Spreading the Pain Can Aggravate the Injury:

Uniform-Pricing Constraints in Payment Networks

by

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1. Introduction

Transactions through electronic payment networks (EPNs) in the U.S. exceeded $1.18 trillion in 1999 and are growing rapidly.[1] Several industry practices have attracted significant controversy and antitrust scrutiny. For example, there is debate over whether the joint setting of certain network fees by EPN-member banks (as in "bank card" associations such as Visa, Mastercard, and regional networks) is anti-competitive. (See Salop 1990; Carleton and Frankel 1995, 1995a; or Evans and Schmalensee 1995, 1999.) Also, a common EPN requirement is that merchants must accept all of that EPN's cards if they wish to accept any, e.g., merchants that accept Visa's credit card must also accept its online debit card. This requirement is the target of a major lawsuit brought by retailers against Mastercard and Visa, alleging anti-competitive tying.[2] Another key feature—and the focus of our analysis—is constraints on merchants' ability to set different prices depending on the means of payment employed, whether different cards or non-card media such as cash or checks.

At times, these constraints were imposed by federal or state laws. Frequently they are imposed by EPN rules that prohibit merchants from imposing surcharges (or adverse non-price terms) for payments with an EPN card, even though merchants may face higher costs for such

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1 This figure includes $1.09 trillion in transactions using credit cards and offline debit cards (of which $561.5 billion was through Visa, $277.9 billion through Mastercard, and the rest through proprietary networks such as American Express and Discover), and $84.9 billion using online debit (mainly through regional electronic funds transfer (EFT) networks). *Nilson Report*, May 2000, issue 716. <http://www.nilsonreport.com/issue_716.html.>

2 Walmart and other retailers are seeking over $8 billion in damages. "Visa, Mastercard Battle with Retailers," by Paul Beckett, *Wall Street Journal*, Nov. 24, 1998. "The Perils of Plastic," by Joseph Webber and Ann Therese Palmer, *Business Week*, February 14, 2000.

transactions due to fees charged by the EPN.[3] Even in the absence of formal prohibitions, merchants are often reluctant to set different retail prices depending on the means of payment.[4] We refer to all these limits as the No-Surcharge "Rule" (NSR) and analyze its impact on prices, output and welfare. Our analysis is relevant to several policy issues. Most directly, it sheds light on the desirability of the rule when imposed by law or private regulations. When the "rule" instead derives from other characteristics of merchant's trading environment (and its repeal is therefore not a policy option), our analysis is relevant for assessing interventions that would restrict an EPNs' *structure* of charges as between merchants and cardholders. Finally, the analysis is a necessary step towards evaluating the effects of card tying policies (see fn. 2 above), since such tying would have no force if merchant surcharges were unrestricted.

We consider an EPN with market power that contracts with a representative merchant. The merchant faces downward-sloping demand from consumers, who pay with the EPN card or other means ("cash").[5] The EPN may set charges to the merchant and to card users. In this setting, one might expect an NSR to benefit consumers and overall welfare, drawing on intuition from optimal taxation (or Ramsey pricing)—where inefficiency is reduced by using a broader tax base so as to lower the tax rate. The limited analogy is that, for a given above-cost charge from

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3 Surcharges on credit card transactions were prohibited by federal statutes from 1968 to 1985 and remain prohibited by some states (e.g., Florida). Visa long had its own no-surcharge rule. It relaxed the rule quite recently. Mastercard currently prohibits its merchants from "surcharging" customers for credit purchases, though, curiously, it allows cash "discounts". (Rochet and Tirole (1999) and www.mastercard.com/consumer/cust_serv.html).

4 Cash discounts are very rare across a broad spectrum of retail categories. According to one retailer survey, fewer than 1% of merchants offer cash discounts. Chain Store Age, *Fourth Annual Survey of Retail Credit Trends*, January 1994, section 2.

5 We use "card" as a general term to denote any of a wide range of electronic payment services, and "cash" to denote the alternative means of payment. Also, we sometimes will refer to the EPN as the card company.

the EPN to the merchant for card transactions, an NSR leads a merchant to set a "moderate" uniform price for card and cash transactions, instead of a higher price for card transactions alone; such price uniformity can reduce misallocation between card and cash transactions. We show, however, that the optimal tax analogy is seriously incomplete.

Here, the EPN is unregulated and its profit is not held constant, and allowing it to tax also non-card sales—indirectly via the NSR—leads the EPN to raise its charge to the merchant. By inducing this increase in the merchant's cost and forcing the merchant to set a uniform retail price, the NSR can bring about a higher retail price for both cash and card transactions. This contrasts with standard comparisons of uniform pricing and third-degree price discrimination where, under regularity conditions also satisfied here, a requirement of uniform pricing causes at least some price(s) to fall (Nahata et al. 1990; Malueg 1992).

We also show how an NSR alters the EPN's preferred structure of charges as between merchants and cardholders. If merchant surcharges to consumers were unrestricted, only the EPN's aggregate charge would matter, its division between cardholders and merchants would be irrelevant (Baxter 1983). With an NSR constraint, however, the EPN concentrates its charges on merchants. Indeed, at least with linear demands, the NSR equilibrium features rebates (negative charges) to cardholders, whenever such rebates are feasible.

Cardholder rebates by EPN-member banks are often viewed as reflecting an EPN's inability to prevent its members from competing for cardholders and dissipating rents generated by high EPN charges to merchants. Our analysis reveals a different possible role for rebates: they enable an EPN to magnify the effect of an NSR constraint on merchant pricing. Consistent with this interpretation, cardholder rebates have been offered not only by bank-card associations, but also by proprietary networks such as Discover, where a single entity asses charges to both merchants and cardholders. The EPN boosts cardholders' demand by granting rebates and raises its charge to merchants knowing that they will absorb part of the increase, since the NSR requires that any increase must apply equally to cash users. Rebates thus misallocate transactions towards cards, the opposite of what occurs absent an NSR. Allowing for rebates and with linear demands, we find that an NSR can lower or raise overall welfare. However, the merchant is always harmed and overall consumer surplus across cash and card users always declines, regardless of the relative sizes of these groups.

Overall, our findings suggest that an NSR is likely to harm consumers. This highlights a contrast with a well known instrument of vertical control—maximum resale price maintenance (RPM). Both practices enable a supplier to reduce the margin charged on its product by an imperfectly competitive downstream firm. Maximum RPM, however, affects only the targeted product, lowering its price and benefitting consumers and overall welfare (Tirole 1988). In contrast, an NSR squeezes the merchant's margin indirectly, by requiring the same retail price to be charged for the other product (here, cash transactions), thus raising that price.

2. The Electronic Payments Market and Related Literature

Despite the significant and growing importance of electronic means of payments (Evans and Schmalensee 1999), there are relatively few formal economic analyses of the EPN industry. The standard reference for the operation of a payment system that involves multiple banks (such as Visa or Mastercard) has long been that of Baxter (1983). As Baxter illustrates, typical electronic payment transactions involve four parties. A cardholder exchanges with a merchant a promise to pay (a credit card receipt, for example) in return for goods. The merchant sells the promise to pay to a bank with which it has contracted, known as the (merchant's) "acquiring bank." The merchant receives the face value of the promise minus a fee called the "merchant discount." The acquiring bank then sells the receipt to the bank that issued the card to the cardholder ("issuing bank"), again at face value minus a discount known as the "interchange fee." The issuing bank collects from the cardholder the amount promised to pay. Conceptually, and sometimes in practice, the issuing bank may also charge the cardholder a fee (or grant a rebate).

The bank-card network performs functions such as clearing transactions, fraud control and joint promotion, and coordinates the setting of the interchange fee; but each bank sets its own terms to its cardholders or merchants. In proprietary networks such as American Express, Discover and Diner's Club, the same integrated entity deals with both merchants and cardholders. The interchange fee in this case is a fiction and there are only two true prices for credit card services, the merchant discount fee and any cardholder fees.

Analyses of bank-card networks, then, potentially require a specification of market structure at all four levels of the transactions: merchant, cardholder, and their respective banks (acquirer and issuer). Baxter (1983) assumes perfect competition at all levels. Rochet and Tirole (1999) and Schmalensee (1999) assume imperfect competition at the merchant level and in card issuance, but perfect competition in merchant acquisition (citing empirical evidence that acquisition is significantly more competitive than issuance). Our model considers a profit-maximizing agent, the EPN, setting the charge to merchants and, for most of the paper, also to cardholders. This model is most obviously interpreted as one of a *proprietary* card network. It is also an approximation of a bank-card network under two conditions: (a) merchant acquisition is competitive, as assumed by the above authors (variations in the interchange fee are then fully passed through to the merchant discount, and one can view the merchant discount as being set by the EPN's issuing banks, through their choice of interchange fee, to maximize their profit); and

(b) there is little competition between issuing banks in pricing to cardholders (so that cardholder charges can also be viewed as being set to maximize overall profits of issuing banks). Later we modify the model to allow competition among EPN banks in setting cardholder charges.

The complexity of this market implies that there are a variety of margins that will be affected by pricing practices. For example, merchants must decide whether or not to accept a card; customers will choose whether or not to use a card and, also, their level of purchases. The competitive impact of pricing rules may be manifested at any of these margins. Schmalensee (1999) examines the impact of the joint setting of interchange fees on the marginal decisions of merchants to accept cards (as well as the decision of consumers to carry cards). Rochet and Tirole (1999) analyze the impact of interchange fees and the NSR on the decision of a consumer to use a card versus an alternative means of payment. We focus, instead, on the impact of an NSR on the quantities of purchases made by card users and cash users.

Rochet and Tirole (1999) is closest to our analysis. In their model, consumer have unit demands for a good but differ in their private values of paying with cards versus cash. The net cost of using cards then affects the number of consumers who choose cards as opposed to cash. However, as Rochet and Tirole observe, the total quantity of purchases is constant (given the assumptions of unit demands and that all consumers are always served in the Hotelling competition among merchants). In contrast, we assume that the means of payment for a given consumer is exogenous; a fraction of consumers use cards and the rest use cash. In our model, however, consumers have continuous demand functions for goods, hence the quantity of purchases for a given consumer can vary continuously with price. Thus, while EPN pricing will not affect the number of cardholders in our model, it can and will affect the total quantities of card purchases and, through the NSR, of cash purchases as well.[6]

This environment leads to some surprising conclusions. While Rochet and Tirole show that an NSR will typically increase the use of cards, we show that, if cardholder rebates are infeasible, an NSR can reduce cards transactions, as well as cash transactions. Thus, in our model an NSR can harm all parties except the EPN. In addition, by separating card users and non-card users, we can examine directly the potential surplus-shifting effects of the NSR. That is, we can examine the degree to which an NSR forces non-card users to cross-subsidize the use of cards.

The remainder of the paper is organized as follows. Section 3 presents our model without the NSR, where a monopolist EPN can commit to setting (linear) charges to a monopolist merchant and to cardholders. We reproduce the familiar result that the EPN is then indifferent between levying its charges on the merchant or on cardholders, and show further that, provided the merchant's gross benefit from accepting a card is not too large, card users pay a higher equilibrium total price than do cash users. Focusing on this case, Section 4 shows that the NSR must increase the card company's profit. Furthermore, holding the sum of merchant and cardholder fees fixed, an EPN now strictly prefers to load all the fees on the merchant.

To assess the overall impact of an NSR, it is necessary to examine the EPN's change in overall prices as well as its changes in pricing structure. Section 5 considers the case where

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[6] Other differences between our approach and Rochet and Tirole's are less consequential. For example, they assume (as do we) that EPN members set the interchange fee (and ultimately the merchant discount) jointly, but may compete in their fees to cardholders. This is modeled by treating the equilibrium cardholder fee as a reduced form function that decreases in the interchange fee. (Raising the interchange fee raises an acquiring bank's margin, thereby inducing the bank to cut its customer fee so as to expand card usage.) The two cases we consider—an EPN monopolist that sets cardholder fees directly, or Bertrand competition among EPN members—are special cases of their specification. Regarding merchant behavior, they assume symmetric duopolists in Hotelling competition while we assume a monopolist, but in both cases the number of merchants is fixed and each faces downward-sloping demand. (Like Rochet and Tirole, we address whether it is rational for the merchant to accept a card.)

rebates to cardholders are not feasible. If the merchant's acceptance constraint does not bind (as occurs if the proportion of cash users is relatively small), then the equilibrium with the NSR features higher prices to both cash and card users than without an NSR. If the merchant's acceptance constraint is binding then, with linear demands, total surplus (welfare) may rise or fall but total consumer surplus across cardholders and cash users always declines with an NSR. Section 6 relaxes the constraint that EPN charges to cardholders must be non-negative (i.e., allows for rebates). Again for linear demands, we find that the equilibrium with an NSR always features cardholder rebates, thereby implying a misallocation of transactions towards card users and away from cash. While rebates increase total consumer surplus relative to no rebates under an NSR, total consumer surplus with rebates is still lower than without an NSR.

Section 7 modifies the basic model by assuming that the EPN cannot publicly commit to the price that will be charged to cardholders. This lack of commitment ability arises in two settings. First, a proprietary EPN will generally have incentives to give secret rebates to cardholders once the merchant has set its retail prices. Second, an EPN consisting of multiple card-issuing banks may be unable to control their prices to cardholders. The unifying result in both cases is that an NSR generates further distortion of purchases in favor of card transactions. In the proprietary EPN case, the NSR always reduces overall welfare and total consumer surplus. In the case of an EPN that is an association of independent banks, if competition among the member banks is strong (Bertrand), then an NSR increases both overall welfare and consumer surplus, though it still biases the mix of payment modes towards cards. Section 8 concludes.

3. The Model and Pricing With Surcharges Possible

Consumers: We consider two types of consumers. Type *e* consumers ("cardholders") buy units of a good using only cards from an electronic payments network (EPN); their mass is 1. Type *c* consumers buy units of a good using only an outside means of payment, call it cash; their mass is α. There is no substitutability across means of payment for these consumers. Consumers are otherwise identical and have quasilinear utility functions as follows:

A1) *Identical, quasilinear preferences:* $U(p_j, q_j)=V(q_j)-p_j\, q_j,\ V'(\bullet)>0,\ V''(\bullet)<0,\ j=c,e.$

where, throughout, q_j is the *per-capita* number of transactions of a consumer of type $j = c, e$, and p_j is the net price per unit of transaction paid by such a consumer. The net price paid by cash users equals the price charged by the merchant but the two prices may differ for card users. Let p_e^M denote the price charged by the merchant to a card using consumer: $p_e = p_e^M + t$, where t is the per unit charge (or rebate if $t < 0$) imposed by the EPN company on card users. For each type of consumer, the inverse demand function is given by $V'(q_j) = p_j$.

Merchants: We assume that merchants are local monopolists who treat the above inverse demand curve as the demand for their product from each type of consumer. The marginal cost of providing a good to a cash consumer is assumed constant and is normalized to zero. The merchant may also gain a benefit from providing a good to an EPN consumer of $b \geq 0$, reflecting potential savings to the merchant from lower cash handling costs. In addition, merchants are charged by the EPN a per- unit fee i.

The merchant's profit is $p_c^M q_c$ from cash users and $p_e^M q_e - (i-b)q_e$ from card users, where quantities are given by $p_c^M = V'(q_c)$ and $p_e^M = V'(q_e) - t$. For given values of i and t, the merchant's problem can therefore be formulated as choosing a level of x in each market to solve

Maximize$_x$ $V'(x)x$

for the cash market, and

Maximize$_x$ $(V'(x)-(i+t-b))x$

for the card market. Written this way, the term $i+t-b$ can be interpreted as a net tax imposed on the card market by the EPN.[7]

The subsequent analysis uses the following lemma frequently. Define $x(k)$ as $x(k)=argmax_x\ (V'(x)-k)x$, the profit-maximizing quantity for a monopolitst that faces inverse demand $V'(x)$ and marginal cost k. (Assumption **A.2** below ensures that the profit-maximizing quantity is unique though this is not required for the Lemma.)

Lemma 1: *$k'>k$ implies $x(k')<x(k)$.*

The proof, which is in the Appendix along with all other proofs, uses a standard revealed preference argument (see, for example, Tirole 1988, pp. 66-67). Note that for a given i and t, the quantity of card transactions is $x(i+t-b)$ while the quantity of cash transactions is $x(0)$. For later reference, we define $x(0) \equiv x_0$. Lemma 1 yields the following corollary:

Corollary 1: *If the sum of the fees to the merchant and to the card user exceeds the merchant's benefit from card use, $(i+t-b) >0$, then per-capita card transactions are lower than per-capita cash transactions.*[8]

[7] This monopoly characterization of the merchant market would emerge in Rochet and Tirole (1999) if their assumption that the full market is always served was relaxed. In their model, two merchants are located at either end of a line with consumers located along the line. If consumers incurred significant transportation costs, each potential duopolist would become a local monopolist.

[8] Whether the net cost of purchasing with a card will be fully passed through to consumers by the merchant depends, in general, on the nature of consumer preferences. For example, if $xV''(x)$ is nonincreasing (as in the case of linear demand), the full net cost of serving EPN users $(i-b)$ is not passed on to card users.

Electronic Payments Network: As noted, we suppress the distinction between the interchange fee and merchant discount, and simply view the EPN as setting the charge to merchants, *i*, monopolistically. With the exception of Section 7, we also assume that the EPN acts monpolistically in the setting of any cardholder fees. Again except in Section 7, we assume that the timing of price setting is in a Stackelberg manner. That is, the EPN sets *t* and *i* and commits to this profile of prices and, given *t* and *i*, the merchant sets her monopoly price. The EPN's marginal cost of servicing a card transaction is assumed to be zero.

We assume that two-part tariffs are not available either to the EPN or to the merchant. What is important for our analysis is that the sequential monopoly environment between the card company and the merchant lead to some inefficient pricing at both the merchant and EPN levels.[9] For simplicity, we assume that only linear pricing is feasible for each agent.

The first-order conditions from the merchant's problem yields a derived inverse demand curve for card transactions defined, implicitly, by

$$i + t = V'(x) + xV''(x) + b \tag{1}$$

Therefore, the EPN maximizes *(i+t)x* or

$$\max_x (V'(x) + xV''(x) + b)x \tag{2}$$

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[9] There are a variety of reasons why fully efficient two-part tariffs (or other nonlinear pricing) may not be achievable for the EPN to eliminate such double marginalization. A typical EPN has relationships with a vast number of merchants, and contracting costs could make merchant-specific, two-part tariffs prohibitively expensive. Furthermore, merchants aggregated together in a single market place, such as a mall, may be able to avoid most of the impact of a fixed fee by channeling all card purchases to a single merchant. Additionally, in the context of asymmetric information, for example with heterogeneous merchants, the optimal two-part tariff generally yields some surplus to the high demand merchant and pricing at levels above marginal cost.

Since x is a function of $i+t$ but not i or t separately, the card company varies x by varying the combined sum, $i+t$. This leads immediately to the next (known) result.[10]

Proposition 1: *Suppose surcharges are allowed. If (i,t) maximizes the profits of the EPN, then so too does (i',t') where t'+i'=t+i.*

That is, it is irrelevant whether the EPN charges its fee to the consumers, to the merchant, or to a combination of the two. Since the sum, $i+t$, can be thought of as a transactions tax, Proposition 1 simply echoes the well-known result that the effects of a tax are independent of whether the obligation to pay the tax is placed on buyers or on sellers. However, we show in the next section that, when a no-surcharge rule is in effect, EPN profits will vary for a given $i+t$, depending on the relative values of i and t.

Corollary 1 indicates that if the combined fees to merchants and card users exceed the merchant's benefit from card use ($i+t > b$), then per-capita card use will be less than per-capita cash use. When will it be in the interest of the EPN to price so that this fee structure results? Proposition 2 exploits equations (1) and (2) to provide sufficient conditions for this outcome.

Proposition 2: *Suppose the merchant's marginal revenue from the cash market, MR(x), is strictly decreasing. Per-capita cash use (x_0) exceeds per-capita card use if $x \geq x_0$ implies $b < -xMR'(x)$.*

As long as $b < -x\,MR'(x)$ for all transaction levels x above the cash level x_0, the EPN's

10 See, for example, Baxter (1983).

profit-maximizing choice of $i+t$, incorporating the merchant's behavior, will bring about a higher net price for card transactions than for cash, and therefore a lower equilibrium quantity per capita for card users than for cash users.[11] In the remainder of this paper, we assume conditions are such that the EPN selects $i+t$ so that $x_0 > x(i+t-b)$ in the absence of an NSR.

A2) *(1) For all x, $xV'(x)$* is strictly concave, *so $MR'(x) < 0$;* and *(2) for $x \geq x_0$, $b < -xMR'(x)$*.

How does the merchant's price to cash users compare with its price to card users? Recall that from Proposition 1, for any given $i+t$, EPN profits are constant; however, the prices a merchant charges different consumers will vary depending on how the EPN divides its aggregate "tax" between merchant discount fees and cardholder fees.

Proposition 3: *Fix any $i+t = k > b$. With no NSR, there exists a critical value $t^* > 0$ such that for all $t \leq t^*$, $p_e^M > p_c$.*

Intuitively, $k > b$ means that the merchant faces a higher net marginal cost of serving card users than cash users; if $t = 0$, a card user's inverse demand is equal to that of a cash user, hence the merchant's higher marginal cost dictates setting a higher price to card users ($p_e^M > p_c$). The same holds if, instead, cardholders are levied a positive charge by the EPN (which reduces their inverse demand facing the merchant) but this charge is sufficiently small ($t \leq t^*$).

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11 Recall that b is interpreted as the per transactions savings for the merchant from handling cards rather than cash. The condition on b is typically quite weak. For example, suppose the inverse demand (in **A1)** is $V' = 1 - Q$. Then $MR' = -2$ and $x_0 = 1/2$, so the condition becomes $b < 1$ which corresponds to the requirement that b be no higher than the price which would choke off demand in the cash market.

An implication of Propositions 2 and 3 is that without the NSR (and with a low cardholder fee chosen by the EPN), the merchant's price to a card user strictly exceeds the cash price, $p_e^M > p_c$. Thus, we can formulate the no-surcharge rule mathematically as the inequality constraint, $p_e^M \leq p_c$. Although this may seem like the obvious formulation since credit card companies, for example, have historically imposed such rules on their merchant clients, the inequality constraint may obscure other reasons for merchant pricing constraints. Some merchants argue that even without a formal no-surcharge rule, social conventions make it very difficult for them to charge different prices for users of different means of payments. Such an environment would be better captured by the constraint, $p_e^M = p_c$ (that is, a uniform pricing rule rather than a no-surcharge on card use rule). Under **A2)**, however, the effects of the two constraints are the same.

4. The Impact of a No Surcharge Rule on Consumer Demand and Merchant Prices

Now suppose that the EPN requires any merchant that accepts its card to charge no more to card users than to cash users, $p_e^M \leq p_c$. Of course, a merchant may refuse and forgo card transactions. This section examines the consequences that acceptance of the EPN policy has on the merchant's pricing and on consumers.

The next result shows that holding constant the EPN's fee to cardholders (t) and to the merchant (i), imposing the NSR lowers cash purchases but raises the quantity of noncash purchases, thereby benefitting the EPN.

Proposition 4: *Assume* ***A1)*** *and* ***A2)*** *and fix any* $i+t = k > b$*. There exists a profile of card user fees and merchant fees such that the imposition of an NSR, holding k fixed, will lead to an increase in cardholder purchases and a decrease in cash purchases.*

The intuition for this result is straightforward. Under the assumed conditions and with no NSR, the EPN generates the same profit by setting *t* low enough and *i* high enough that the merchant charges $p_e^M > p_c$. With a high enough *i*, the NSR binds on the merchant and induces her to choose a uniform price between these two levels because, starting from a uniform price equal to p_e^M, a small move towards p_c imposes a zero first-order loss in the card market while yielding a first-order gain in the cash market (we move closer to the optimal cash price) and similarly starting from p_c^M and moving towards p_e^M. This result is a special case of the finding that a prohibition of third-degree price discrimination will lead a monopolist to charge an *intermediate* uniform price if its marginal cost is non-decreasing and if it faces independent demands in the various markets such that its profit function is quasi-concave in each market individually (Nahata et al. 1990, Malueg 1992).

Proposition 4 suffices to establish that the EPN's profit rises when an NSR is accepted: the EPN's profit increases at its non-NSR level of charges and, by revealed preference, any departure from these charges post NSR would further increase its profit. In which direction would the EPN change its charges? In Proposition 3, we showed that low card user fees (*t*) ensured that the NSR was binding on the merchant. Next we show that the EPN benefits further by choosing a small reduction in *t* accompanied by an equivalent increase in *i*, since this increases card transactions. Proposition 5 assumes that the merchant continues to accept the NSR as *t* falls, that is, the merchant's individual rationality constraint is not binding.

Proposition 5: *Assume* ***A1-A2),*** *suppose that the NSR is in place and suppose also that the merchant individual rationality constraint does not bind. Holding constant any $k = (i+t) > b$, when i is high enough that the NSR binds, a reduction in t induces a rise in the quantity* *purchased by cardholders, and, therefore, increases the EPN's profit.*

The intuition behind Proposition 5 is as follows. A cut in *t* and an offsetting increase in *i* leave the EPN's margin unchanged, and hence leave its profit unchanged, only if the per-capita quantity of card transactions remains unchanged. This in turn will only happen if the merchant's response is to raise its price to card users by the full increase in *i*, since card users' inverse demand shifts up by an amount equal to the fall in *t* (equivalently, to the increase in *i*). But since the NSR forces the merchant to charge the same price to cash users as to card users, and since the marginal cost of serving cash users has not risen, the merchant prefers to raise its uniform price by less than the full increase in *i* and accept a lower margin on card sales (given that the merchant's acceptance constraint was not binding). Interestingly, a stronger sufficient condition is required to show that cash transactions decline as *t* falls.[12] However, we show later that the EPN's profit-maximizing prices (*i*, *t*) given the NSR indeed cause cash transactions to decline.

Proposition 5 shows that with the NSR, it becomes relevant how *i*+*t* is distributed: the EPN prefers lower *t* and higher *i* (provided the merchant still accepts). It might be thought that card issuer rebates to cardholders (negative *t*) is evidence of strong competition for cardholders. These results show, instead, that rebates may be a pricing tactic by a monopolist, designed to increase the impact of the NSR!

Given the incentives for an EPN to raise *i* and reduce *t*, what are the constraints which keep *t* from becoming unboundedly low? One limit may be institutional. For historical, practical or

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12 A proof along the same lines as that for Proposition 5 shows that *V'(•)* convex is a sufficient condition.

other reasons, cardholder rebates may not be an option for the EPN.[13] Thus, EPN profit maximization may be subject to a non-negativity constraint in *t*. Alternatively, the operative constraint on the EPN may be the merchant's willingness to accept the restrictions implied by the NSR. The outside option for the merchant is to serve the cash market alone, yielding a per-capita level of transactions x_0 and total profit of $\alpha\, x_0\, V'(\, x_0)$. The merchant must be assured at least this amount under the NSR.[14] Following the incentives literature, we refer to this as the "individual rationality" or IR constraint.

Section 5 investigates the effects of the NSR when the $t \geq 0$ constraint binds and Section 6 examines what occurs when this non-negativity constraint is relaxed. When the constraint $t \geq 0$ binds, the IR constraint may or may not bind at the EPN optimal choice of *i* and these two cases are examined separately. In the case where *t* is allowed to be negative, we show that the EPN may be constrained either by the IR constraint or by the constraint that the merchant continue to be willing to serve the *cash* market (a form of an incentive compatibility constraint).

5. EPN Pricing With No Rebates ($t \geq 0$)

Proposition 4 showed that an NSR will decrease cash transactions but increase non-cash transactions, holding constant the EPN's charges to cardholders and to the merchant. However,

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13 The phenomenon of cardholder rebates is relatively recent. While credit cards date to the late 1960s/early 1970s, cash rebates were first offered, by Discover, in 1986. Rebate cards only became common in the early 1990's with the introduction of the GM Mastercard, and other cards that offer reward points associated with co-branding partner companies (such as frequent-flier miles). See generally, Evans and Schmalensee (1999). Today, roughly half of all credit volume is associated with rebates of various sorts. Faulkner and Gray (2000).

14 Notice that in (i,t) space, under the NSR, the merchant's level sets have slope strictly less than -1. Therefore, for any given *k*, the line $t=k-i$ eventually crosses the line given by $\Pi^M(i,t)=\alpha Q_c^* V'(Q_c^*)$. Thus, if the EPN holds $i+t$ fixed and lowers *t*, it eventually runs against the merchant acceptance constraint.

the NSR also alters the derived demand facing the EPN from the merchant, inducing the EPN to adjust its charges. Furthermore, Proposition 5 shows that the EPN will benefit more from an NSR the lower it sets the cardholder fee, *t*. Thus, we can construct a three-step process. Starting with an optimal *i* and *t* with no NSR, Proposition 1 indicates that EPN profits remain constant if (step 1) it adjusts its fee structure so that $t=0$ and all revenues are raised through merchant fees. Proposition 4 indicates that profits then rise with (step two) the imposition of the NSR and Proposition 5 suggests the impact will be maximized by setting *t* as low as possible. Now the EPN may also wish to adjust *i* optimally given its altered derived demand (step three). Its determination of the profit maximizing *i* under the NSR may be constrained by the willingness of the merchant to accept the new pricing structure along with the NSR. This case is examined in Proposition 7. Alternatively, the IR constraint may not bind at the EPN's optimal *i*. In this case, an NSR induces a decline in *both* cash and card transactions.

Proposition 6: *Assume* ***A1)-A2)*** *and suppose that only the constraint* $t \geq 0$ *binds. If* $b=0$*, adopting the NSR leaves card transactions unchanged but causes cash transactions to fall. If* $b>0$*, adopting the NSR causes both cash and card transactions to fall.*

Thus, if the only constraint limiting the EPN is a non-negativity constraint on cardholder fees, then the NSR will leave the quantity of card transactions unchanged if $b=0$ (no benefits to the merchant from card use) and *lower* it if $b>0$. Cash transactions therefore fall in both cases, since with no NSR cash use (per-capita) exceeds card use (by **A2**), while under the NSR (and with $t=0$) both the per-capita quantity of cash and card transactions are equal. Thus, the NSR harms *both* types of consumers (card users are harmed only weakly if b=0).

The NSR also harms the merchant. The first step in the process, a shift in fee structure to zero cardholder fees, is merchant-neutral. But the next step, the imposition of the NSR, harms the merchant because it is a binding constraint on the merchant's retail prices; and the final step, the increase in the fee to the merchant (i) with an NSR in place, is source of further harm. EPN profits are higher even with a lower quantity of card transactions (as occurs for $b>0$) by revealed preference, since the original quantity is feasible with the NSR at a higher fee to the merchant.

One might have expected that optimal pricing by the EPN under an NSR would induce a merchant price that is a convex combination of its cash and card prices absent the NSR. Instead the merchant's final price with the NSR is *higher* than even the original card price! The conclusions of Proposition 6 emerge because of the way the NSR affects the derived demand curve of the EPN. With $b=0$, the NSR induces a proportional rise (by a factor of $(1+\alpha)$) in the EPN's inverse demand curve (i as a function of q_e). Thus, the non-NSR optimal quantity is also the optimal quantity with the NSR but at a higher interchange fee. With $b>0$, the NSR also lowers the elasticity of the derived demand curve and thus prompts the EPN to induce a strict fall in q_e. Since both quantities fall, total surplus must fall.

Proposition 6 requires the assumption that the merchant's IR constraint does not bind at $t=0$, $i=i^*$. This will be more likely when α, the ratio of cash users to card users, is small. When the IR constraint binds, the constraint fully describes the quantity choice problem for the EPN. For general $V(\bullet)$ functions, this constraint set can take on many shapes. Proposition 7 considers the linear demand case where $b=0$, $V(q) = q\text{-}q^2/2$, hence $V'(q) = 1\text{–}q$ and $x_0=1/2$.

A3) *V'(q) = 1–q, b=0.*[15]

Proposition 7: *Assume* ***A1)–A3)*** *and t=0. Then with optimal EPN pricing under an NSR:*

i) The merchant's IR constraint binds for $\alpha > 1/3$.

ii) Card transactions do not change with an NSR for $\alpha \leq 1/3$ and are higher with the NSR for $\alpha > 1/3$, while cash transactions are always lower with an NSR.

iii) As α, approaches infinity, the quantity (per capita) of both card and cash transactions under an NSR approaches the single-level monopoly quantity, 1/2.

iv) For all α , the EPN's profit rises with the NSR and the merchant's profit falls.

v) If the IR binds at t=0 (i.e.,for $\alpha > 1/3$), then the NSR has the following effects:

a) total quantity of transactions falls;

b) total surplus may rise or fall;

c) total consumer surplus falls.

Note that 7iii) implies that as the cash market becomes very large, the NSR may induce a rise in social surplus by reducing the cost of double marginalization that is present with no NSR. The logic is that, as α increases, the EPN must cut *i* in order to continue satisfying the merchant's IR constraint given the NSR. The EPN benefits because the NSR reduces the merchant's margin on card transactions, so that the increased volume of card transactions compensates for the lower

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15 Choosing this simple demand function entails no loss of generality compared to any other linear form *a–mq*: Since *b* and all costs (aside from *i*) are zero, the choice of intercept *a* is simply a matter of defining units; the same is true for the slope term *m*, given that all marginal costs (the merchant's net marginal cost will be *i*) are constant. Note also that the case of *b=0* may understate the harm from an NSR, because Proposition 6 (which assumed that the merchant's IR constraint is not binding) showed that card transactions remain unchanged in this case but decline if *b>0*.

i.

In part iv), the merchant's profit falls because Proposition 6 shows that merchant surplus declines when the IR constraint does not bind; and when it does bind, the NSR eliminates all the surplus the merchant was earning surplus from cards without the NSR. The quantity of card transactions rises here when IR binds because the decrease in the merchant's margin on card transactions outweighs here the increase in the EPN's charge to the merchant (due to the need to maintain merchant acceptance). Total quantity of transactions falls, however, because with equal linear demands by card and cash users (since $t=0$), imposing the NSR would leave total quantity unchanged only if the EPN's charge to the merchant, i, were unchanged; but i increases as the EPN exploits the decreased elasticity of demand that it faces from the merchant. Total surplus may rise or fall because the NSR reduces total quantity but achieves an efficient allocation of this lower quantity between cash and card users. (With $b=0$, efficient allocation requires equal per-capita quantities, as achieved with the NSR, whereas without the NSR card transactions are lower than cash transactions.)

Notably, with linear demand and no rebates, the combined consumer surplus of card and cash users always declines. To see this, observe that total consumer surplus would have fallen even if total quantity had remained unchanged: in such a case, the losses to cash users from the price increase to them would have exceeded the gain to card users from their price decrease, because the two quantities would be equal with the NSR, while initially the cash quantity is higher. In actuality, the NSR causes total quantity to decline, which reduces consumer surplus even further. Thus, while the NSR can increase overall welfare, any such efficiency gains are appropriated by the EPN.

6. EPN Pricing With Rebates ($t<0$)

Proposition 5 suggests that the outcome $t=0$ is not stable, since the EPN's profit generally rises as t falls. We have already discussed one obvious constraint on the EPN's charges —the merchant's option to refuse to deal with the EPN. If the EPN can offer cardholder rebates, then another, less evident constraint emerges: the merchant's willingness to continue serving *cash* customers.[16] With very favorable cardholder rebates and given the NSR's prohibition on offering cash customers a lower price than to cardholders, if the cash market is relatively small then a merchant may prefer to set price high enough that cash customers choose not to purchase at all. Such an outcome is not in the EPN's interest, however, since all cross-subsidization of cash to non-cash customers then disappears. Observe that this issue does not arise with $t \geq 0$, since in that case (per-capita) inverse demand from cash users always exceeds that from card users, so any price that yields sales to the former will also yield sales to the latter.

In this section we examine a special case where the constraint $t \geq 0$ is replaced by the joint constraint that the merchant be willing to accept the EPN's card and to serve both markets. That is, we consider optimization by the EPN when t can take also negative values. As in the case of Proposition 7, general results are not available because of the complicated nature of the constraint set, so we restrict attention to linear demand (**A3)**) and where the merchant derives no gross benefit from processing card rather than cash transactions ($b=0$). To isolate the incremental effects of rebates, Proposition 8 compares the equilibrium under the NSR when rebates are feasible to that without rebates (examined in Propositions 6 and 7). Proposition 9 compares the equilibrium under the NSR when rebates are feasible with the equilibrium without the NSR.

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[16] Technically, this constraint arises because the non-negativity constraint on quantities implies that the merchant's objective function is not quasi-concave.

Proposition 8: *Assume **A1)-A3)**, the NSR holds, and rebates (t<0) are feasible. Then:*

i) For all α , the EPN's optimal choice involves granting card users rebates (t<0), implying a misallocation of transactions towards cards and away from cash.

ii) For low α (<1/5), the binding constraint on the EPN is the requirement that (i,t) induce the merchant to continue to sell to cash customers; for higher α (>1/5), the IR constraint binds.

iii) For α >1/5, consumer surplus of card users is higher with rebates but that of cash users is lower than in the constrained equilibrium without rebates.

iv) For α >1/5, total consumer surplus is higher with rebates than in the constrained equilibrium with no rebates.

v) For α >1/5, total surplus is higher with rebates than in the constrained equilibrium with no rebates.

The EPN always chooses to grant rebates (result 8i)) because this is a more effective way to stimulate card transactions than by cutting the fee to the merchant. The difference arises because of the NSR, as discussed following Proposition 5: cutting *t* boosts cardholders inverse demand directly, while the effect of cutting *i* operates through the merchant's price and is therefore dampened because the NSR requires any price cut to apply equally to cash transactions.[17]

The EPN's incentive to cut *t* is seen most easily when the merchant's IR is not binding at

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18 Gerstner and Hess (1991) obtain a similar effect in a somewhat different context. They consider a monopolist manufacturer selling through a monopolist retailer (as in our model), that faces two customer groups: low demanders and high demanders, and the latter also incur a higher transaction cost than low demanders of using a rebate coupon. In our model, the NSR plays roughly the same role as their differential transaction costs in motivating rebates.

the optimal i conditional on $t=0$, (i_0). Cutting i when the IR does not bind produces a zero first-order loss to EPN, hence an equal cut in t yields a strict gain, since the effect on the EPN's margin is the same, but the increase in card transactions is larger. The same force induces the EPN to cut t and raise i also when the IR constraint is binding at $(i_0,0)$ (that is, for $\alpha > 1/3$). In that case, the EPN's indifference curve in $(i\ t)$ space is positively sloped where the merchant's negatively-sloped IR cuts $t=0$; thus, the EPN would be willing to raise t in order to increase i, but can meet the IR by cutting t, which is preferable.

For $\alpha > 1/5$, the EPN will cut t and raise i until the merchant's IR binds. For $\alpha < 1/5$, the floor on t is not the merchant's IR but the need to induce the merchant to continue serving the cash market; consequently, the EPN is not able to extract the full surplus from the merchant solely by choosing (i,t) appropriately in conjunction with the NSR. It is harder to obtain analytic results for this case ($\alpha < 1/5$), and for those values of α all the results in Proposition 8 are proved computationally.

Part iii) of Proposition 8 is understood as follows. Under the NSR, the merchant's optimal price is $p = 1/2 + (i-t)/(2(1+a))$, hence $\Delta p=(\Delta i-\Delta t)/(2(1+a))$, as a function of changes in i and t. Note that a cut in t induces a rise in p, because the increased inverse demand of cardholders (caused by the fall in t) prompts the merchant to increase its retail price.[18] Cash users therefore will be harmed by the granting of rebates to cardholders ($t<0$), even if rebates were not associated with an increase in the EPN's charge to the merchant. In actuality, when the EPN lowers t it also will raise i somewhat, which puts further upward pressure on the retail price p. Since cardholders get the rebate, the change in their net price is $\Delta p_e = \Delta p + \Delta t = (\Delta i + \Delta t + 2\alpha\Delta t)/(2(1+a))$. Thus, a

19 Gerstner and Hess (1991) cite empirical evidence that retailers indeed raise their prices in response to manufacturers' granting of rebates to consumers.

sufficient condition for cardholders to get a lower price as a result of rebates is that i increases by less than the rebate amount, $\triangle i < -\Delta t$, a condition which is met in equilibrium as explained next.

To see why aggregate consumer surplus across cash and card users rises (result 8iv)), we examine the equilibrium with rebates more closely when the equilibrium values of (i, t) are determined by the merchant's IR constraint. With linear demand, the EPN's optimal charge to the merchant conditional on $t=0$ is $i_0=(1+\alpha)/2$. We must consider two sub-cases: for $1/5 < \alpha < 1/3$, the merchant's IR constraint does not bind at $(i_0,0)$; while for $\alpha > 1/3$, the IR does bind at $(i_0,0)$. Figure 1 illustrates the first case. Recall from Proposition 5 that, for a fixed $i+t$, the EPN wishes to lower t in the absence of other constraints. Thus, a movement downward and to the right along the line $i+t = i_0 = (1+\alpha)/2$ (i.e., a cut in t and an equal increase in i) raises EPN profits. Let $\Pi^M(i,t)$ denote merchant profits under an NSR when the fee structure is (i,t). If the IR manifold $\Pi^M(i,t)= x_0V'(x_0)$ is reached before the zero quantity constraint (Point B in Figure 1), the optimal solution for the EPN is, then, to move downward and to the right along this locus, until it reaches an indifference curve in (i,t) space that is just tangent to this manifold. (Point C in Figure 1). (The IR manifold is downward sloping with slope steeper than -1.) This point represents a lower $i+t$ and a lower t compared to $(i_0,0)$. In the second case ($\alpha > 1/3$) the IR constraint does bind at $t=0$, hence $i < i_0$. With rebates feasible, the EPN immediately moves down and to the right along the IR manifold to a point of tangency, so again $(i+ t)$ falls relative to the constrained equilibrium with no rebates.

The reason why total consumer surplus rises with rebates can now be seen as follows. Straightforward algebra demonstrates that, in response to equal and opposite changes in i and t, $\Delta p \alpha q_c = -\Delta p_e q_e$, the rise in the price to cash users multiplied by their total initial transactions equals the fall in the price to card users multiplied by the total initial quantity (the mass of card users is 1). Thus, in response to $\Delta i = -\Delta t$, total consumer surplus would remain unchanged *if* quantities remained unchanged, and therefore must rise after the actual quantity responses to the price changes. Moreover, we showed that $(i+t)$ in fact falls with rebates, which increases consumer surplus (and total quantity) even further.

The final result (Proposition 8v)) concerns overall welfare. We saw that, starting from $t=0$, a reduction in t (granting rebates) and equal increase in i would increase total consumer surplus, because of the quantity responses, which increase consumers' gain in the market where price fell (card market, where quantity rises) and decrease the loss in the (cash) market where price rose. The same output re-allocation effect, however, means that overall welfare would decline: a cut in t holding $i+t$ constant would leave total output unchanged (see Appendix) but create misallocation between the markets: the negative t implies that, now, card transactions exceed cash transactions—cash users select a lower and further distorted quantity of transactions than in the case with a no rebates. However, rebates cause $i+t$ to fall, reducing the total "transaction tax" on card purchases. A fall in $i+t$ in turn causes total output to rise (see Appendix), and this beneficial output-expansion effect outweighs the loss from output misallocation, causing overall welfare to rise with rebates.

Can rebates reverse the negative effects of the NSR on total consumer surplus, found in Propositions 6 and 7 when rebates were not feasible? Proposition 9 addresses this and other welfare questions by comparing the NSR equilibrium when rebates are feasible with the outcome without an NSR, for all values of the relative size of the cash market α. Figures 2a), b) and c) illustrate graphically the quantity, surplus and pricing consequences of an NSR as α varies.

Proposition 9: *Assume* ***A1)-A3)*** *and cardholder rebates are feasible. Relative to the equilibrium* *with no NSR:*

i) Under an NSR, total surplus is lower for $\alpha<1/3$ *and higher for* $\alpha>1/3$*.*

ii) Under an NSR, consumer surplus of cash users is lower while that of card users is higher for all α*.*

iii) Under an NSR, total consumer surplus is lower for all α*.*

Proposition 6 showed that with $t=0$ and $b=0$, card purchases were the same with and without an NSR. When cardholder rebates are feasible and $b=0$, result 9ii) shows that card purchases rise with the NSR. Nevertheless, the NSR reduces overall welfare if the cash market is relatively small ($\alpha<1/3$, result 9i)). Furthermore, this harm occurs even though the total fee ($i+t$) is the same as without the NSR (see Figure 2c)). The source of welfare harm is the misallocation of transactions from cash users towards card users. In this case where $b=0$, the efficient allocation entails equal quantities for each type of consumer. Without the NSR, the EPN's monopolistic charge to the merchant induces too few card transactions, hence a misallocation away from cards. With the NSR and cardholder rebates, the pattern is reversed and misallocation again emerges, albeit in the other direction. This contrasts with the case of $t=0$ addressed in Proposition 7, where the NSR can only reduce welfare because of the decrease in total quantity (since, for this lower quantity, allocation is then efficient).

Finally, even with rebates, total consumer surplus still falls under the NSR, even when the cash market is large enough that overall welfare rises ($\alpha>1/3$). In that case ($\alpha>1/3$), the EPN's pricing drives the merchant's profit down to the IR level, hence the merchant also loses from the NSR. Thus, when the NSR does increase welfare, it is the EPN that benefits at the expense of the merchant and of consumers as a whole (though card users gain).

7. Lack of Commitment Ability by the EPN

The opposing interests of the card company and the merchant in lower values of cardholder fees suggest that there may be credibility questions concerning the card company's incentives or ability to maintain an initial announced profile of prices, (i,t). The commitment question arises in two different forms. In both cases, the extensions reinforce the message that the NSR generates incentives to distort purchases in favor of card transactions.

First, once a merchant has decided to accept the card, if the merchant incorrectly anticipates a fixed cardholder rebate, then further incentives remain for the EPN to modify t. In the case where t is known and fixed, lower values of t are less attractive to the EPN because they are partially offset by a corresponding merchant price rise. However, when t is not known by the time the merchant sets prices and can change, the merchant must set prices in anticipation of an optimal EPN cardholder fee response and, similarly, the EPN must set t as a best response to an anticipated merchant price response. Since price is not directly conditioned on t, the EPN will typically respond with further cuts in cardholder fees.

A second commitment issue arises when an EPN does not consist of a single card issuer (as in proprietary networks such as American Express) but instead is made up of a consortium of banks (as in bankcard networks, such as Visa and Mastercard). Member banks issue the cards, and they rather than the network set most of the terms to cardholders, including prices (annual fee, interest rate, rebates). Departing from our assumptions to this point, member banks may set cardholder fees non-cooperatively and compete with one another for card users. The next two subsections explore the consequences of an inability of the EPN to control t directly.

7.1. Monopolist Issuing Bank – No Commitment

While commitment in *i* may seem plausible, commitments to the merchant about the level of *t*, the arrangement between the card company and its individual cardholders, may not be possible. Merchants are generally unable to monitor agreements between bank issuers and their cardholders, and it may therefore be difficult for a card company to persuade its merchant partners that it will maintain an (ex post) suboptimal transactions fee with its cardholders. Consider a simple, stylized version. The EPN sets and commits to *i*, and the merchant decides whether or not to accept the NSR. Given acceptance and the value of *i*, the merchant and the card company choose *p* and *t* simultaneously.[19] In the first stage, therefore, the EPN selects *i* to alter the outcome of the second stage game in its favor. For simplicity, we assume that the binding constraint on the EPN is the merchant's participation constraint.

Proposition 10: *Assume* ***A1)-A3)*** *and suppose that α is such that the IR constraint binds:*

i) In the equilibrium of the two stage game with an NSR, both t and t+i are lower when the EPN cannot commit to t than when it is able to commit to t;

ii) Under an NSR, both social surplus and consumer surplus are higher when the EPN cannot commit to t than when it is able to commit to t;

iii) Compared to no commitment in t and no NSR , social surplus and consumer surplus always falls when the NSR is imposed and the EPN continues to be unable to commit to t.

Proposition 10 illustrates yet a further reason why the EPN may distort card purchases over cash purchases. In the absence of an ability to commit to a given cardholder fee, the

[19] This strategic game is similar to the game analysed in Rochet and Tirole (1999).

merchant anticipates that the EPN will lower t further and thus responds with a higher retail price. This response, in turn, relaxes the merchant's IR constraint and the EPN responds by raising i though by less than the equilibrium fall in t. The reduction in pricing power induced by the absence of commitment to cardholder rebates causes total surplus to rise relative to the commitment environment. The strong surplus implication of result 10iii) may seem surprising given the ambiguous surplus results of Proposition 9 and the intuition that, in this environment, the EPN has *less* strategic power. The reason for the result is that, when the EPN cannot commit to t, social surplus is quite high without the NSR. Compared to *this* outcome, the imposition of the NSR lowers both consumer surplus and total surplus.

7.2 Bank Card Issuers' Dissipation of Rents

Now consider a different reason for the failure to commit to a given value of t. First, through their partnership with the EPN, banks set the merchant discount fee i and commit to it. Merchants continue to set prices taking i and t as given. If bank issuer member W of the EPN is one of m banks charging the lowest cardholder fee, it obtains sales of $q_W = x/m$, where x is derived from equation (1) and is given by $x=(1+b-(i+t))/2$. If the cardholder fee of bank W is not among the lowest, q_W is zero. That is, taking i as given, banks compete as Bertrand price setters to cardholders and each of the banks that charge the lowest fee t obtains $1/m$ of total transactions, where the latter volume x is determined by the equality of the merchant's marginal revenue function from card transactions with its net marginal cost. Suppose that banks can only set cardholder fees in discrete units, $\in$. In this case, the standard Bertrand result follows. The equilibrium t_W satisfies $t_W = -i + \in$. Card companies compete away (virtually) all their rents by offering rebates to their cardholders that are close to the interchange fee.

A similar argument holds with the NSR except that now the demand curve becomes Again, the Bertrand assumption leads to $i+t \approx 0$. In this case, it may appear ambiguous whether the NSR actually raises noncash transactions. However, recall the assumption that the NSR is binding on the merchant which occurs for $t<-b/2$. This condition implies that, with surcharges, the price charged by the merchant to noncash users exceeds the cash price. It also implies that the NSR will increase demand for non-cash transactions. Furthermore, as long as the EPN enjoys *some* profits from transactions (> 0), it will wish to generate the largest quantity of such transactions possible. Since transactions are decreasing in t, this leads to an incentive for the EPN to fix a high i, inducing its competing issuers to offer large negative values of t (i.e., large card user rebates). While this response induces greater card transactions, a large negative t induces misallocation as between cash and card transactions, biased towards cards. The results are gathered in Proposition 11.

Proposition 11: *Under* ***A1)-A3)****, with perfectly competitive issuers:*

i) If the mass of cash users is less than the mass of card users, $\alpha<1$, the EPN sets i until merchants are just indifferent about selling to cash customers or not; if $\alpha >1$, the EPN sets i until merchants are just indifferent between accepting the EPN contract and rejecting it and serving the cash market alone.

ii) The total transactions remain the same before and after an NSR with the EPN sales rising with an NSR and cash sales falling.

iii) For all values of , an NSR raises consumer surplus but lowers merchant profits and social surplus.

iv) In the limit as the mass of cash users becomes large, the cash-transaction quantity *approaches the single monopoly level and the card-transaction quantity approaches the competitive level.*

Regarding part i), the stronger tendency to offer rebates under competition among card issuers than under monopolistic issuers means that, in the competitive situation, it is more likely that the binding constraint for the EPN is to maintain the merchant's interest in serving the cash market because the larger rebates make the resulting higher noncash demand more attractive to the merchant. Part ii) is an implication of the constant price constraint of the NSR along with linear demand. Given that total market quantity remains constant, social surplus must fall since now the NSR along with cardholder rebates forces the per consumer sales to be different across cash and noncash users. For a similar reason, consumer surplus rises. The rise in price to cash users is more than compensated by the corresponding fall in price to the noncash market. Result iv) shows that as the cash market becomes large relative to cards, the NSR in conjunction with competitive rebates by card issuers succeed in eliminating the distortion in the pricing of card transactions due to the monopolist merchant. The merchant charges a uniformly high (monopoly) price to both card and cash users, but card users receive a rebate and therefore obtain a net price close to the competitive price. However, the net price to cash users is the (uniform) price charged by the merchant. Since the cash market is relatively large by hypothesis, the merchant's price will be driven by the cash market and thus will approach the simple monopoly level.

8. Conclusion

The complex cycle which makes up a typical payments network offers a rich field for economic analysis. Prices play important roles at every link of the cycle. We have shown how distortions at one link invite further distortions at other links—the No Surcharge "Rule" induces electronic payment networks both to raise total charges and to shift charges away from cardholders to merchants. Overall welfare can increase or decrease with the NSR, because of the tradeoff between the expanded total quantity of transactions and the misallocation from cash to cards. Total consumer surplus, however, always fell with the NSR. Allowing cardholder rebates, under the NSR, harms cash users but benefits card users by more. Thus, cardholder rebates (which entail somewhat higher charges to merchants) are beneficial *if* the relevant policy goal is total consumer welfare, and if repeal of the NSR is not an option (e.g., because it is dictated by merchants' inherent reluctance to set different prices rather than by explicit prohibitions).

Our emphasis has been on the impact of limits on pricing behavior at the merchant level when there exists some power over price. To highlight this effect, we assumed monopoly pricing at both the merchant and EPN levels, but we conjecture that similar effects will arise whenever there remains a margin between price and cost at both levels. We have also abstracted away from consumers' choice of the means of payment in order to focus on the impact of the constraint on the level of purchases. Extensions of this research would include analyses of the effects of the "rule" under a broader class of merchant market structures and with endogenous consumer choice of the means of payment. Another direction will be to examine how the NSR influences the nature of competition among rival electronic payments networks both in pricing and in other practices such as the tying of multiple cards to merchants. The growing role of new payments technologies such as online and offline debit cards makes it increasingly important to obtain a fuller understanding. of the impact of the NSR.

Appendix

Proof of Lemma 1: Let $x=x(k)$, $x'=x(k')$. By definition,

$$\begin{gathered}(V'(x)-k)x \geq (V'(x')-k)x' \\ (V'(x)-k')x \leq (V'(x')-k')x' \\ so \\ (k'-k)x \geq (k'-k)x'.\end{gathered}$$

This implies $x \geq x'$. Now, suppose $x=x'$. The first order condition for $x(k)$ satisfies $xV''(x)+V'(x)-k=0$. For $k'>k$, then, $xV''(x)+V'(x)-k'<0$. ‖

Proof of Proposition 2: The derivative of the EPN's profit function is

$$\frac{\partial \pi^e}{\partial q_e}(x) = MR(x) + xMR'(x) + b$$

For $x>x_0$, $MR(x)<0$ by the assumption that $MR'(x)<0$ and the fact that optimality of x_0 for the merchant implies $MR(x_0)=0$. The second maintained assumption implies for $x \geq x_0$, $xMR'(x)+b<0$. Therefore, EPN profits are declining in x for $x \geq x_0$. ‖

Proof of Proposition 3: Per capita card transactions, $x(k-b)$ is less than x_0 by Lemma 1. Therefore, $V'(x(k-b))>V'(x_0)$. Define $t^*=V'(x(k-b))-V'(x_0)$. For all t,i such that $i+t=k$, $x(k-b)$ remains constant. For any $t<t^*$, we have $V'(x(k-b))-t=p_e^M>V'(x_0)=p_c^M$. ‖

Proof of Proposition 4: Consider an optimal choice of (q_e, q_c) that solves the merchant's profit maximization problem with an NSR. Suppose that $q_e<x(k-b)$. The pair $(x(k-b),q_c)$ is also feasible for the merchant since

$V'(q_c)+t \geq V'(q_e)$ implies $V'(q_c)+t \geq V'(x(k-b))$

by the concavity of $V(.)$. But the choice of (q_e, q_c) over $(x(k-b),q_c)$ then implies that

$q_e (V'(q_e)-k+b) \geq x(k-b)(V'(x(k-b))-k)$

which violates the definition of $x(k\text{-}b)$. A similar proof shows $q_c \leq x(0)$. Now suppose $q_e = x(k\text{-}b)$. The merchant's first order condition with respect to q_e under the NSR constraint is $q_e V''(q_e)+V'(q_e)-i-t+b-\lambda V''(q_e)$ where $\lambda>0$ is the multiplier on the constraint imposed by the NSR. Evaluating this expression at $x(k\text{-}b)$ yields $-\lambda V''(x(k\text{-}b))>0$ since the first terms are the merchant's first order condition with no NSR and equal zero at $x(k\text{-}b)$. Therefore, merchant profits are strictly increasing in q_e at $q_e=x(k\text{-}b)$. ‖

Proof of Proposition 5: Define $f(p) \equiv V'^{-1}(p)$ to be the demand curve of cash users. Note that $f(p+t)$ is the demand of card users and **A2)** implies that $pf(p)$ is concave. Let $i+t=k$ and let p denote the optimal (uniform) price charged by the merchant under an NSR when the card user fee is t so $i=k\text{-}t$. Similarly, let p' denote the optimal uniform price charged by the merchant when the card user fee is $t'<t$ and the merchant fee is $k\text{-}t'$. Finally, for convenience, set $t\text{-}t' \equiv \Delta>0$. By definition of p, charging a price p under the fee profile, $(k\text{-}t,t)$ raises more profits than charging a price $p'\text{-}\Delta$. Note that this second price implies a net price to card users of $p'+t'$. Thus,

$$\alpha pf(p)+(p+t-(k-b))f(p+t) \geq \alpha(p'-\Delta)f(p'-\Delta)+(p'+t'-(k-b))f(p'+t').$$

Similarly, under the fee profile, $(k\text{-}t',t')$, p' raises more profits than charging a price $p+\Delta$.

$$\alpha p'f(p')+(p'+t'-(k-b))f(p'+t') \geq \alpha(p+\Delta)f(p+\Delta)+(p+t-(k-b))f(p+t).$$

Adding the two inequalities and eliminating the common terms which denote revenues in the card market, yields

$$\alpha(pf(p)-(p+\Delta)f(p+\Delta)) \geq \alpha((p'-\Delta)f(p'-\Delta)-p'f(p')).$$

Recall that the function $pf(p)$ is concave and that p and p' are to the right of the price which maximizes $pf(p)$. Suppose that $p'+t'>p+t$. This implies $p'\text{-}\Delta>p$. But this violates the assumption of concavity since the slope of the revenue function must become steeper as we move further to the right of the maximum point. ‖

Proof of Proposition 6: Using the first order condition of the merchant, $i=b+V'(x)+xV''(x)$, define $q \in \text{argmax}_x\, x(b+V'(x)+xV''(x))$ to be the quantity of card-user transactions which maximizes EPN profits without the NSR.

Proposition 5 implies that, under an NSR, if the IR constraint is not binding, the EPN will offer a price pair, $(i_0\, ,0)$. Together, $t=0$ and **A1**) imply that a cash user and a card user present the merchant with the same demand, while the NSR and **A2**) imply that the merchant charges both types the same price (despite facing a higher net marginal cost of catering to card users). Thus, for any fee to the merchant, i, the solution involves similar per capita cash and card use. The first-order condition for the merchant's profit-maximization problem yields the optimal choice of $x^{NSR}(i)$ defined implicitly by $(1+\alpha)(V'(x)+xV''(x))+b=i$.

Let $q' \in \text{argmax}_x\, x(b+(1+\alpha)(V'(x)+xV''(x)))$ be the profit maximizing quantity with the NSR. If $b=0$, then the definition indicates that $q \in \text{argmax}_x\, x(b+(1+\alpha)(V'(x)+xV''(x)))$ and so q also solves the EPN's problem with the NSR. Therefore, assume $b>0$.

By definition,

$$q(b+V'(q)+qV''(q)) \geq q'(b+V'(q')+q'V''(q'))$$

and

$$q(b+(1+\alpha)(V'(q)+qV''(q))) \leq q'(b+(1+\alpha)(V'(q')+q'V''(q')))$$

Subtract the two inequalities and divide by $-\alpha$ to get

$$q(V'(q)+qV''(q)) \leq q'(V'(q')+q'V''(q'))$$

Suppose that $q'>q$, so that $bq<bq'$. This then implies

$$q(b+V'(q)+qV''(q)) < q'(b+V'(q')+q'V''(q'))$$

which violates the definition of q. The EPN first order conditions, evaluated at q, indicates that EPN profits are strictly declining in quantity at that point:

$$\frac{\partial \pi^e(x)}{\partial x}_{|x=q} = b(1-(1+\alpha)) = -\alpha b < 0$$

so $q' < q$ with $b > 0$. ‖

Proof of Proposition 7: The merchant participation constraint can be written $(q_e^{NSR})^2 \geq \alpha/(4(1+\alpha))$.Thus, when the constraint binds in the linear demand case, the total quantity demanded by each consumer type is an increasing function of α. From Proposition 6, when the participation constraint does not bind, then the quantity of non-cash transactions with the NSR is constant at $1/4$. With no NSR, the total quantity of transactions is $1/4+\alpha/2$.

i) and ii) The participation equation implies that the constraint does not bind for $\alpha \leq 1/3$ and Proposition 6 implies that $q_e^{NSR}=1/4$. For $\alpha > 1/3$, the constraint binds and determines q_e^{NSR}. At $\alpha = 1/3$, total surplus is lower since EPN use is the same but cash use falls.

iii) As α approaches infinity, since q_e^{NSR} approaches $1/2$ (the cash use quantity without the NSR) and the quantity of transactions is the same for cash and non-cash, total surplus must be strictly higher.

iv) The rise in EPN profits is an implication of Proposition 5. At constant $i+t$, q_e rises so the EPN can only do better by further modifying i and t. The fall in merchant profits is implied by revealed preference. Equal pricing is an option without the NSR and is not selected by the merchant.

v)a) The NSR raises total quantity if and only if,

$$(1+\alpha)\sqrt{\frac{\alpha}{1+\alpha}} = \sqrt{1+\alpha}\sqrt{\alpha} \geq 1/2+\alpha$$
$$\alpha+\alpha^2 \geq 1/4+\alpha+\alpha^2$$

This is impossible so total quantity falls. b) Simple computations show that total surplus effect is increasing in α and exceeds total surplus with no NSR at $\alpha = 1.53$. c) The net effect on consumer surplus is negative. To see this, note that if total quantity had remained constant with card use rising and cash use falling, consumer surplus would have to fall since the loss in consumer surplus for cash users -- whose initial per capita quantity exceeded that of card users -- would necessarily be larger than the gain enjoyed by card users. Since, in fact, total quantity actually falls, the consumer surplus effects can only be worse. ‖

Proof of Proposition 8: The merchant's optimization problem, yields as a solution, $p=(1+(i-t)/(2(1+\alpha)))$, $q_c=(1-(i-t)/(2(1+\alpha)))$, $q_e=(1-i/(1+\alpha)-t(1+2\alpha)/(2(1+\alpha)))$. Thus for generic changes in i and t, di,dt, we have $dp=(di-dt)/(2(1+\alpha))$. Note that this implies that as t falls, p rises implying that lower t's harm cash users through higher merchant prices. Also, $dq_c=-dp=-(di-dt)/(2(1+\alpha))$, $q_e=-dp-dt=-(di-dt)/(2(1+\alpha))-dt=-(di+(1+2\alpha)dt)/(2(1+\alpha))$. Change in *total* quantity, then is $\alpha dq_c+dq_e = -((1+\alpha)di-(1+\alpha)dt)/(2(1+\alpha))=-(di+dt)/2$. Observe that this shows that total quantity remains the same for any changes in i and t such that $i+t$ remains constant and rises for any changes such that $-dt>di>0$.

8i) The merchant's optimization problem yields, via the envelope theorem, $d\Pi^M(i,t)=-q_e di+-(p-i)dt$ In the linear case, with no NSR, $q_e=(p-i)$. With the NSR, $q_e>(p-i)$, the volume of card sales exceeds the profit margin on card sales. A small fall in i increases merchant's profits by the number of card sales. A small fall in t increases card sales by a unit and therefore increases merchant profits only by the per unit profit margin. Thus, in (i,t) space, with an NSR, the merchant's indifference curves are steeper than -1. The EPN's optimization problem can be expressed as

$$max_{i,t}\ (i+t)q_e(i,t)$$

Differentiating implies

$d\Pi^E(i,t)=(q_e+(i+t)\partial q_e/\partial i\ )di+(q_e+(i+t)\partial q_e/\partial t\ )dt$

Consider any point such that $t=0, i>1/2$. With an NSR. $\partial q_e/\partial t<\partial q_e/\partial i<0$. Using the definitions of q_e we get

$$d\Pi^e=\frac{1}{2(1+\alpha)}((1+\alpha-2i)di+(1+\alpha)(1-2i)dt)$$

Since $i>1/2$ (the value which maximizes EPN profits with no NSR, the coefficient on dt is negative and so EPN indifference curves are positively sloped and if the $t\geq 0$ constraint is relaxed, the EPN will move downward and to the right along the merchant's IR curve.

8ii): By computation.

8iii),iv): Consumer surplus is given by $CS=(\alpha\ q_c^2+q_e^2)/2$. So,

$2\Delta CS=q_c\ \alpha\ \Delta\ q_c+q_e\ \Delta q_e=q_c\ (\alpha\ \Delta\ q_c+\ \Delta q_e)+(q_e\text{-}q_c)\Delta q_e$

Suppose that the IR binds at the optimal solution with $t=0$. The optimal solution with the $t\geq 0$ relaxed is at a point downward and to the right of this point. Since the IR curve has slope steeper than -1, this implies a rise in i, and a fall in t and $i+t$. The rise in i and fall in t imply a rise in merchant price and therefore a fall in cash user surplus. The fall in $i+t$ implies a rise in card user surplus, a rise in total quantity and therefore a rise in total consumer surplus. Revealed preference implies that EPN profits rise and, since we remain on the merchant's IR curve, merchant profits stay the same. Thus, total surplus rises when the $t\geq 0$ constraint is relaxed from a point at which the IR constraint binds. Now suppose that the IR constraint does not bind at $t=0$. The optimal interchange fee at this point is $i_0=(1+\alpha)/2$. Note that from the EPN's objective function above, we get

$$d\Pi^e=(q_e-\frac{i+t}{2(1+\alpha)})di+(q_e-\frac{(i+t)(1+2\alpha)}{2(1+\alpha)})dt$$

Note that if the coefficient for *di* is negative, so is that for *dt.* Also, the locus of points such that $q_e-(i+t)/(2(1+\alpha)) = 0$, goes through the point $(i_0,0)$ and has slope steeper than minus one. Now consider point B on Figure 1. This is the point where the line $i+t=i_0$ intersects the merchant's IR curve. By the above argument, EPN profits are decreasing in both *i* and *t* and therefore the indifference curves are negatively sloped. The slope is

$$\frac{dt}{di}=-\frac{q_e-i_0/(2(1+\alpha))}{q_e-i_0(1+2\alpha)/(2(1+\alpha))}=-(1+\frac{i_0\alpha/(1+\alpha)}{q_e-i_0(1+2\alpha)(2(1+\alpha))})>-1.$$

Therefore, at point B the EPN will wish to move downward and to the right along the IR curve. This implies a further rise in *i* and fall in *t* and a fall in $i+t$ which by the argument above, implies the cash users surplus falls, and card and total consumer surplus rises.

8 v) Total surplus is given by $TS=\alpha\,(1-.5q_c)q_c+(1-.5q_e)q_e.$ So,

$$\Delta TS=(1-q_c)\,\alpha\,\Delta\, q_c+(1-q_e\,)\Delta q_e=(1-q_c\,)(\alpha\,\Delta\, q_c+\,\Delta q_e)+(q_c-q_e)\Delta q_e$$

While we see that total quantity rises also in the case where the IR constraint does not bind at $(i_0,0)$, which has a positive impact on total surplus, the second term, which is a misallocation term is negative. Computations indicate that total surplus also rises in this case but there do not appear to be formal arguments except for pure algebra supporting the conclusion. Note that if it were the case that total surplus falls, then, interestingly, it would be because the loss in merchant profits outweigh the gains to consumers and the EPN.

Proof of Proposition 10: 10i): For a given *i*, if the NSR is accepted, then the merchant's best response in prices is $P(t;i)=(1+\alpha+i-t)/(2(1+\alpha))$. Given *i*,, EPN's best response in *t* is $t(P;i)=(1-P-i)/2$. Solving for *P* and *t* simultaneously gives $t^*(i)=(1+\alpha-(3+2\,\alpha)i)/(3+4\,\alpha)$. Observe that since EPN profits are the product of $t^*(i)+i$ and $q_e(t^*(i),i)$ and both of these are increasing in *i*, then the optimal choice of *i* for the EPN is the highest *i*, such that the merchant's participation constraint binds. The curve, *t*(i)* is linear, downward sloping and has slope greater than negative one. If the binding constraint is the merchant's participation constraint, the optimal strategy for the EPN in the first stage is to select a value of *i* such that *(i,t*(i))* represents the intersection point of *t*(i)* and the merchant's participation constraint. How does this point compare with the value of *i* and *t* when the EPN can commit to both? At the optimal choice of *t* with commitment, the EPN's first order condition in *t* satisfies

$$\frac{\partial \Pi^{EPN}}{\partial t} = 1 - p(t;i) - (i+t) + \mu \frac{\partial \Pi^{M}(t;i)}{\partial t} + -(i+t)\frac{\partial p(t;i)}{\partial t} = 0$$

where μ is the lagrange multiplier on the merchant's participation constraint. The last term is non-negative. If the merchant cannot observe *t*, then at the commitment prices, *(i,t)*, the EPN can assume that a change in *t* would not be followed by a price response by the merchant. Therefore, the last term in the above equation vanishes and the EPN would wish to lower *t* from that commitment point. This implies that holding *i* constant, the curve *t*(i)* lies below the commitment value of *t*. Since the merchant's slope is less than negative one, the *t*(i)* line intersects it from below, so the intersection point must be downward and to the right of the commitment point. Again, since the participation curve has slope strictly less than negative one, this also implies a lower value of *i+t* as well as *t*.

10ii),iii): Shown through computations. ‖

Proof of Proposition 11: 11i): Solving the merchant participation constraint simultaneously with the constraint *t=-i*, yields

$$i^{comp} = \frac{1}{2}\left(1 + \frac{1}{\alpha + \sqrt{\alpha}\sqrt{1+\alpha}}\right)$$

The constraint that the merchant continue to be willing to serve the cash market is $t>i-(1+\alpha)^{.5}/2$. Using $t=-i$, this yields a value

$$i^{comp}=\frac{1}{2}\sqrt{1+\alpha}$$

The lowest value for i^{comp} is the binding constraint. The second one is lower than the first if and only if $\alpha<1$.

11ii),iii): Note that with the NSR, the merchant's optimal choice of price is $p=(1+\alpha+i-t)/(2(1+\alpha))$. Using $t=-i$ and plugging in the demand equations yields $\alpha q_c=\alpha(.5-i/(1+\alpha))$ and $q_e=(.5+\alpha\, i/(1+\alpha))$. Summing the two yield a quantity which is independent of i. Conditional on total quantity remaining constant, social surplus is maximized when the cash and non-cash quantities are the same. Any value of t strictly less than zero along with the NSR, violates this condition, so social surplus must fall. Consumer surplus rises because, holding total quantity fixed, the loss to cash consumers from the higher price is more than compensated by the gain to EPN consumers from the lower price. Using $q_e=(.5+\alpha\, i/(1+\alpha))$ and letting α grow large yields i approaches $1/2$, EPN quantity approaches 1 and cash quantity approaches ½.

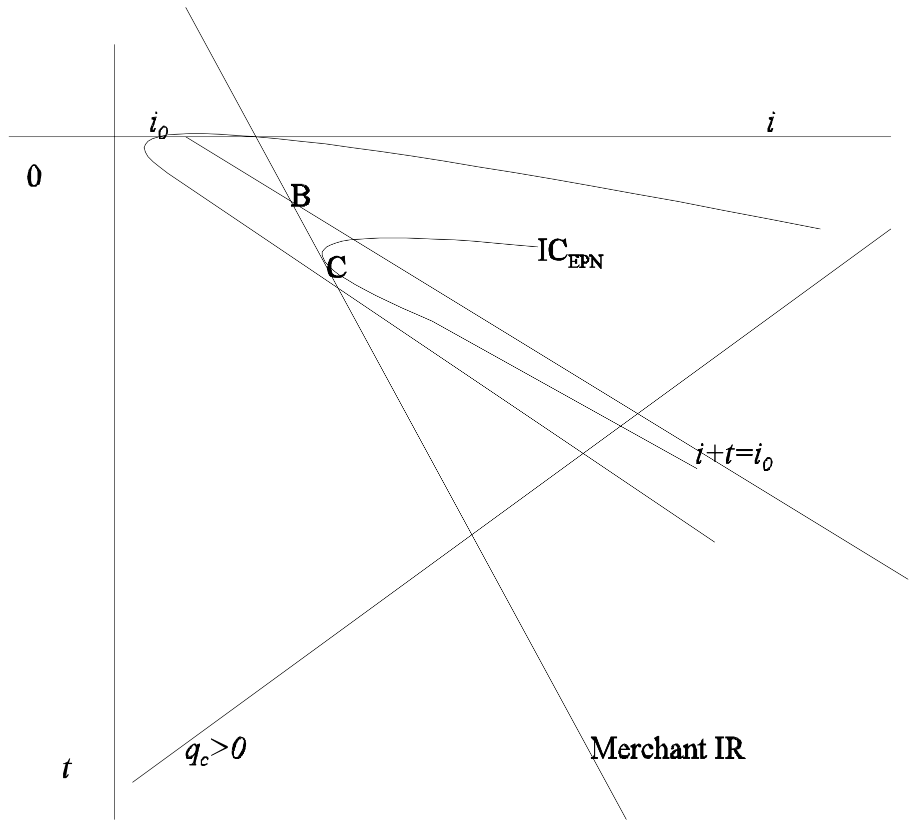


Figure 1

Figure 2a) Quantity Effects

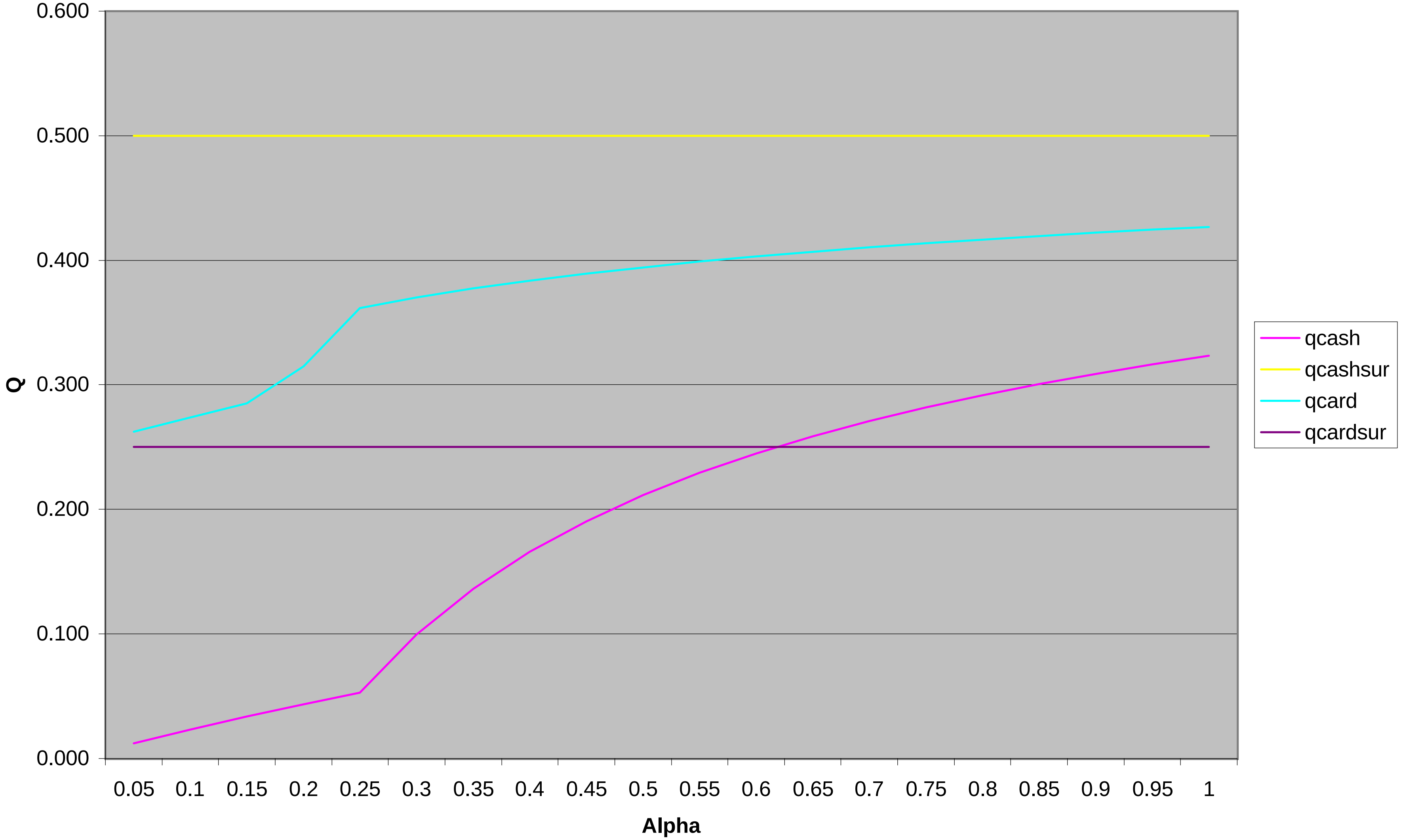


Figure 2b) Surplus Effects

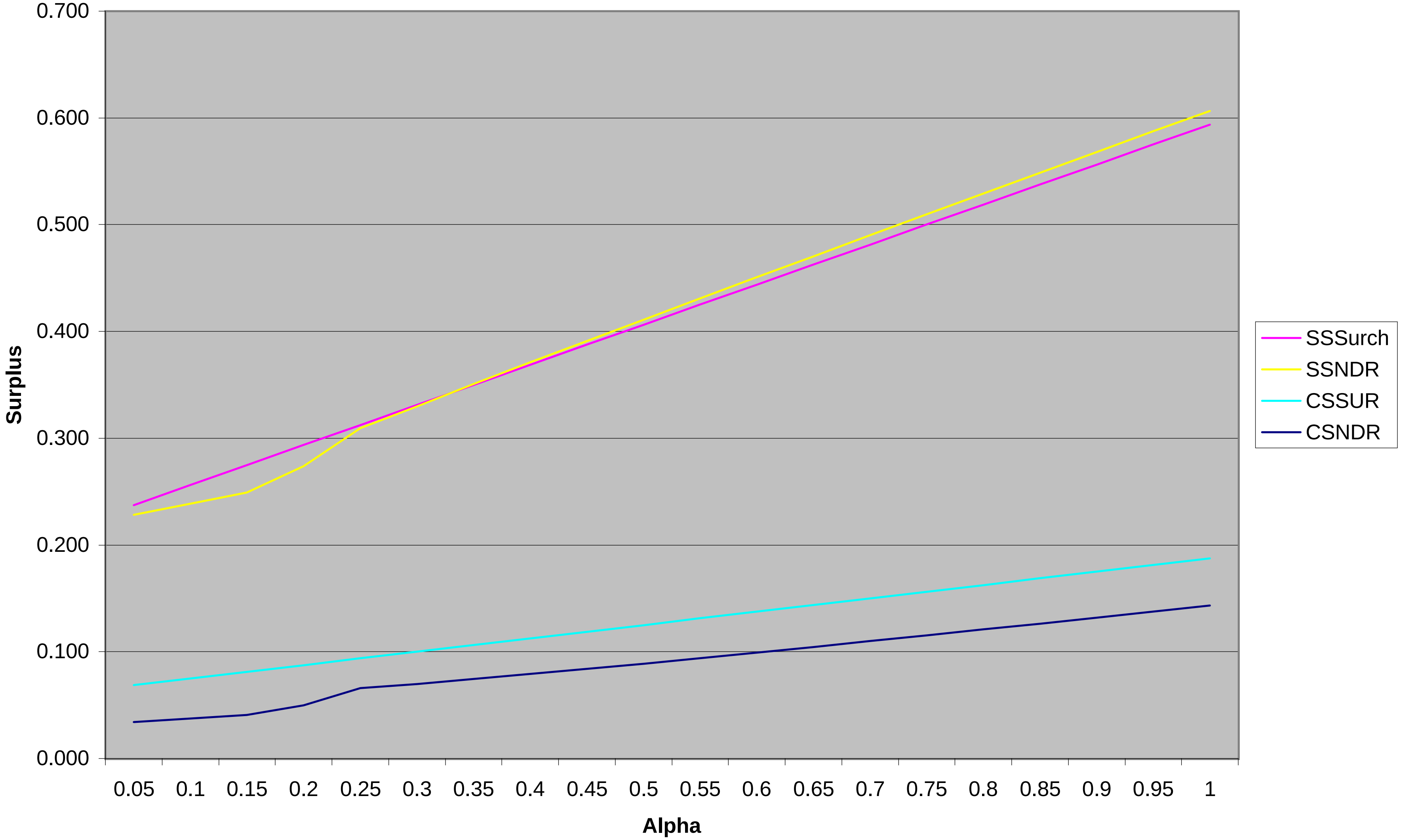
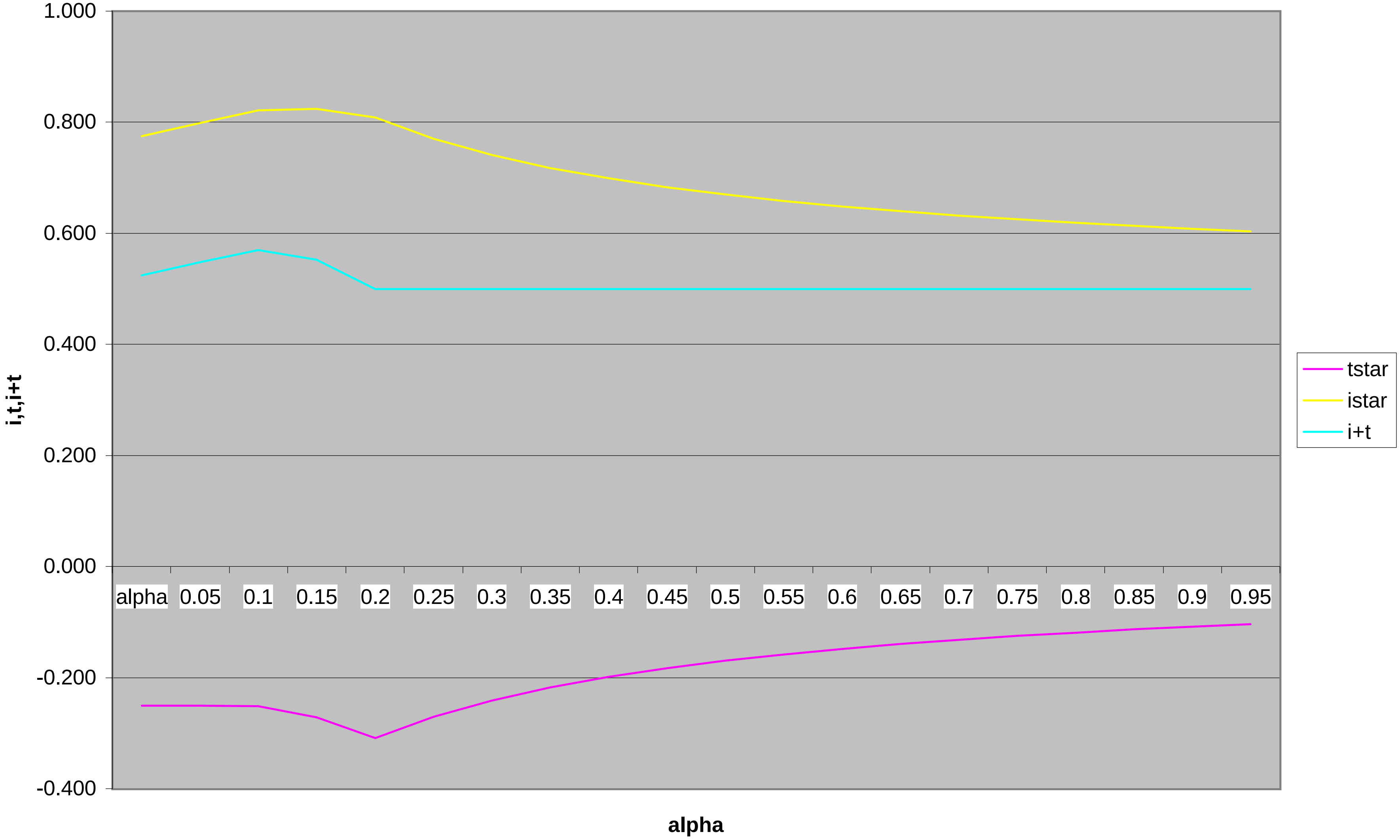


Figure 2c) Price Effects



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