Regulating Debit Cards: The Case of *Ad Valorem* Fees

By Zhu Wang

Debit cards have become an indispensable part of the U.S. payments system, accounting for more than a third of consumer payments at point of sale. With this development has come controversy: Card networks charge merchants fees that merchants believe are too high. And most of the fees are *ad valorem*—that is, based on transaction value—rather than fixed fees per transaction.

Merchants are critical of the *ad valorem* debit card fees. They argue that debit cards, unlike credit cards, do not extend credit to card users, and the risks of debit fraud are small. So, there should be no cost rationale for debit cards to charge *ad valorem* fees. In fact, fixed per-transaction fees are the norm for debit cards in many countries around the world.

This controversy raises interesting questions. Given that debit cards incur a fixed cost per transaction, why do they charge *ad valorem* fees? How do *ad valorem* fees affect payment market participants, including consumers, merchants, and card networks? And should policymakers consider regulating debit cards by requiring fixed per-transaction fees?

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These questions are a part of a broader debate on payment card markets. In recent years, researchers, market participants, and policymakers have been scrutinizing payment card fees and rules. As a result, a large body of literature, called "two-sided market theories," has developed, most of which focuses on the level of card fees on merchants and cardholders, but few have touched on fee structure issues.

This article explores a major controversy about debit card fee structures, namely, *ad valorem* fees versus fixed per-transaction fees. The analysis shows that, when card networks and merchants both have market power, card networks earn a higher profit by charging *ad valorem* fees than fixed per-transaction fees. At the same time, merchant profits are reduced, but both consumer surplus and social welfare are increased.[1] Merchants complain that the current *ad valorem* fees charged by debit cards deviate from a cost basis. However, policymakers may have difficulty directly setting card fees at cost-based levels due to various information and implementation constrains. As an alternative, should policymakers regulate the debit fee structure simply by requiring fixed per-transaction fees (but allowing card networks to freely set the fee levels)? Our analysis suggests that this alternative may increase merchant profits at the expense of card networks, consumers, and social welfare. Therefore, caution should be taken when policymakers consider intervening in the debit card market.

The first section of the article provides some background on the debit card industry and related policy debates. The second section analyzes why card networks prefer charging *ad valorem* fees. We show in some circumstances *ad valorem* fees and fixed per-transaction fees are equivalent, but they are often different. The analysis considers how card networks, merchants, and consumers are each affected by *ad valorem* fees versus fixed per-transaction fees. The third section discusses policy implications.

I.   INDUSTRY BACKGROUND

The U.S. payments system is changing rapidly as electronic payments replace paper transactions. This section briefly describes how rapidly the debit card industry has evolved—along with the fees charged to merchants. The section then outlines the debate over the *ad valorem* fees that most card networks charge merchants for making debit transactions.

The rise of debit card use

The growth of U.S. debit card usage has been striking. Debit card use increased 23 percent annually from 1996 to 2008, exceeding 34 billion transactions in 2008. Debit cards now account for 37 percent of consumer retail payments, compared to 21 percent in 1999.[2]

Debit card payments are authorized either with a PIN or by the cardholder's signature. Growth has been sharp for both signature-based and PIN-based debit. From 1996 to 2008, signature debit transactions increased 24 percent annually, and PIN debit transactions increased 20 percent annually. In 2008, signature debit accounted for 60 percent of debit transactions, and PIN debit accounted for 40 percent.

In addition to signature and PIN debit cards, credit cards and charge cards are the two other types of general purpose payment cards in the United States.[3] Signature and PIN debit cards are different from those cards mainly because they do not provide credit or float to cardholders, but instead debit the cardholder's bank account right after each transaction.

Visa and MasterCard, the two major credit card networks in the United States, are also primary providers of debit cards.[4] The two networks, which hold 80 percent of the U.S. credit card market share, are the sole participants in the signature debit card market. Visa holds a 75 percent market share, and MasterCard holds a 25 percent share. In contrast, PIN debit card transactions are routed over PIN debit networks. Currently, there are 14 major PIN debit networks in the United States. Interlink, Star, and Pulse are the top three ones, holding 40, 30, and 11 percent of the PIN debit market share, respectively. The largest PIN network, Interlink, is in fact operated by Visa.[5]

Changes in debit card fees

When signature debit cards were introduced in the 1990s, Visa and MasterCard charged merchants *ad valorem* rates equal to their credit cards. The debit card rates fell after the settlement of the so-called *Wal-Mart* case in 2003 and since then have been lower than the credit card rates.[6]

PIN debit cards used to charge merchants fixed per-transaction fees. However, in recent years, PIN debit cards have been shifting to the *ad valorem* fee model, though typically with a cap.[7] The fees have been rising gradually, approaching the rates charged by signature debit cards, as shown in Chart 1.[8]

Chart 1

DEBIT CARD INTERCHANGE FEE: $50 (NON-SUPERMAR-KET) TRANSACTION

$ Dollar

MasterCard (sig)

Visa (sig)

Interlink (PIN)

Maestro (PIN)

Pulse (PIN)

Star (PIN)

NYCE (PIN)

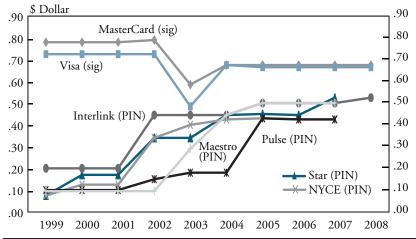1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

Chart 2 shows the average total fees paid by merchants for accepting various payment cards (Hayashi, 2009). A major component of these fees is the interchange paid by merchants to card issuers through merchant acquirers. The fees for credit card transactions are among the highest, followed by the fees for signature debit cards and PIN debit cards. On average, merchants pay about 1.75 percent of the transaction value for accepting signature debit cards and 0.62 percent for accepting PIN debit cards.

The ad valorem debate

Merchants have been critical of the *ad valorem* fees charged by debit cards. Recently, in testimony to the Canadian Senate Committee on Banking, Trade, and Commerce, merchant groups characterized the U.S. debit card controversy:

> We only need to look to the U.S. to see how the two card companies [Visa and MasterCard] suppressed efficient debit card services. . . . Fees have since skyrocketed and now include both flat fees and ad valorem rates. . . . Why should the debit fee bear any relation to the size of the transaction at the point of sale? If the money is transferred from a customer's account to the issuer in real time, and is clearly not a loan or credit advance, how can Visa and MasterCard justify charging a percentage fee? The answer is simple: Currently they can and they are unregulated.
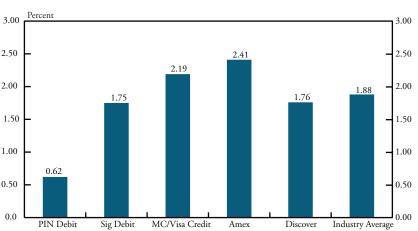
Chart 2
AVERAGE MERCHANT CARD FEE

Percent

	PIN Debit	Sig Debit	MC/Visa Credit	Amex	Discover	Industry Average
	0.62	1.75	2.19	2.41	1.76	1.88

The Canadian merchant groups requested rules to limit debit card pricing in a competitive environment and to impose a flat-fee structure rather than a percentage-based interchange fee. They also requested that there be transparency, oversight, and correlation between the flat-fee charged and the service provided.[9]

While card networks disagree, policymakers are somewhat sympathetic with the merchants' view. For example, the Canadian Senate Committee on Banking, Trade, and Commerce stated the following in its ruling report:

> *The Committee believes… that debit card transactions are inherently less risky and costly than credit card transactions; consequently, they do not warrant a percentage-based fee structure, whether at the level of interchange fees or switch fees.[10]*

As a result, the committee recommended that the federal government require switch and interchange fees to be calculated as a flat fee for debit card transactions.

The debate on debit card *ad valorem* fees raises important questions that affect all payment market participants—consumers, merchants, and card networks. Should policymakers regulate debit cards by requiring fixed per-transaction fees? And, if so, how would each payment market participant be affected?

II.   THE ANALYSIS

This section develops a framework for studying debit card pricing and market performance. First, it describes the market where debit cards are a payment alternative for consumers and merchants. Next, it examines three scenarios to show how *ad valorem* fees result in different market outcomes for market participants and overall social welfare. Finally, it provides the intuition of the analysis, which explains how monopolies in the market influence the market outcomes. More analytical details are provided in the Appendix.

Market environment

Consider a simple market environment where each consumer wants to purchase one unit of a good. The consumer receives the benefit of consuming the good, valued as v dollars. To provide the good, the merchant incurs a cost of u dollars per unit. Neither v nor u includes any benefits or costs related to using a particular form of payment.

Consumers have two options for making the purchase—they can pay with cash or use a card. Using a card in a transaction generates a benefit of b_c dollars to consumers for the convenience value for not using cash. Here we assume b_c to be heterogeneous among consumers.

Merchants have the same options for accepting payments—card or cash. Accepting a card in a transaction generates a benefit of b_m dollars to merchants for the cost savings from not handling cash. We assume that all merchants have the same value of b_m.

The card service is provided by a card network with market power, which incurs a fixed cost of d dollars for processing each card transaction. The costs of using cash, measured relative to the costs of using a card, are set to be zero for consumers and merchants. As shown in Figures 1 and 2, when a consumer makes a card purchase, the merchant submits a charge to the card network, which then bills the consumer.[11] The overall price consumers pay for a card purchase is composed of two parts: the retail price charged by merchants to card customers, denoted by p_{card}; and the card fee charged by the card network to consumers, denoted by f_c. The card fee could be proportional to the price, or a fixed dollar fee per transaction. Therefore, if f_c is an *ad valorem* fee, the
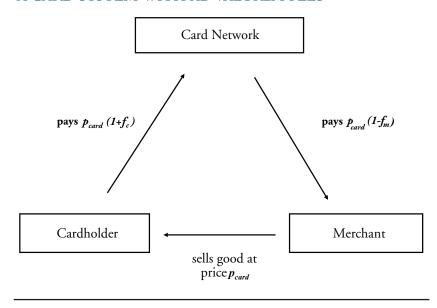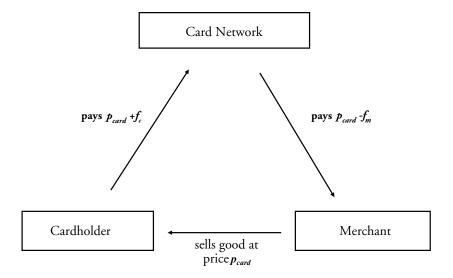
Figure 1

A CARD SYSTEM WITH *AD VALOREM* FEES

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                         ┌─────────────────────┐
                         │    Card Network     │
                         └─────────────────────┘
                          ↗                    ↘
        pays $p_{card}(1+f_c)$              pays $p_{card}(1-f_m)$

   ┌──────────────────┐                          ┌──────────────────┐
   │   Cardholder     │ ←──────────────────────  │    Merchant      │
   └──────────────────┘                          └──────────────────┘
                         sells good at
                         price $p_{card}$
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Figure 2

A CARD SYSTEM WITH FIXED PER-TRANSACTION FEES

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                         ┌─────────────────────┐
                         │    Card Network     │
                         └─────────────────────┘
                          ↗                    ↘
        pays $p_{card}+f_c$                pays $p_{card}-f_m$

   ┌──────────────────┐                          ┌──────────────────┐
   │   Cardholder     │ ←──────────────────────  │    Merchant      │
   └──────────────────┘                          └──────────────────┘
                         sells good at
                         price $p_{card}$
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total price consumers pay for the goods is $p_{card}(1+f_c)$; if f_c is a fixed per-transaction fee, the total price is $p_{card}+f_c$.[12]

Alternatively, if consumers make a purchase using cash, they simply pay the retail price charged by merchants to cash users, denoted by p_{cash} (recall that the cost of using cash is set to be zero). Thus, when deciding whether to make a purchase and what payment method to use, consumers need to weigh their consumption benefit, v, and card usage benefit, b_c, against the respective total prices for purchasing the good using a card or cash.

Merchants, on the other hand, receive a card or cash payment from their customers in each purchase. If a card is used, merchants receive a payment $p_{card}(1-f_m)$ under an *ad valorem* fee or $p_{card}-f_m$ under a fixed per-transaction fee, where f_m is the fee the card network charges to merchants. Alternatively, if cash is used, merchants simply receive a payment, p_{cash} (recall that the cost of accepting cash is set to be zero). Therefore, to maximize profits, merchants must decide whether to accept cards and, if they do, what prices to charge to card customers (p_{card}) and cash customers (p_{cash}). When making these decisions, they must weigh the per-transaction revenues and the card acceptance benefit, b_m, against the merchandise cost, u, the card fees (f_c and f_m), as well as the number of purchases affected by the retail prices and card fees.

In the debit card market, the timing of events is assumed to proceed as follows:

Stage I. The card network sets the no-surcharge rule, which prohibits individual merchants from charging a higher retail price to card customers than to cash customers.[13] The card network also sets card fees to consumers (f_c) and merchants (f_m), which could be either *ad valorem* fees or fixed per-transaction fees.

Stage II. Given the no-surcharge rule and card fees (f_c and f_m), merchants decide whether to accept cards and what prices to charge card customers (p_{card}) and cash customers (p_{cash}).

Stage III. Given the card fees (f_c and f_m) and retail prices (p_{card} and p_{cash}), consumers decide whether to make the purchase, which merchant to purchase from, and what payment method to use.

Table 1

GAIN FROM *AD VALOREM* FEES VERSUS FIXED PER-TRANSACTION FEES

Gain from *ad valorem* fees versus fixed per-transaction fees	Merchant Market Scenarios		
	(1)	(2)	(3)
	Perfectly Competitive merchants	Monopoly merchant serving card and cash customers	Monopoly merchant serving only card customers
Card network profit	0	0	+
Merchant profit	0	0	–
Consumer surplus	0	0	+
Social welfare	0	0	+

Notes: If no-surcharge rules are eliminated, all merchants, regardless whether they are competitive or monopolistic, would serve both card customers and cash customers with different prices. For perfectly competitive merchants, charging *ad valorem* card fees instead of fixed per-transaction fees would not affect any market outcome, as shown in Scenario 1. However, for monopoly merchants, charging *ad valorem* card fees instead of fixed per-transacation fees would affect the market outcome, as in Scenario 3.

Market outcomes

In the environment described above, the effects of *ad valorem* fees versus fixed per-transaction fees depend on specific scenarios in the merchant market. We consider three scenarios in this analysis: 1) perfectly competitive merchants, 2) local monopoly merchants serving both card customers and cash customers, and 3) local monopoly merchants serving only card customers.

Table 1 summarizes the effects of *ad valorem* fees versus fixed per-transaction fees on card network profit, merchant profit, consumer surplus, and social welfare in each of the three scenarios.

In the first scenario, all merchants are perfectly competitive. Merchants offer an identical product and compete over price. Because merchants earn zero margins on all transactions under perfect competition, the no-surcharge rule will cause merchants to divide into two groups, one that accepts cards and one that does not. Merchants that do not accept cards will set a price equal to the merchandise cost, *u,* and only serve cash customers. Merchants that accept cards will set a higher price to cover the cost of accepting cards. Taking this into account, the card network will then set the card fees, f_c and f_m, to maximize its profit. It can be shown that the resulting market allocations are the

same whether the card network charges *ad valorem* fees or fixed per-transaction fees.

In the next two scenarios, merchants each have local monopoly power.[14] Given the no-surcharge rule, each merchant will have to set a common price, *p,* for cash customers and card customers. Then, depending on the distribution of the card usage benefit, b_c, among consumers, two different outcomes may result. In one, shown as Scenario 2 in Table 1, merchants can maximize profits by setting the retail price, *p*, equal to consumers' consumption benefit, *v*, so that cash consumers will make the purchase. Meanwhile, consumers whose benefit of using card b_c is higher than the consumer card fee will use a card. Merchants will accept cards only if their benefits of accepting card b_m exceed the merchant card fee. Therefore, the card network will set the merchant fee equal to merchant card benefit b_m and then choose the consumer card fee to maximize its profit. In this scenario, it can be shown that the market outcomes are the same whether the card network charges *ad valorem* fees or fixed per-transaction fees. [15]

In the third scenario, merchants may earn more profits by excluding cash customers. In this case, merchants will set the price, *p*, higher than cash customers' highest "willingness to pay," *v*, and serve only card customers.[16] Given the price set by the merchant, the number of purchases made with cards is the number of consumers whose overall benefit of purchasing the good with cards, including both the consumption benefit, *v*, and the card usage benefit, b_c, is greater than the costs incurred. The merchant, taking the card fees $(f_m$ and $f_c)$ and consumers' decisions as given will choose the price level, *p*, to maximize its profit. The card network, accounting for the merchant and consumer decisions, will set the card fees $(f_m$ and $f_c)$ to maximize its own profit. In this scenario, setting card fees at an *ad valorem* rate or a fixed per-transaction rate does make a difference. Comparing the outcomes under *ad valorem* fees and fixed per-transaction fees, we obtain the following results:

- The card network earns a higher profit by charging *ad valorem* fees than fixed per-transaction fees.
- Merchants earn a lower profit under the *ad valorem* fees.
- The consumer surplus is higher under the *ad valorem* fees.
- The overall social welfare is higher under the *ad valorem* fees.

Economic intuition

The analysis has shown that *ad valorem* fees and fixed per-transaction fees are equivalent in Scenarios 1 and 2 but different in Scenario 3. One may wonder what the reasoning behind the analysis is.

The payment card market described above is a vertical system, with the card network acting as an upstream monopoly serving consumers through downstream merchants. When the downstream merchants are perfectly competitive (Scenario 1), or when the merchants are monopolies but their market power for excessively pricing to card customers is constrained (Scenario 2), the vertical system ends up with one monopoly—the card network. Because the monopoly card network sets a markup over the marginal cost, the market will inevitably have some welfare loss compared to the social optimum. However, in a single monopoly system, *ad valorem* fees and fixed per-transaction fees are equivalent.

In contrast, when the downstream merchants are monopolies that serve card customers exclusively (Scenario 3), things get more complicated. In this case, there are two monopolies in the vertical system, with the card network being the upstream monopoly and the merchant being the downstream monopoly. Both monopolies will price excessively to card customers, setting a markup over the marginal cost. Recall that pricing above marginal costs yields welfare loss—and two monopolies yield welfare loss *twice,* creating a classic "double marginalization" problem. In this case, however, by charging *ad valorem* fees the upstream monopoly can better restrain the market power of the downstream monopoly. As a result, the card network earns a higher profit at the expense of merchants. In addition, consumer surplus and social welfare are higher than with fixed per-transaction fees.

This analysis suggests that double marginalization is the key for understanding the conflicts between merchants and card networks over *ad valorem* fees versus fixed per-transaction fees. In our simple model environment, the double marginalization problem exists under two conditions: 1) when merchants are local monopolies, and 2) when they serve card customers exclusively.

This analysis can be applied to a much broader empirical context in which these two conditions can be relaxed. Consider a monopoly merchant selling a product with two brands, with one brand attracting card customers and the other brand attracting cash customers. In this case, even though the merchant serves both card customers and cash customers under the no-surcharge rule, the double marginalization problem may still be present in the card payment system. As another example, consider a group of merchants (such as Internet retailers) selling a homogenous product to card customers. These merchants do not have to be monopolies; still, the double marginalization problem exists if they behave oligopolistically, such as in a Cournot competition.[17] Therefore, in a broad range of scenarios, card networks strictly prefer *ad valorem* fees, while merchants prefer fixed per-transaction fees.

In short, under the assumption that card networks have market power, *ad valorem* fees and fixed per-transaction fees are equivalent when merchants are perfectly competitive or when merchants have market power but are prevented from using it in the pricing to card customers. However, when merchants have market power and use it in the pricing to card customers, card networks can better restrain merchants' market power by charging *ad valorem* fees than fixed per-transaction fees. As a result, card networks earn a higher profit under *ad valorem* fees, while merchants experience a reduced profit. Consumer surplus and social welfare are both higher.

III. POLICY DISCUSSIONS

Our analysis sheds some new light on the performance of the debit card market. We demonstrate that card networks earn higher profits by charging merchants *ad valorem* fees than fixed per-transaction fees in the presence of double marginalization. This finding helps explain the existing debit card fee structure and provides a framework to discuss related policy issues.

Regulating debit fee structures

First, it is important to recognize that market participants and policymakers generally have different objectives. Market participants, such as card networks, merchants, or consumers, seek to maximize their own

profits or benefits. In contrast, policymakers seek to increase the consumer surplus, or total social welfare.

As noted before, the monopoly power of card networks could reduce consumer surplus and social welfare because they charge a markup over marginal cost. This concerns policymakers, who try to align card fees with the cost basis. However, it might be difficult to directly regulate the card fee levels due to policymakers' lack of cost information or other constraints.

As an alternative, it seems natural and easy for policymakers to regulate the debit card fee structures by simply requiring fixed per-transaction fees (but allowing card networks to freely set the fee levels). But our analysis suggests that, given the market power of card networks, *ad valorem* fees and fixed per-transaction fees are equivalent in some scenarios. So imposing fixed per-transaction fees may not make a difference in market outcomes. In some other scenarios, *ad valorem* fees and fixed per-transaction fees yield different market outcomes. However, as it turns out, allowing card networks to charge *ad valorem* fees may actually produce better results for consumer surplus and social welfare. Findings such as these suggest that policymakers should consider intervening in the debit card markets with caution.

Regulating debit fee levels

Given that merely regulating card fee structures would not necessarily improve the market outcome, should policymakers take a step further to directly regulate card fee levels? This approach sounds plausible in theory because regulating down card fees close to their cost-based levels should suppress the market power of card networks and may improve the market outcome. In fact, several countries and economic areas have already begun to implement, or are considering, regulating card fee levels:

- In the *European Union*, the European Commission reached an agreement with Visa in 2002 to reduce its cross-border interchange fees by December 2007. The benchmark was to set the interchange fee at the level of the cost of supplying Visa payment services and would not exceed the cost of the services which issuing banks provide, wholly or partly, to the benefit of merchants. Currently, the Visa debit card interchange fee is set at 0.15 euro.

- In *Australia*, the Reserve Bank of Australia introduced an inter-change fee regulation for the Visa and EFTPOS debit transactions in 2006.[18] The regulation requires that the weighted-average inter-change fee on Visa debit transactions is limited to 0.12 Australian dollar per transaction, and the interchange fee (paid by the card issuers to the payment processor) must be between 0.04–0.05 Australian dollar per transaction for EFTPOS debit transactions.

- In *Canada*, the debit system, Interac, has operated under a Consent Order imposed by the Competition Tribunal since 1996. In 2007, Interac began discussions with the Competition Bureau in an attempt to change its Consent Order, including charging *ad valorem* debit fees. A hearing was held by the Canadian Senate Committee on Banking, Trade, and Commerce, which denied Interac's request. The committee recommended that the federal government require the calculation of switch and interchange fees on the basis of a flat fee for debit card transactions, and set the debit card interchange fee at zero for a period of three years.

- In the *United States*, regulating interchange fees is still a point of discussion. Currently, debit card fees include both fixed per-transaction fees and *ad valorem* fees.

The differences of card regulation across countries reflect the complexity that policymakers face in setting appropriate card fee levels. There are several fundamental challenges. First, policymakers may lack information on card costs because card networks and issuers treat their cost information as proprietary. Even if policymakers can mandate collecting the cost information, determining what cost components should be included in setting the card fees remains at issue. Historical lessons have shown that cost-based price control can distort firms' incentives—for example, firms may overinvest in things that are counted as cost components by the regulation, but underinvest in others (Averch and Johnson, 1962).

Second, the market costs of payment instruments may not fully reflect their social costs. This issue is particularly challenging when comparing payment cards with alternative payment instruments. For example, in the United States, the production of cash is a government activity, subsidized through the federal budget. The check system is run by the Federal Reserve, which essentially mandates banks to exchange

checks at par—that is, to have a zero interchange fee. Therefore, those payment systems are not fully market-driven, and social costs may diverge from private costs. Conditions such as these make it more difficult for policymakers to evaluate the social costs of using payment cards relative to other payment instruments.

Third, policymakers must consider endogenous changes in the payment card system. Assuming that payment costs are influenced only by exogenous conditions, suppressing the card networks' market power by regulating down card fees appears to enhance social welfare. In reality, however, the market power and profitability of card networks may affect their incentives for improving products and technologies. Moreover, the profitability in the card industry also provides incentives for inventing and developing competing payment products and technologies. All these endogenous and dynamic factors may make the welfare results of card fee regulation less clear.

Finally, it is important to recognize that price regulation is not the only option, or necessarily the best option, for policymakers to improve market outcomes. Other policy options are worth exploring, such as reforming the payment card market structure, or supporting technology progress of competing payment services. A number of ideas along these lines have been proposed, such as introducing multi-network cards, requiring bilateral interchange fees between card issuers and merchants, and reforming the network ownership and governance structure. In addition, increasing public scrutiny and regulatory threat may also be effective policy measures.

IV. CONCLUSIONS

This article explores the following questions regarding the fee structure of debit cards: Given that debit cards incur a fixed cost per transaction, why do they charge *ad valorem* fees? How do the *ad valorem* fees affect payment market participants, including consumers, merchants, and card networks? Should policymakers regulate debit cards by requiring fixed per-transaction fees? And, were such a regulation in place, how would each payment market participant be affected?

The analysis shows that, when card networks and merchants both have market power, card networks earn higher profits by charging *ad valorem* fees than fixed per-transaction fees. Meanwhile, consumers are

relatively better off under the *ad valorem* fees, but merchants experience a reduced profit. If policymakers regulate debit cards by requiring fixed per-transaction fees, but allow card networks to freely set the fee levels, merchants would gain from the regulation but card networks and consumers would lose. Altogether, overall social welfare is likely to be reduced.

The findings of the analysis help explain the existing debit card fee structure and suggest that policymakers should be cautious about intervening in the payment card markets. The analysis points out that there is no easy way for policymakers to improve the market outcome merely by regulating the fee structure of debit cards, and many challenging issues need to be considered before regulating the card fee levels.

APPENDIX

The Appendix provides technical details for the analysis in Section II.

Consider a simple market environment where each consumer wants to purchase one unit of a good. The consumer receives the benefit of consuming the good, valued as v dollars. To provide the good, the merchant incurs a cost of u dollars per unit. Neither v nor u includes any benefits or costs related to using a particular form of payment, and we assume $v > u$.

Using a card for a transaction generates a benefit of b_c to consumers and b_m to merchants. Benefit b_c varies among types of consumers and is distributed according to a cumulative distribution function H, defined as $H(x)=Prob\ (b_c < x)$. All merchants have the same value of b_m. Consumers know their own b_c, and both parties know the distribution of b_c and the value of b_m.

The card service is provided by a monopoly card network. The card network incurs a fixed cost, d, for processing each card transaction. In return, it charges card fees f_m and f_c to merchants and consumer respectively, where f_m and f_c could be either proportional to the retail price or a fixed dollar fee per transaction. The costs of using cash are normalized to be zero for consumers and merchants.

Therefore, the overall price that consumers pay for a purchase made with cards is composed of two parts: One is the retail price charged by merchants to card customers, denoted by p_{card}; and the other is a card fee, f_c, charged by the card network to consumers. Alternatively, if consumers make a purchase using cash, they simply pay the retail price charged by merchants to cash customers, denoted by p_{cash}. As a result, a consumer of type b_c receives consumer surplus U_{bc} as follows:

$$U_{bc} = \begin{cases} v\text{-}p_{cash} & \text{if cash is used} \\ v\text{-}p_{card}\,(1\text{+}f_c)\text{+}b_c & \text{if card is used under an } \textit{ad valorem} \text{ fee} \\ v\text{-}p_{card}\text{-}f_c\text{+}b_c & \text{if card is used under a fixed per-transaction fee} \end{cases}$$

The number of card transactions, Q, is the number of consumers whose consumer surplus of using cards is higher than using cash, determined by:

$$Q = \begin{cases} 1\text{-}H(p_{card}\,(1\text{+}f_c)-p_{cash}) & \text{under an } \textit{ad valorem} \text{ fee} \\ 1\text{-}H(p_{card}\text{+}f_c-p_{cash}) & \text{under a fixed per-transaction fee} \end{cases}$$

Merchants, on the other hand, receive a card or cash payment in each transaction. When a card is used, merchants receive a payment $p_{card}(1-f_m)$ if f_m is an *ad valorem* fee, or $p_{card}-f_m$ if f_m is a fixed per-transaction fee. Alternatively, if cash is used, merchants receive a payment p_{cash}. As a result, merchants make a profit margin, π_m, in each transaction:

$$\pi_m = \begin{cases} p_{cash}-u & \text{if cash is used} \\ p_{card}(1-f_m)-u+b_m & \text{if card is used under an } ad\ valorem \text{ fee} \\ p_{card}-f_m-u+b_m & \text{if card is used under a fixed per-transaction fee} \end{cases}$$

The card network, given the retail prices (p_{card} and p_{cash}) and card fees (f_m and f_c), makes a total profit:

$$\Pi_N = \begin{cases} p_{card}\,(f_m+f_c)\,Q-dQ & \text{under } ad\ valorem \text{ fees} \\ (f_m+f_c-d)Q & \text{under fixed per-transaction fees} \end{cases}$$

In the market, the timing of events proceeds as follows.

Stage I. The card network sets rules. In particular, a rule is set whereby merchants are either allowed to set a surcharge for card payment, or not (referred to as the no-surcharge rule). Also, the card network sets card fees to merchants and consumers (f_m and f_c), which could be either *ad valorem* fees or fixed per-transaction fees.

Stage II. Given the card fees (f_m and f_c), merchants decide whether to accept cards, and what prices to charge to card customers (p_{card}) and cash customers (p_{cash}).

Stage III. Given the card fees (f_m and f_c) and retail prices (p_{card} and p_{cash}), consumers decide whether or not to make the purchase, which merchant to purchase from, and what payment method to use.

In the environment described above, the effects of *ad valorem* fees versus fixed per-transaction fees depend on specific scenarios in the merchant market, as shown in the following propositions. The detailed proofs of the propositions can be found in Wang (2010b).

Proposition 1. When merchants are perfectly competitive, regardless of the no-surcharge rule, the market outcomes are the same whether the card network charges *ad valorem* fees or fixed per-transaction fees.

Proposition 2. When merchants have monopoly power and serve both card customers and cash customers under the no-surcharge rule, the market outcomes are the same whether the card network charges *ad valorem* fees or fixed per-transaction fees.

Proposition 3. When merchants have monopoly power and serve exclusively (or surcharge) card customers, compared with charging fixed per-transaction fees,

(a) the card network earns a higher profit by charging *ad valorem* fees;

(b) merchants earn lower profits under *ad valorem* fees;

(c) consumer surplus is higher under *ad valorem* fees;

(d) social welfare is higher under *ad valorem* fees.

ENDNOTES

[1]*Consumer surplus* is defined as the difference between the total amount consumers would be willing to pay to consume the goods and the amount they actually have to pay for those goods, which measures the monetary value of consumer satisfaction. *Social welfare* is defined as the sum of card network profits, merchant profits and consumer surplus in our analysis, which measures the total welfare gain to the society.

[2]Source: *Studies of Consumer Payment Preferences* by Dove Consulting (1999) and Hitachi Consulting (2008).

[3]Charge cards are similar to credit cards, except that they require cardholders to pay off full charges every month.

[4]American Express and Discover are the other two major networks that account for the remaining 20 percent of the U.S. credit card market share.

[5]Other credit card networks are also major players in the PIN debit markets, such as Discover's Pulse and MasterCard's Maestro.

[6]In 1996, a number of merchants and retail trade associations filed lawsuits against Visa and MasterCard challenging the networks' rules that required merchants that accepted their credit cards to also accept their signature debit cards (the honor-all-cards rules). The various lawsuits were combined into a single, consolidated action, which became known as the *Wal-Mart* case. In 2003, the *Wal-Mart* case was settled, with Visa and MasterCard agreeing to pay over $3 billion in damages and to rescind partially the honor-all-cards rules. Following the settlement, merchants were allowed to make separate acceptance decisions for credit cards and signature debit cards.

[7]Note that *ad valorem* fees on PIN debit transactions started in 1996 (or earlier) by Interlink for non-supermarket transactions. Star and NYCE followed suit in 2000. Exchange started using *ad valorem* fees in 2002, Maestro in 2003, and Pulse and Jeanie in 2005. Major PIN debit cards currently charge between 0.45 to 0.75 percent of the transaction value plus 5 to 15 cents, capped around 40 to 65 cents for non-supermarket transactions. More recently, some leading networks removed "caps" for small retail merchant categories, and many networks raised the "capped amount." (Sources: *EFT Data Book*, various issues, MasterCard International and Visa USA).

[8]Chart 1 is taken from Hayashi (2006) and has been updated to 2008.

[9]Source: "Transparency, Balance and Choice: Canada's Credit Card and Debit Card Systems," Chapter 5, the Standing Senate Committee on Banking, Trade, and Commerce, Canada, June 2009.

[10]Switch fees are charged by card networks to card issuers and payment processors for transferring information through the network for each card transaction.

[11]Thus, for the purpose of our paper we deliberately abstract from the internal organization of card networks, which include merchant acquirers who receive the

request for payments from merchants and card issuers who bill consumers and send the money to merchant acquirers who then pay the merchants.

[12] The consumer card fee, f_c, could be negative if consumers receive card rewards.

[13] No-surcharge rules are imposed by card networks in the U.S. market. Hence, it is a realistic assumption and also helps keep our analysis simple. The no-surcharge assumption is relaxed in the Appendix and the notes following Table 1 describe the market outcomes without no-surcharge rules.

[14] In economics, market power refers to the ability of a firm to alter the market price of a good or service. A firm with market power can raise prices without losing all customers to competitors. Firms are considered to have market power in a range of market structures, such as monopolistic or oligopolistic markets, all of which fall short of perfect competition.

[15] For a simple example, consider a merchant whose majority of customers do not own a card. The merchant would have to lose all the profits made from those customers if it raises price p higher than v, so its profit-maximizing price has to be set at $p=v$.

[16] This is typically the case for merchants whose business relies heavily on card payments, such as Internet retailers, hotels, airlines or merchants selling high-value goods. In this scenario, cash customers cannot make purchases and hence their consumer surplus is zero.

[17] Cournot competition is an economic model named after French economist Antoine Augustin Cournot. The model describes an industry structure in which firms compete on the amount of output they will produce, which they decide on independently of each other and at the same time.

[18] EFTPOS is the PIN debit card system in Australia.

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