product price do not necessarily make all parties involved in the payment card market better off. Especially, consumers who use the alternative payment method, instead of a card, would likely be worse off, if the product price they face is higher. Since the product price is generally positively correlated with the merchant fee, the higher the merchant fee, the worse off the consumers who use the alternative payment method are. Moreover, not all card-using consumers are better off with the most efficient fee structure and product price. Card-using consumers whose choice of payment method between the card and the alternative payment method is very sensitive to the cardholder fee (or rewards) would likely be worse off if the product price is higher. In contrast, card-using consumers whose transactional benefit from cards is high would likely be better off. Because of the incentive compatibility constraints, the merchants and card networks would be unlikely to incur losses under the most efficient fee structure and product price.

Whether the most efficient cardholder fee is positive or negative is an empirical question. Available existing cost studies, which used relatively old information on merchant costs, suggest that the most efficient cardholder fee may likely be positive, which implies providing rewards may not be the most efficient.[21] In order for policymakers to accurately evaluate whether currently provided payment card rewards are efficient or not, collecting comprehensive and updated information on costs and benefits of various parties is required.

[21] Hayashi (forthcoming 2009) calculates the most efficient cardholder fees using available empirical evidence.

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Appendix

A. Providing rewards is unlikely the most efficient in Scenario IV.

We investigate whether $f = c - \hat{b}_S$ is higher than, lower than, or the most efficient level. If $\frac{\partial CS}{\partial f} > 0$ at $f = c - \hat{b}_S$, then $f = c - \hat{b}_S$ is lower than the most efficient cardholder fee. Suppose $c - \hat{b}_S \leq 0$.

The incentive compatibility constraints imply, at $f = c - \hat{b}_S$:

$$\frac{dp}{df} = \frac{-p(1-H(f))\{a - bp + bp(\hat{b}_B - f)\}}{(1-\hat{b}_S)\{a - bp + bp(\hat{b}_B - f)(1-H(f))\}} < 0, \tag{A1}$$

and

$$\frac{\partial CS}{df} = \frac{dp}{df}[(a-bp)\{(\hat{b}_B - f)(1-H(f)) - \hat{b}_S\} + bp\int_f^{\bar{b}_B}(b_B - f)^2 h(b_B)db_B]. \tag{A2}$$

Since $\frac{dp}{df} < 0$ from equation A1, if [ ] in equation A2 is negative, then $\frac{\partial CS}{\partial f} > 0$. The second term in [ ] is always positive, however the first term in [ ] can be negative. In fact, unless the highest transactional benefit to consumers, $\bar{b}_B$, is quite high (i.e., $\bar{b}_B \geq c + \frac{1+H(c-\hat{b}_S)}{1-H(c-\hat{b}_S)}\hat{b}_S$), then the first term is negative. If a, the cash user's quantity demanded when the product price is zero, is high enough so that monopolistic merchants can set the positive product price, then $a - bp$ is always greater than bp when $p = \frac{d}{1-\hat{b}_S}$. Thus, [ ] is likely negative and $\frac{\partial CS}{\partial f}$ is likely positive when $f = c - \hat{b}_S \leq 0$. This implies that providing rewards to card users is unlikely the most efficient.

B. The most efficient fee structure with merchants' discriminatory pricing in Scenario II.

The marginal card user is indifferent between using a card or an alternative payment method, which implies that:

$$p^A = p^C(1+f-b_B^m),$$

where p^A and p^C are the prices for alternative payment methods users and for card users, respectively. The social welfare function is defined as:

$$\begin{aligned} SW = &\int_f^{\bar{b}_B}\{\upsilon - p^C(1+f-b_B)\}h(b_B)db_B + \int_{\underline{b}_B}^{f}(\upsilon - p^A)h(b_B)db_B \\ &+\int_f^{\bar{b}_B}\{p^C(1-m)-d\}h(b_B)db_B + \int_{\underline{b}_B}^{f}\{p^A(1-\hat{b}_S)-d\}h(b_B)db_B \\ &+\int_f^{\bar{b}_B}p^C(f+m-c)h(b_B)db_B, \end{aligned} \tag{B2}$$

which is equivalent to:

$$SW = \upsilon - d - p^A\hat{b}_S H(b_B^m) + p^C(\hat{b}_B - c)(1-H(b_B^m)), \tag{B2'}$$

where $\hat{b}_B$ is the average transactional benefit among card users.

The first-order conditions with respect to price for cash users, price for card users, and marginal card user are:

$$\frac{\partial SW}{\partial p^A} = -\hat{b}_S H(b_B^m) < 0, \tag{B3}$$

$$\frac{\partial SW}{\partial p^C} = (\hat{b}_B - c)(1-H(b_B^m)) = 0 \tag{B4}$$

$$\frac{\partial SW}{\partial b_B^m} = \{p^C(c-b_B^m) - p^A\hat{b}_S\}h(b_B^m) = 0 \tag{B5}$$

Equation B3 implies social welfare increases as price for cash users decreases. The lowest price for cash users is $p^{A*} = \dfrac{d}{1-\hat{b}_S}$. An interior solution exists if $\bar{b}_B \geq c \geq \dfrac{\bar{b}_B + \underline{b}_B}{2}$.

$$b_B^{m^*} = 2c - \overline{b}_B,$$

$$p^{C*} = \frac{d}{1-m} = \frac{\hat{b}_S d}{(1-\hat{b}_S)(\overline{b}_B - c)}, \text{ and}$$

$$p^{A*} = \frac{d}{1-\hat{b}_S}.$$

If $\overline{b}_B < c$, then $b_B^{m^*} > \overline{b}_B$, which implies that social welfare is maximized when nobody uses the cards. If $c < \frac{\overline{b}_B + \underline{b}_B}{2}$, then $b_B^{m^*} < \underline{b}_B$, which implies that social welfare is maximized when everybody uses the cards.

THE ECONOMICS OF PAYMENT CARD FEE STRUCTURE: WHAT DRIVES PAYMENT CARD REWARDS?

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October, 2008

Abstract

This paper investigates potential market forces that cause payment card rewards even when providing payment card rewards is not the most efficient. Three factors—oligopolistic merchants, output-maximizing card networks, and the merchant's *inability* to set different prices across payment methods—may potentially explain the prevalence of payment card rewards programs in the United States today. The paper also points out that competition among card networks may potentially make payment rewards too generous, and thus *deteriorate* social welfare and its distribution. The situation may potentially warrant public policy interventions.

1. Introduction

Payment card rewards programs have become increasingly popular in the United States. However, providing payment card rewards may not be necessarily beneficial to consumers and society as a whole. According to the theoretical literature on payment card fee structure, in most cases the most efficient cardholder fees would be the difference between the card network's costs for a card transaction and the merchant's transactional benefit from the card transaction. Available empirical evidence suggests that in the United States the merchant's transactional benefit from a card transaction may not exceed the card network's cost. This implies providing rewards would unlikely be the most efficient. What drives payment card rewards?

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This paper is the second of a series of three papers. The first paper examined the optimal balance between the merchant fee and the cardholder fee from both efficiency and equity perspectives.[2] In this paper, we investigate what market forces drive payment card rewards. The results are useful for policymakers when determining whether the current situation should call for public policy interventions and if so what policies are appropriate. Policy options are considered in the third paper.

The equilibrium card fee structure is greatly influenced by many factors. This paper examines the equilibrium fee structure under various combinations of assumptions and identifies what factors potentially cause payment card rewards. We also consider the welfare consequences of equilibrium card fee structures. The results suggest three factors that together may explain the prevalence of rewards card programs in the United States today. They are oligopolistic merchants, output-maximizing card networks and the merchant's inability to set different prices according to their customers' payment methods. Whether per transaction costs and fees are fixed or proportional to the transaction value may also play an important role in determining the level of rewards. When per transaction costs and fees are proportional and the three factors mentioned above co-exist, competition among card networks would likely *increase* the level of rewards as well as the merchant fees. The higher merchant fees would result in the higher product prices, and as a result the equilibrium social welfare would be potentially lower than the social welfare without cards at all. Although the previous studies suggested competition in a two-sided market may not necessarily improve efficiency, the finding in this paper—competition in a two-sided market may potentially *deteriorate* efficiency—is new in the literature and has a potentially important public policy implication.

[2] Hayashi (2008).

The rest of the paper is organized as follows. Section 2 constructs theoretical models. Section 3 examines the market equilibrium—fee structures and their welfare consequences for different parties that are involved in payment card markets. Section 4 concludes.

2. Models

We use the models that were constructed in the first paper (Hayashi, 2008) as the base models here. We also make additional assumptions regarding merchants and card networks, which greatly affect equilibrium fee structure. This section first recaps our base models then makes additional assumptions regarding merchants and card networks.

2.1 Recap of the Base Models

The assumptions common to all models are the following. The payment card markets are considered to be matured. All consumers hold at least one card and merchants accept cards as long as the merchant fees are lower than a certain threshold level, which is endogenously determined.

Consumers are heterogeneous in their transactional benefit from cards as opposed to the alternative payments. A consumer's transactional benefit from a card, b_B, consists of three parts. One is a gross benefit minus gross cost from using a card, B_B^C;[3] one is a gross benefit minus gross cost from using the alternative payment method, B_B^A;[4] and one is the consumer fee paid for the alternative payment method, f^A. Thus, the transactional benefit from a card is defined as: $b_B = B_B^C - B_B^A + f^A$. To simplify the model, we assume every consumer receives the same level of B_B^A, which is equal to f^A (i.e., $B_B^A = f^A$). b_B is assumed to be distributed over the interval

[3] Note that gross cost does not include the fees for using a card.
[4] Again, gross cost does not include the fees for using the alternative payment method.

$[\underline{b}_B, \overline{b}_B]$ with a density function of $h(b_B)$, and a cumulative distribution function of $H(b_B)$. Consumers pay the cardholder fee of f when they use a card.

Merchants are homogeneous (at least ex-ante) and their transactional benefit from cards, $\hat{b}_S$, is defined as the merchant cost for the alternative payment method, c_S^A, plus the merchant fee paid for the alternative payment method, m^A, minus the merchant cost for a card transaction, c_S^C (i.e., $\hat{b}_S = c_S^A + m^A - c_S^C$). To simplify the model, we assume $c_S^C = 0$. Merchants pay the merchant fee of m when their customers use a card. Merchants also incur a cost of selling one unit of goods, d.

The assumptions in terms of (i) per transaction costs and fees; (ii) consumer demand for goods; and (iii) merchant ability to set different prices according to the payment method can vary. Per transaction costs and fees are either flat or proportional to the transaction value. Consumer demand for goods is either elastic (i.e., a consumer makes a fixed number of transactions) or downward-sloping (i.e., the number of transactions increases as the effective price of goods decreases). A merchant either sets the same price for all of its customers regardless of the payment method or sets the different prices according to the payment method its customers use.

2.2 Additional Assumptions

Merchants

Although some merchants are possibly monopolistic, many U.S. merchants are considered to be quite competitive. However, a perfectly competitive market described as the Bertrand competition unlikely reflects the reality. At equilibrium under the Bertrand competition, two types of merchants—cash-only merchants and card-accepting merchants—

serve the customers separately, and because of the higher price set by card-accepting merchants, only card-using consumers make transactions at the card-accepting merchants. In reality, however, most card-accepting merchants serve both card-using customers and non-card-using consumers.

Thus, oligopolistic merchants are more realistic. This paper assumes ologopolistic merchants compete according to the Hotelling model. Although the other models, such as the Cournot model, can be used to describe oligopolistic merchants, the Hotelling model is more flexible.[5]

The basic framework of the Hotelling model is the following: There are two merchants, Merchant A and Merchant B. Consumers are uniformly distributed on the interval of [0, 1], which is independent of their transactional benefit from cards. Merchant A is located at point 0 and Merchant B is located at point 1. For the consumers 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 $t(1-x)$. A consumer located at point x with transactional benefit from cards b_B chooses a merchant and a payment method, which gives the consumer the lower effective price plus transportation costs. For example, suppose a monopoly card network provides the card services, only Merchant A accepts the cards, and Merchant A sets an identical price p_A for both card-using consumers and non-card-using consumers. Merchant B sets price p_B for their customers. Then, the consumer's effective price plus transportation cost is $p_A + f - b_B + tx$, when he purchases goods at Merchant A with a card, $p_A + tx$, when he purchases goods at Merchant A with an alternative payment method, and $p_B + t(1-x)$, when he purchases goods at Merchant B. Suppose $b_B \ge f$. The

[5] For example, the Cournot model requires downward-sloping consumer demand for goods to obtain equilibrium price.

consumer chooses a card at Merchant A, and therefore, he compares $p_A + f - b_B + tx$ and $p_B + t(1-x)$. If $p_A + f - b_B + tx > p_B + t(1-x)$, then he purchases goods at Merchant B with an alternative payment method, otherwise he purchases goods at Merchant A with a card.

Card networks

This paper assumes the card network sets both cardholder fees (rewards) and merchant fees. Although, in reality, four-party scheme card networks do not directly set merchant fees, assuming a card network sets its merchant fees is not too far from the reality because a major part of the merchant fee (70-80 percent) is an interchange fee, almost all acquirers entirely pass through the interchange fee to merchants, and the acquirers' charges to merchants in addition to the interchange fees seem not to vary very much within an industry. In contrast, assuming a card network (four-party scheme) sets its cardholder fees may appear to be unrealistic. Cardholder fees, especially credit card rewards, vary by card issuers: Large card issuers tend to provide more generous rewards than their smaller counterparts. However, about 80 percent of the total four-party scheme credit cards are issued by the top 10 card issuers. Although it is difficult to compare the level of rewards among the top 10 issuers, if, as card networks and their issuers claim, they compete vigorously in the consumer-side of the payment card market, then the level of rewards should be very close to the difference between the interchange fees and the issuer's costs of processing a card transaction. Again, card issuers' costs of processing a card transaction vary. But if the top 10 issuers' costs of processing a card transaction are similar, then the interchange fees set by a card network greatly influence the level of rewards on the cards issued by the top 10 issuers.

There is a variety of assumptions about the objective of payment card networks, but the objective can be abstracted as either profit- or output-maximization. Profit-maximization is obvious, but output-maximization may not be. When card networks compete, each card network may reduce its markup to undercut its' rival card networks until the markup reaches the reservation markup. And the reservation markup may potentially be very close to zero. In such a case, card networks likely aim to increase their market share as much as possible. Even when card networks are monopolistic (potentially collude), their objective can be output-maximization. In a four-party scheme card network, it is possible that each acquirer and issuer gets a small fixed markup. Typically, an acquirer's markup is small, and because of the intensified competition among issuers, each issuer may get a small markup even when the card network they join is monopolistic.

Competitive card networks' behavior is likely affected by their cardholders' homing behavior. When a cardholder holds only a single-branded card or has a strong preference among cards (singlehoming), then each card network can set monopolistic merchant fees. In contrast, if all cardholders hold multiple cards and they are indifferent among those cards (multihoming), then card networks cannot set monopolistic merchant fees, because merchants may influence their customers' choice of payment methods. In the model, we assume that singlehoming cardholders are not sensitive to rewards when deciding which card to use, while multihoming cardholders are very sensitive to rewards and they always choose a card with the highest level of rewards among the cards the merchant accepts.

In this paper, three types of card networks are considered: (i) profit-maximizing monopoly, (ii) output-maximizing monopoly, and (iii) output-maximizing competing networks with cardholders who are all multihoming. Although we do not explicitly consider the case of output-maximizing competing networks with some singlehoming cardholders, the results would be somewhere between those of an output-maximizing monopoly network and those of output-maximizing duopoly networks with cardholders who are all multihoming.[6]

3. Market Equilibrium

In the first paper, we looked at the most efficient fee structure under various combinations of the assumptions. In most cases, the most efficient cardholder fee is the difference between the card network's costs for a payment card transaction and the merchant transactional benefit from the card transaction. This implies that unless the merchant transactional benefit from a card exceeds the card network's costs of processing a card transaction, providing payment card rewards to consumers is less efficient. According to the available cost studies in the United States, the merchant transactional benefit from a card may not be higher than the card network's costs.[7] Nevertheless, payment card rewards programs are prevalent in the United States.

This section examines the equilibrium fee structures and their influence on the welfare of different parties, such as card-using consumers, non-card-using consumers, merchants, and payment card networks (and their member financial institutions). The main purpose of this exercise is to find out what market forces may potentially drive payment card rewards. The results may also be useful for public policy consideration: For example, does encouraging competition among card networks reduce the level of payment card rewards? Does regulatory intervention that abolishes the no-surcharge rules improve social welfare?

This section looks at four factors: i) Competition among card networks and their objectives; ii) Consumer demand for goods; iii) Per transaction costs and fees for payment

[6] Output-maximizing networks may have a positive reservation markup per transaction; however, this section assumes the markup is zero (i.e., the profit of output-maximizing network is zero) for simplicity.
[7] These cost studies are Garcia-Swartz et. al. (2006), Food Marketing Institute (1998), and Star Network (2006, 2007). See also Hayashi (2008) for more detailed discussion.

methods; and iv) The merchant's ability to set different prices according to their customers' payment methods.

Because tedious calculations are required to obtain market equilibrium fee structures under various combinations of assumptions, this section summarizes the results. Detailed calculations are in the Appendix.

Tables 1 and 2, respectively, summarize the equilibrium fee structure when merchants set the same price for card-using consumers and consumers who use an alternative payment method, and when merchants set different prices for those two groups of consumers. Tables 3 and 4, respectively, summarize the welfare consequences, when merchants set the same price and different prices for two groups of consumers. There are several key observations.

First, when merchants set the same price, a profit-maximizing monopoly network would set the most efficient cardholder fees. This implies that if providing rewards to card-using consumers is not the most efficient, then the profit-maximizing monopoly network would not provide rewards. However, this does not necessarily imply that social welfare is maximized under a profit-maximizing card network. Except for Scenario I, the social welfare is also affected by the product price, which is affected by the merchant fee. The merchant fee set by the profit-maximizing monopoly network is higher than the merchant's transactional benefit from cards, which implies the merchant fee is not necessarily at the most efficient level. As a result, with profit-maximizing monopoly network(s), the social welfare may not be reached at the maximum level (except for Scenario I).

Second, when merchants set the same price for two groups of consumers, an output-maximizing monopoly network would set cardholder fees lower than the most efficient cardholder fees. This implies that even when providing rewards is not the most efficient, the output-maximizing monopoly network would likely provide rewards to card-using consumers. Because the highest merchant fee the monopoly network can set increases as the cardholder fee decreases (or the level of rewards increases), the merchant fee set by the output-maximizing monopoly network is higher than that set by the profit-maximizing monopoly network. As a result, the equilibrium product prices set under the output-maximizing monopoly network are higher than those set under the profit-maximizing monopoly network. The social welfare under the output-maximizing monopoly network is also lower than that under the profit-maximizing monopoly network.

Third, when merchants set the same price for two groups of consumers, whether competing card networks would set their cardholder fees at the most efficient level depends on their cardholders' homing behavior and the nature of per transaction costs and fees. When all cardholders are singlehoming (either they have only one card or they have a strong preference and cardholder fees do not affect their card choice), competing card networks can act like an output-maximizing monopoly network. When all cardholders are multihoming (i.e., they are indifferent among cards as long as the cardholder fees are the same), the equilibrium cardholder fee depends on whether per transaction costs and fees are fixed (Scenario I) or proportional to the transaction value (Scenario II). If the former is the case, the competing card networks would set their cardholder fee at the most efficient level and their merchant fee at the merchant's transactional benefit. This is because oligopolistically competing merchants would only accept the cards with the lower merchant fee. If the latter is the case, the competing card networks would set their cardholder fees as low as possible—so that all consumers use cards—and as a result, the merchant fees are higher. In this case, two types of merchants would co-exist ex-post: One is only accepting the cards with the lower merchant fee and the other is accepting both networks' cards. In fact, the card network with the higher merchant fee (thus the lower cardholder fees) would have more transactions than its rival card network. Knowing at least some merchants would accept both cards, card networks would not lower their merchant fees. Rather, they would raise merchant fees and lower cardholder fees in order to increase their card transactions. Thus, competition among card networks would likely *increase* the equilibrium merchant fee and the level of payment card rewards.

Fourth, related to the previous observations, when merchants set the same price for two groups of consumers, whether per transaction costs and fees are fixed (Scenario I and III) or proportional to the transaction value (Scenario II) would significantly affect social welfare. If the former is the case, the social welfare with cards is always at least as high as the social welfare without cards. While merchant profits are not affected by competition among card networks and their objectives, the surplus of consumers as a whole is higher when card networks are competing (Scenario I). In contrast, if the latter is the case (Scenario II), the social welfare with cards is at *most* as high as or even lower than the social welfare without cards. In this case, social welfare is the highest under the profit-maximizing monopoly network and the lowest under output-maximizing competing networks with cardholders who are all multihoming. Similar to the social welfare, the surplus of consumers as a whole and the merchant profits are the highest under the profit-maximizing monopoly network and the lowest under output-maximizing card networks with multihoming cardholders.

Finally, fifth, when merchants set different prices for card-using consumers and for non-card-using consumers, competition among card networks would unlikely influence the equilibrium fee structure and product price, as long as card networks maximize their output. Under profit-maximizing networks, the number of card transactions would likely be smaller than the most efficient number of card transactions, while under output-maximizing networks, the number of card transactions would likely be the most efficient. If per transaction costs and fees are fixed, the merchant's discriminatory price setting makes card fee structures neutral. That is, the fee structure does not affect the number of card transactions; rather, the sum of the cardholder fee and merchant fee affects the number of card transactions.[8] In this case, the card networks would not have an incentive to provide rewards. If per transaction costs and fees are proportional to the transaction value, the card fee structures still affect the number of card transactions even when merchants set different prices across payment methods. Nevertheless, the merchant's ability to set different prices allows the merchants to reject the cards when the merchant fee exceeds their transactional benefits. Thus, both profit- and output-maximizing card networks would set the merchant fee at the merchant transactional benefit.

These observations suggest three potential market forces that together may drive payment card rewards. One is output-maximizing card network(s), two is the merchant's *inability* to set different prices across payment methods, and three is oligopolistic merchants. As mentioned, merchants are unlikely perfectly competitive, but some merchants may be monopolistic at least locally. Having rewards at equilibrium with monopolistic merchants is possible but in rather limited circumstances. It is easy to show that providing rewards (or a negative cardholder fee) is unlikely to be at equilibrium when merchants are monopolistic *and* consumers make a fixed number of transactions. In this case, monopolistic merchants would not accept cards if the merchant fee exceeds their transactional benefit, and thus card networks cannot provide rewards without incurring losses. When a consumer's demand function for goods is downward-sloping, the equilibrium cardholder fee may potentially be negative. In this case, monopolistic merchants

[8] This is consistent with the neutrality of interchange fees found in Gans and Small (2000).

would accept the cards even when the merchant fee exceeds their transactional benefit because accepting the cards may induce a consumer demand curve shift upwards.

The observations also suggest competition may not necessarily improve efficiency; rather, it may possibly deteriorate efficiency in some circumstances. The previous literature on two-sided markets suggests that competition in a two-sided market does not necessarily improve efficiency but few studies suggested that competition in a two-sided market may *deteriorate* efficiency. In the context of the payment card market, Guthrie and Wright (2007) found that competition among payment card networks would not improve efficiency when all cardholders are singlehoming, while it would improve efficiency as more cardholders become multihoming. The results in this paper are consistent with their results because Guthrie and Wright assume per transaction costs and fees are fixed. However, when per transaction costs and fees are proportional to the transaction value, competition among card networks would not improve efficiency even if all cardholders are multihoming; rather, it would potentially deteriorate efficiency. In this sense, the paper makes a contribution to the literature by showing a potential negative effect of competition on efficiency in a two-sided market.

4. Conclusion

This paper investigated what market forces drive payment card rewards, when providing rewards may not be the most efficient. The paper identified three factors that together may explain the prevalence of rewards programs in the United States today. They are output-maximizing card networks, ologopolistic merchants and the merchant's inability to set different prices across payment methods. Existence of these three factors in the U.S. payment card market is quite plausible. Although whether per transaction costs and fees are proportional to the transaction value is an empirical question, the theoretical models suggest that when per transaction costs and fees are proportional to the transaction value, the equilibrium social welfare would potentially be lower than the social welfare without cards at all. Consumers as a whole and merchants would be worse off, compared with the economy without cards at all. This may warrant public policy interventions. In this case, enhancing competition among card networks would not improve efficiency but would potentially deteriorate efficiency. The equilibrium fee structures and their welfare consequences may be useful for policymakers when they consider policy options.

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Table 1: Equilibrium Fee Structure: No Discriminatory Pricing

Scenario	Scenario I		
Type of network	Monopoly Network		Competitive Networks
Objective	Profit-max	Output-max	Output-max
Consumer homing	Single	Single	All multihoming
Cardholder fee(f)	$c-\hat{b}_S$	$c-\hat{b}_S-(\bar{b}_B+\hat{b}_S-c)$ or $\underline{b}_B$	$c-\hat{b}_S$
Merchant fee (m)	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)/2$	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)$ or $\hat{b}_S+(\bar{b}_B-\underline{b}_B)/2$	$\hat{b}_S$
Card transactions	Efficient	More	Efficient

Scenario	Scenario II		
Type of network	Monopoly Network		Competitive Networks
Objective	Profit-max	Output-max	Output-max
Consumer homing	Single	Single	Multihoming
Cardholder fee(f)	$c-\hat{b}_S$	$c-\hat{b}_S-(\bar{b}_B+\hat{b}_S-c)+\varepsilon$ or $\underline{b}_B$	$\underline{b}_B$
Merchant fee (m)	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)/2$	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)-\varepsilon$ or $\hat{b}_S+(\bar{b}_B-\underline{b}_B)/2$	$\hat{b}_S+(\bar{b}_B-\underline{b}_B)/2$
Card transactions	Efficient*	More	More

Scenario	Scenario III		
Type of network	Monopoly Network		Competitive Networks
Objective	Profit-max	Output-max	Output-max
Consumer homing	Single	Single	All multihoming
Cardholder fee(f)	$c-\hat{b}_S$	$c-\hat{b}_S-(\bar{b}_B+\hat{b}_S-c)+\varepsilon$ or $\underline{b}_B$	
Merchant fee (m)	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)/2$	$\hat{b}_S+(\bar{b}_B+\hat{b}_S-c)-\varepsilon$ or $\hat{b}_S+(\bar{b}_B-\underline{b}_B)/2$	Not available
Card transactions	Efficient**	More	

Notes: *: The number of card transactions is at the most efficient level; however, due to a higher merchant fee, the equilibrium product price is higher than the most efficient product price. Thus, the social welfare is not maximized at equilibrium.

**: The equilibrium fee structure results in the most efficient marginal card users; however, due to a higher merchant fee, the equilibrium product price is higher than the most efficient product price. Thus, the social welfare is not maximized at equilibrium.

Table 2: Equilibrium Fee Structure: Discriminatory Pricing

Scenario	Scenario I		
Type of network	Monopoly Network		Competitive Networks
Objective	Profit-max	Output-max	Output-max
Consumer homing	Single	Single	All multihoming
Marginal card user (b_B^m)	$c - \hat{b}_S + \{1 - H(b_B^m)\}/h(b_B^m)$	$c - \hat{b}_S$	
Cardholder fee (f)	$c + \{1 - H(b_B^m)\}/h(b_B^m)$	c	
Merchant fee (m)			
Card transactions	Fewer	Efficient	

Scenario	Scenario II		
Type of network	Monopoly Network		Competitive Networks
Objective	Profit-max	Output-max	Output-max
Consumer homing	Single	Single	Multihoming
Marginal card user (b_B^m)	$c - \hat{b}_S + \{1 - H(b_B^m)\}/h(b_B^m)$	$c - \hat{b}_S$	
Cardholder fee (f)	b_B^m	b_B^m	
Merchant fee (m)	$\hat{b}_S$	$\hat{b}_S$	
Card transactions	Fewer†	Efficient†	

Notes: †: When Hotelling merchants set different prices according to their customers' payment methods, card networks always set merchant fee at merchant transactional benefit from cards. Thus, the prices for card using consumers and non-card-using consumers become the same at equilibrium. The number of card transactions is compared with the most efficient number of card transactions when product prices for card-using consumers and non-card-using consumers are the *same*. Thus, the number of card transactions is not necessarily the most efficient when merchants are allowed to set different prices for these two groups of consumers.

Equilibrium fee structure under Scenario III is not available.

Table 3: Consumer, Merchant, and Network Surplus: No Discriminatory Pricing

Scenario	Scenario I			
Type of network	Monopoly Network		Competitive Networks	No-Card
Objective	Profit-max	Output-max	Output-max	
Consumer homing	Singlehoming	Singlehoming	Multihoming	
Social Welfare	$\tilde{\upsilon}+(\bar{b}_B+\hat{b}_S-c)^2h/2$	$\tilde{\upsilon}$ or $\tilde{\upsilon}+(\bar{b}_B+\underline{b}_B)/2+\hat{b}_S-c$	$\tilde{\upsilon}+(\bar{b}_B+\hat{b}_S-c)^2h/2$	$\tilde{\upsilon}$
Consumer Total	$\tilde{\upsilon}-t$	$\tilde{\upsilon}-t$	$\tilde{\upsilon}-t+(\bar{b}_B+\hat{b}_S-c)^2h/2$	$\tilde{\upsilon}-t$
Cash user/ Marginal card user	$\tilde{\upsilon}-t-(\bar{b}_B+\hat{b}_S-c)^2h/2$	$\tilde{\upsilon}-t-2\{\bar{b}_B-(c-\hat{b}_S)\}^2h$ or $\tilde{\upsilon}-t-(\bar{b}_B-\underline{b}_B)/2$	$\tilde{\upsilon}-t$	$\tilde{\upsilon}-t$
Card user w/ b_B	$\tilde{\upsilon}-t-(\bar{b}_B+\hat{b}_S-c)^2h/2$ $+(b_B+\hat{b}_S-c)$	$\tilde{\upsilon}-t+b_B-2(c-\hat{b}_S)+\bar{b}_B$ $+2\{\bar{b}_B-(c-\hat{b}_S)\}^2h$ or $\tilde{\upsilon}-t+b_B-(\bar{b}_B+\underline{b}_B)/2$	$\tilde{\upsilon}-t+b_B+\hat{b}_S-c$	Not applicable
Merchant Total	t	t	t	t
Network Total	$(\bar{b}_B+\hat{b}_S-c)^2h/2$	0 or $(\bar{b}_B+\underline{b}_B)/2+\hat{b}_S-c$	0	0

Notes: $h=1/(\bar{b}_B-\underline{b}_B)$. $\tilde{\upsilon}=\upsilon-d-\hat{b}_S$.

Table 3: Consumer, Merchant, and Network Surplus: No Discriminatory Pricing (Cont.)

Scenario	Scenario II			
Type of network	Monopoly Network		Competitive Networks	No-Card
Objective	Profit-max	Output-max	Output-max	
Consumer homing	Singlehoming	Singlehoming	Multihoming	
Social Welfare	About the same as "No-card"	Lower than "Monopoly, Profit-Max"	Lower than (or equals to) "Monopoly, Output-Max"	$\upsilon + \frac{\hat{b}_S t - d}{1-\hat{b}_S}$
Consumer Total	Lower than "No-card"	Lower than "Monopoly, Profit-Max"	Lower than (or equals to) "Monopoly, Output-Max"	$\upsilon - t - \frac{d}{1-\hat{b}_S}$
Cash user/ Marginal card user	Lower than "No-card"	Lower than "Monopoly, Profit-Max"	Not applicable	$\upsilon - t - \frac{d}{1-\hat{b}_S}$
Card user w/ b_B	Lower or higher than "No-card" cash user	Lower or higher than "Monopoly, Profit-Max"	Lower or higher than (or equals to) "Monopoly, Output-Max"	Not applicable
Merchant Total	Lower than "No-card"	Lower than "Monopoly, Profit-Max"	Lower than (or equals to) "Monopoly, Output-Max"	$(1-\hat{b}_S)t$
Network Total	Higher than "No-card"	Same as "No-card" or higher than "No-card" but lower than "Monopoly, Profit-Max"	Same as "No-card"	0

Table 3: Consumer, Merchant, and Network Surplus: No Discriminatory Pricing (Cont.)

Scenario	Scenario III			
Type of network	Monopoly Network		Competitive Networks	No-Card
Objective	Profit-max	Output-max	Output-max	
Consumer homing	Singlehoming	Singlehoming	Multihoming	
Social Welfare	Higher than “No-card”	Higher than “No-card” but lower than “Monopoly Profit-Max”	Not available	$b\{\tilde{a}^2 - 2t\tilde{a} - 2t^2 + \tilde{a}\sqrt{4t^2 + \tilde{a}^2}\}$
Consumer Total	Slightly higher than “No-card”	Slightly higher than “Monopoly, Profit-Max”		$b\{\tilde{a}^2 - 2t\tilde{a} + 2t^2 + (\tilde{a} - 2t)\sqrt{4t^2 + \tilde{a}^2}\}$
Cash user/ Marginal card user	Lower than “No-card”	Lower than “Monopoly, Profit-Max”		$b\{\tilde{a}^2 - 2t\tilde{a} + 2t^2 + (\tilde{a} - 2t)\sqrt{4t^2 + \tilde{a}^2}\}$
Card user w/ b_B	Lower or higher than “No-card” cash user	Lower or higher than “Monopoly, Profit-Max”		Not applicable
Merchant Total	Slightly lower than “No-card”	About the same as “Monopoly, Profit-Max”		$2bt\{\sqrt{4t^2 + \tilde{a}^2} - 2t\}$
Network Total	Higher than “No-card”	Same as “No-card”		0

Note: $\tilde{a} = a/b - d - \hat{b}_S$.

Table 4: Consumer, Merchant, and Network Surplus: Discriminatory Pricing

Type of merchants	Scenario I			
Type of network	Monopoly Network		Competitive Networks	No-Card
Objective	Profit-max	Output-max*	Output-max*	
Consumer homing	Singlehoming	Singlehoming	Multihoming	
Social Welfare	$\tilde{\upsilon}+3(\bar{b}_B+\hat{b}_S-c)^2h/8$	$\tilde{\upsilon}+(\bar{b}_B+\hat{b}_S-c)^2h/2$		$\tilde{\upsilon}$
Consumer Total	$\tilde{\upsilon}-t+(\bar{b}_B+\hat{b}_S-c)^2h/8$	$\tilde{\upsilon}-t+(\bar{b}_B+\hat{b}_S-c)^2h/2$		$\tilde{\upsilon}-t$
Cash user/ Marginal card user	$\tilde{\upsilon}-t$	$\tilde{\upsilon}-t$		$\tilde{\upsilon}-t$
Card user w/ b_B	$\tilde{\upsilon}-t+b_B+\hat{b}_S$ $-\{(c-\hat{b}_S)+\bar{b}_B\}/2$	$\tilde{\upsilon}-t+b_B+\hat{b}_S-c$		Not applicable
Merchant Total	t	t		t
Network Total	$(\bar{b}_B+\hat{b}_S-c)^2h/4$	0		0

Notes: $h=1/(\bar{b}_B-\underline{b}_B)$. $\tilde{\upsilon}=\upsilon-d-\hat{b}_S$.

Table 4: Consumer, Merchant, and Network Surplus: Discriminatory Pricing (Cont.)

Type of merchants	Scenario II			
Type of network	Monopoly Network		Competitive Networks	No-Card
Objective	Profit-max	Output-max*	Output-max*	
Consumer homing	Singlehoming	Singlehoming	Multihoming	
Social Welfare	$\upsilon - \hat{b}_S t - \frac{d}{1-\hat{b}_S} + 3(t + \frac{d}{1-\hat{b}_S})(\bar{b}_B + \hat{b}_S - c)^2 h/8$	$\upsilon - \hat{b}_S t - \frac{d}{1-\hat{b}_S} + (t + \frac{d}{1-\hat{b}_S})(\bar{b}_B + \hat{b}_S - c)^2 h/2$		$\upsilon - \hat{b}_S t - \frac{d}{1-\hat{b}_S}$
Consumer Total	$\upsilon - t - \frac{d}{1-\hat{b}_S} + (t + \frac{d}{1-\hat{b}_S})(\bar{b}_B + \hat{b}_S - c)^2 h/8$	$\upsilon - t - \frac{d}{1-\hat{b}_S} + (t + \frac{d}{1-\hat{b}_S})(\bar{b}_B + \hat{b}_S - c)^2 h/2$		$\upsilon - t - \frac{d}{1-\hat{b}_S}$
Cash user/ Marginal card user	$\upsilon - t - \frac{d}{1-\hat{b}_S}$	$\upsilon - t - \frac{d}{1-\hat{b}_S}$		$\upsilon - t - \frac{d}{1-\hat{b}_S}$
Card user w/ b_B	$\upsilon - t - \frac{d}{1-\hat{b}_S} + (t + \frac{d}{1-\hat{b}_S})(b_B - \frac{\bar{b}_B + c - \hat{b}_S}{2})$	$\upsilon - t - \frac{d}{1-\hat{b}_S} + (t + \frac{d}{1-\hat{b}_S})(b_B + \hat{b}_S - c)$		Not applicable
Merchant Total	$(1-\hat{b}_S)t$	$(1-\hat{b}_S)t$		$(1-\hat{b}_S)t$
Network Total	$(t + \frac{d}{1-\hat{b}_S})(\bar{b}_B + \hat{b}_S - c)^2 h/4$	0		0

Note: $h = 1/(\bar{b}_B - \underline{b}_B)$.

Appendix: Equilibrium Fee Structure

1: No-Discriminatory Pricing

Scenario I: Fixed Demand and Flat Costs and Fees

When both Merchants A and B accept the cards, they earn the same profit of $t/2$. Furthermore, as long as each merchant takes the same strategy as its rival's, each earns the same profit of $t/2$.

Consider the highest merchant fee the monopoly card network can charge to the merchants. Suppose Merchant A accepts the cards but Merchant B does not. Each merchant's profit is:

$$\pi_A = \frac{1}{2t}[\{t + \frac{1-H(b_B^m)}{3}(\hat{b}_B - f + \hat{b}_S - m)\}^2 - H(b_B^m)(1-H(b_B^m))(\hat{b}_B - f)(m - \hat{b}_S)],$$

$$\pi_B = \frac{1}{2t}\{t - \frac{1-H(f)}{3}(\hat{b}_B - f + \hat{b}_S - m)\}^2,$$

where $\hat{b}_B$ is the average transactional benefit from cards among card-using consumers. When merchant fee is $m > \hat{b}_S + \hat{b}_B - f$, Merchant B rejects the cards, given Merchant A accepts the cards. Given Merchant B rejects the cards, Merchant A rejects cards, too. When merchant fee is $m \le \hat{b}_S + \hat{b}_B - f$, Merchant B does not reject cards, given Merchant A accepts the cards. Thus, the highest merchant fee the monopoly card network can charge is:

$$m = \hat{b}_S + \hat{b}_B - f.$$

<u>Profit-maximizing monopoly network</u>

The profit-maximizing monopoly network solves the following problem:

Max $\Pi = (f + m - c)(1 - H(f))$, s.t. $m \le \hat{b}_S + \hat{b}_B - f$.

The equilibrium fee structure is:

$$m = \hat{b}_S + \hat{b}_B - f = \hat{b}_S + \frac{\overline{b}_B - (c - \hat{b}_S)}{2}, \text{ and}$$

$$f = c - \hat{b}_S .$$

Output-maximizing monopoly network

The output-maximizing monopoly network solves the following problem:

Max $1 - H(f)$, s.t. $f + m - c \geq 0$ and $m \leq \hat{b}_S + \hat{b}_B - f$.

When $c - \hat{b}_S$ is large enough (i.e., $c - \hat{b}_S \geq (\overline{b}_B + \underline{b}_B)/2$), both constraints bind. The equilibrium fee structure is:

$$m = \hat{b}_S + (\overline{b}_B + \hat{b}_S - c), \text{ and}$$

$$f = (c - \hat{b}_S) - (\overline{b}_B + \hat{b}_S - c) .$$

However, if $c - \hat{b}_S$ is small (i.e., $c - \hat{b}_S < (\overline{b}_B + \underline{b}_B)/2$), then the cardholder fee reaches the consumers' lowest transactional benefit from cards before the budget constraint binds. The equilibrium fee structure in this case is:

$$m = \hat{b}_S + \frac{\overline{b}_B - \underline{b}_B}{2}, \text{ and}$$

$$f = \underline{b}_B .$$

Output-maximizing competitive networks with all multihoming cardholders

Suppose two competing card networks, Network 1 and Network 2, are symmetric in terms of their costs of processing card transactions and cardholder bases. The number of card transactions increases as the cardholder fee decreases. Both networks reduce their markups to lower their card holder fees, which means their total fee revenues per transaction is reduced to their costs per transaction: $f_1 + m_1 = f_2 + m_2 = c$. Suppose Network 1 sets the higher cardholder fee than Network 2 ($f_1 > f_2$). If both merchants accept Network 2's card (Card 2), then consumers whose transactional benefit from cards exceeds f_2 use Card 2 only. Merchants A and B earn the same profit of $t/2$. If Merchant A accepts both Cards 1 and 2 and Merchant B accepts Card 1 only, then their profits are:

$$\pi_A = \frac{1}{2t}[\{t + \frac{H_1 - H_2}{3}(\tilde{b}_B + \hat{b}_S - f_2 - m_2) + \frac{1-H_1}{3}(f_1 + m_1 - f_2 - m_2)\}^2$$
$$- H_2(m_2 - \hat{b}_S)\{(H_1 - H_2)(\tilde{b}_B - f_2) + (1-H_1)(f_1 - f_2)\}],$$

$$\pi_B = \frac{1}{2t}[\{t - \frac{H_1 - H_2}{3}(\tilde{b}_B + \hat{b}_S - f_2 - m_2) - \frac{1-H_1}{3}(f_1 + m_1 - f_2 - m_2)\}^2$$
$$+ (1-H_1)(m_1 - \hat{b}_S)\{(H_1 - H_2)(f_1 - \tilde{b}_B) + H_2(f_1 - f_2)\}],$$

where $H_1 = H(f_1)$, $H_2 = H(f_2)$, and $\tilde{b}_B = \int_{f_2}^{f_1} b_B h(b_B) db_B /(H(f_1) - H(f_2))$. By definition, $f_1 > \tilde{b}_B > f_2$. If Network 2 sets $m_2 = \hat{b}_S$ and $f_2 = c - \hat{b}_S$, rejecting Card 2 makes a merchant worse off, given the other merchant accepts Card 2. It is also true that if Network 1 sets $m_1 = \hat{b}_S$ and $f_1 = c - \hat{b}_S$, accepting Card 2 makes a merchant worse off, given the other merchant rejects Card 2. The equilibrium fee structure is:

$$m_1 = m_2 = \hat{b}_S,$$

$$f_1 = f_2 = c - \hat{b}_S.$$

Scenario II: Fixed Demand and Proportional Costs and Fees

In contrast to the case where per transaction costs and fees are fixed, the Hotelling merchant's profits are affected by the card fee structure and transactional benefit from cards, even when each merchant takes the same strategy as its rival's. When both merchants reject cards, their profit, π^0, is:

$$2t\pi^0 = (1-\hat{b}_S)t^2.$$

When both merchants accept cards, each sets its price at:

$$p = t + \frac{d}{(1-\hat{b}_S)H + (1-m)(1-H)},$$

and each earns profit π^C:

$$2t\pi^C = \frac{\{(1-\hat{b}_S)-(m-\hat{b}_S)(1-H)\}^2 t^2 - (m-\hat{b}_S)(\hat{b}_B - f)(1-H)Htd}{(1-\hat{b}_S)-(m-\hat{b}_S)(1-H)-(1-m)(\hat{b}_B - f)(1-H)},$$

where $H = H(f)$.

Consider the highest merchant fee the monopoly card network can charge to the merchants. Suppose Merchant A accepts the cards but Merchant B does not. Each merchant sets its price at:

$$p_A = \frac{1}{A}[\{3(1-\hat{b}_S)-3(m-\hat{b}_S)(1-H)\}t$$
$$+\{3(1-\hat{b}_S)-(m-\hat{b}_S)(1-H)-2(1-\hat{b}_S)(\hat{b}_B - f)(1-H)\}d/(1-\hat{b}_S)]$$

$$p_B = \frac{1}{A}[\{3(1-\hat{b}_S)-3(m-\hat{b}_S)(1-H)-(3-2m-\hat{b}_S)(\hat{b}_B - f)(1-H)+(m-\hat{b}_S)(\hat{b}_B - f)(1-H)^2\}t$$
$$+\{3(1-\hat{b}_S)-2(m-\hat{b}_S)(1-H)-(4-2m-2\hat{b}_S)(\hat{b}_B - f)(1-H)+(1-\hat{b}_S)(\hat{b}_B - f)^2(1-H)^2\}$$
$$\times d/(1-\hat{b}_S)]$$

where $A = 3\{(1-\hat{b}_S)-(m-\hat{b}_S)(1-H)\}-\{(3-4m+\hat{b}_S)+(m-\hat{b}_S)(1-H)\}(\hat{b}_B - f)(1-H)$. And each merchant earns the following profit, respectively,:

$$2t\pi_A = \{(1-\hat{b}_S)p_A - d\}(p_B - p_A + t)H + \{(1-m)p_A - d\}\{p_B - p_A + t + (\hat{b}_B - f)p_A\}(1-H)$$

$$2t\pi_B = \{(1-\hat{b}_S)p_B - d\}(p_A - p_B + t)H + \{(1-\hat{b}_S)p_B - d\}\{p_A - p_B + t - (\hat{b}_B - f)p_B\}(1-H)$$

It is difficult (if not impossible) to analytically obtain the highest merchant fee that monopoly card networks can charge. However, numerical examples suggest that the highest merchant fee is slightly less than the sum of the merchant's transactional benefit and the average consumer's net transactional benefit i.e., $\overline{m} \cong \hat{b}_S + \hat{b}_B - f$.

Profit-maximizing monopoly network

The profit-maximizing monopoly network solves the following problem:

Max $\Pi = p(f + m - c)(1 - H(f))$, s.t. $m \le \overline{m}$ and $p = t + \dfrac{d}{(1-\hat{b}_S)H + (1-m)(1-H)}$.

It is difficult to analytically solve the equilibrium fee structure; however, the numerical examples suggest that the equilibrium fee structure is:

$$m = \overline{m} \cong \hat{b}_S + \hat{b}_B - f = \hat{b}_S + \frac{\overline{b}_B - (c - \hat{b}_S)}{2}, \text{ and}$$

$$f \cong c - \hat{b}_S .$$

Output-maximizing monopoly network

The output-maximizing monopoly network solves the following problem:

Max $1 - H(f)$, s.t. $f + m - c \ge 0$ and $m = \overline{m}$.

If $c - \hat{b}_S$ is large enough (i.e., $c - \hat{b}_S \ge (\overline{b}_B + \underline{b}_B)/2$), then two constraints bind. The equilibrium fee structure is:

$$m = \overline{m} \cong \hat{b}_S + (\overline{b}_B + \hat{b}_S - c), \text{ and}$$

$$f = c - \hat{b}_S - (\overline{b}_B + \hat{b}_S - c).$$

If $c - \hat{b}_S$ is small (i.e., $c - \hat{b}_S < (\overline{b}_B + \underline{b}_B)/2$), then the cardholder fee reaches the consumers' lowest transactional benefit from cards before the budget constraint binds. The equilibrium fee structure in this case is:

$$m = \hat{b}_S + \frac{\overline{b}_B - \underline{b}_B}{2}, \text{ and}$$

$f = \underline{b}_B$.

Output-maximizing competitive networks with all multihoming cardholders

As discussed in Scenario I , two competing symmetric card networks reduce their markup to zero, i.e., $f_1 + m_1 = f_2 + m_2 = c$. Suppose Network 1 sets the higher cardholder fee than Network 2 ($f_1 > f_2$), and Merchant A accepts both Cards 1 and 2 and Merchant B accepts Card 1 only. The equilibrium product prices in this case are:

$$p_A = \frac{1}{4K_1L_1 - K_2L_2}\{(K_2L_3 + 2K_3L_1)t + (K_2L_4 + 2K_4L_1)d\},$$

$$p_B = \frac{1}{4K_1L_1 - K_2L_2}\{(2K_1L_3 + K_3L_2)t + (2K_1L_4 + K_4L_2)d\},$$

where

$$K_1 = (1-m_2)(1+f_2)(1-H_2) + (1-\hat{b}_S)H_2 - (1-m_2)\int_{f_2}^{\bar{b}_B} b_B h(b_B)db_B;$$

$$K_2 = (1-m_2)(1-H_2) + (1-m_2)f_1(1-H_1) + (1-\hat{b}_S)H_2 - (1-m_1)\int_{f_1}^{\bar{b}_B} b_B h(b_B)db_B;$$

$$K_3 = (1-m_2)(1-H_2) + (1-\hat{b}_S)H_2;$$

$$K_4 = (1+f_2)(1-H_2) + H_2 - \int_{f_2}^{\bar{b}_B} b_B h(b_B)db_B;$$

$$L_1 = (1-m_1)(1+f_1)(1-H_1) + (1-\hat{b}_S)H_1 - (1-m_1)\int_{f_1}^{\bar{b}_B} b_B h(b_B)db_B;$$

$$L_2 = (1-m_1)(1+f_2)(1-H_2) + (1-\hat{b}_S)f_2(H_1 - H_2) + (1-\hat{b}_S)H_1 - (1-m_1)\int_{f_1}^{\bar{b}_B} b_B h(b_B)db_B - (1-\hat{b}_S)\int_{f_2}^{f_1} b_B h(b_B)db_B;$$

$L_3 = (1-m_1)(1-H_1) + (1-\hat{b}_S)H_1$; and

$$L_4 = (1+f_1)(1-H_1) + H_1 - \int_{f_1}^{\bar{b}_B} b_B h(b_B)db_B.$$

Since analytical solutions are difficult to obtain, we use numerical examples to examine the equilibrium. Suppose Network 2 sets its cardholder fee at $f_2 = c - \hat{b}_S$ and Network 1 sets its cardholder fee slightly higher, i.e., $f_1 = c - \hat{b}_S + \varepsilon$, where $\varepsilon > 0$. Merchant B's profit is likely higher than the profit it would have accepted Card 2. Thus, given the rival merchant accepts Card 2, accepting Card 1 only is the most profitable than any other strategies, such as accepting Card 2 and rejecting both Cards 1 and 2. In contrast to Scenario I, Merchant A's profit is also likely higher than that when both merchants accept Card 2. Thus, given the rival merchant accepts Card 1 only, accepting Card 2 is the most profitable strategy. In fact, Network 2's number of card transactions is greater than Network 1's. Knowing one of the two merchants accept Card 2, Network 2 has no incentive to reduce its merchant fee; rather, it would lower its cardholder fee further by raising its merchant fee. Although Network 1 would be able to make at least one merchant accept Card 1 only by reducing its merchant fee, it would have a smaller number of transactions than that when it sets the same merchant fee (thus cardholder fee) as Network 2's. As a result, both networks reduce their cardholder fees until they no longer gain additional card users. The equilibrium fee structure is

$$m_1 = m_2 = \hat{b}_S + \frac{\overline{b}_B - \underline{b}_B}{2}, \text{ and}$$

$$f_1 = f_2 = \underline{b}_B.$$

Scenario III: Downward-Sloping Demand Curve and Flat Costs and Fees

In contrast to the previous two scenarios, where consumers make a fixed number of purchases and thus transactions, it is difficult to obtain analytical solution when each consumer's demand function is downward-sloping. Even equilibrium product prices are difficult to obtain when two merchants take different strategies. We are able to predict what the equilibrium fee structure looks like by making an additional assumption when cards are provided by monopoly networks; however, in order to predict the equilibrium fee structure when cards are provided by competing networks, we need to use more sophisticated simulation methods than just numerical examples used in this paper. Therefore, here we only examine the equilibrium fee structure when cards are provided by monopoly networks.

We assume that if one of the two merchants rejects the cards, the card-rejecting merchant changes its product price, but the card-accepting merchant keeps its price at the same price level where both merchants accept the cards. The card-rejecting merchant's profit derived under this assumption is likely higher than the profit when both merchants change their product price. Thus, the highest merchant fee the monopoly networks charge ($\overline{\overline{m}}$) is likely lower than the highest merchant fee they charge ($\overline{m}$) when both merchants adjust their product prices. As long as monopoly card networks set the merchant fee at $\overline{\overline{m}}$, both merchants accept the cards. The product price they set is:

$$p^C = d + \hat{b}_S + \frac{t\{D(p^C) + b(\hat{b}_B - f)(1-H)\} + (m - \hat{b}_S)(1-H)\{D(p^C) + b(\hat{b}_B - f) + tb\}}{D(p^C) + b(\hat{b}_B - f)(1-H) + tb},$$

where $D(p^C) = a - bp^C$.

<u>Profit-maximizing monopoly network</u>

Max $\Pi = (f + m - c)\int_f^{\bar{b}_B} \{a - bp^C - bf + bb_B\} h(b_B) db_B$ s.t. $m \le \overline{\overline{m}}$ and

$$p^C = d + \hat{b}_S + \frac{t\{D(p^C) + b(\hat{b}_B - f)(1-H)\} + (m - \hat{b}_S)(1-H)\{D(p^C) + b(\hat{b}_B - f) + tb\}}{D(p^C) + b(\hat{b}_B - f)(1-H) + tb}.$$

Numerical examples suggest that the equilibrium fee structure is:

$$m = \overline{\overline{m}} \approx \hat{b}_S + \hat{b}_B - f = \hat{b}_S + \frac{\bar{b}_B - (c - \hat{b}_S)}{2}, \text{ and}$$

$$f \cong c - \hat{b}_S .$$

<u>Output-maximizing monopoly network</u>

$$\text{Max } Q = \int_f^{\bar{b}_B} \{a - bp^C - bf + bb_B\} h(b_B) db_B \text{ , s.t. } m \le \overline{\overline{m}}, \; f + m \ge c \text{, and}$$

$$p^C = d + \hat{b}_S + \frac{t\{D(p^C) + b(\hat{b}_B - f)(1-H)\} + (m - \hat{b}_S)(1-H)\{D(p^C) + b(\hat{b}_B - f) + tb\}}{D(p^C) + b(\hat{b}_B - f)(1-H) + tb} .$$

Numerical examples suggest that it is quite likely to have corner solutions for this problem. When $m = \overline{\overline{m}}$ and $f + m = c$, $\hat{b}_B \cong c - \hat{b}_S$. By definition, $f < \hat{b}_B$, and thus the equilibrium cardholder fee is likely lower than the efficient cardholder fee. The merchant fee is higher than the efficient one, so is the product price.

2. Discriminatory Pricing

Scenario I: Fixed Demand and Flat Costs and Fees

When both Merchants A and B accept the cards, they set the price for cash users at $p^{cash} = t + d + \hat{b}_S$ and the price for card users at $p^{card} = t + d + m$. The marginal card user is, therefore:

$$b_B^m = f + m - \hat{b}_S .$$

Notice that marginal card user is determined by the total fee, not by the fee structure. It is easy to show that rejecting the cards always makes a merchant worse off, given the other merchant accepts the cards.

<u>Profit-maximizing monopoly network</u>

$$\text{Max } \Pi = (b_B^m + \hat{b}_S - c)(1 - H(b_B^m)) .$$

The equilibrium marginal card user and total fee are:

$$b_B^m = c - \hat{b}_S + \frac{1 - H(b_B^m)}{h(b_B^m)} \text{, and}$$

$$f + m = c + \frac{1 - H(b_B^m)}{h(b_B^m)}.$$

<u>Output-maximizing monopoly and output-maximizing competing networks</u>

Since the total fee determines the marginal card user, the problems of output-maximizing networks become the same for monopoly and competing networks.

Max $1 - H(f)$, s.t. $f + m - c \geq 0$.

The equilibrium marginal card user and total card fee are:

$b_B^m = c - \hat{b}_S$, and

$f + m = c$.

Scenario II: Fixed Demand and Proportional Costs and Fees

When both Merchants A and B accept the cards, they set the price for cash users at $p^{cash} = t + \dfrac{d}{1 - \hat{b}_S}$ and the price for card users at $p^{card} = t + \dfrac{d}{1 - m}$. The marginal card user is, therefore, $b_B^m = 1 + f - \dfrac{(1 - \hat{b}_S)(1 - m)t + (1 - m)d}{(1 - \hat{b}_S)(1 - m)t + (1 - \hat{b}_S)d}$.

When Merchant A accepts the cards but Merchant B does not, then the marginal card user is determined by Merchant A's product prices. When the merchant fee is lower than the merchant's transactional benefit from cards, then Merchant B is always worse off by rejecting the cards, given Merchant A accepts the cards. When the merchant fee exceeds the merchant's transactional benefit, Merchant A sets the product prices so that no customers use cards. Thus, card networks cannot set the merchant fee higher than the merchant's transactional benefit. If doing so, one merchant rejects the cards and the other merchant accepts the cards but sets a high product price for card using customers, so that no customers use cards.

Profit-maximizing monopoly network

$$\text{Max } \Pi = (f + m - c)(1 - H(b_B^m)), \quad \text{s.t. } m \le \hat{b}_S \text{ and } f = b_B^m$$

The equilibrium marginal card user (i.e., cardholder fee) and the merchant fee are:

$$b_B^m = f = c - \hat{b}_S + \frac{1 - H(b_B^m)}{h(b_B^m)} \text{ , and}$$

$$m = \hat{b}_S \text{ .}$$

Output-maximizing monopoly network

The budget constraint binds before the marginal card user reaches to the consumer with the lowest transactional benefit from cards. The equilibrium marginal card user (i.e., cardholder fee) and the merchant fee are:

$$b_B^m = f = c - \hat{b}_S \text{ , and}$$

$$m = \hat{b}_S \text{ .}$$

Output-maximizing competing networks

It is easy to show an output-maximizing competing network has no incentive to set different fee structure than output-maximizing monopoly network. Thus, the equilibrium in this case is the same as the equilibrium under output-maximizing monopoly network.

Scenario III: Downward-Sloping Demand Curve and Flat Costs and Fees

Since it is extremely difficult to obtain analytical solution in this case, we will leave it for future research.