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Malte Krueger

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Abstract

Card payment systems are sometimes accused of taking from the poor and giving to the rich. The argument is as follows: High card fees are leading to higher retail prices for both, card users and cash users. However, high income card holders are receiving rewards when purchasing by card. The result may be a net transfer of, mostly low-income, cash users to, mostly high-income, card users. In this article a model with monopolist product differentiation is used to show that rich card holders may actually be paying for their card rewards themselves. In this case, there is perverse distribution effect.

JEL-Classification: L15, L41, G29

Keywords: Two-sided markets, card rewards, cross-subsidy, pricing strategies

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1 Introduction

In a recent study, Schuh, Shy and Stavins (2010) find that low income, cash using households are basically paying for card rewards of high-income card holders.

"On average, ... , each low-income household pays \$8 to high-income households and each high-income household receives \$430 from low-income households every year." (Schuh, Shy and Stavins, 2010, p. 3)

The hypothesis that card payment systems are characterised by a perverse distributional effect can be found in many studies.[1] This distributional effect has been dubbed "Reverse-Robin-Hood-Cross-Subsidy" (Semeraro, 2009).

The main cause of this effect is the interaction of interchange fees and reward programs. Interchange fees are flowing from the acquiring side of the market to card issuers. Issuers in turn use interchange income to finance card holder reward programs. High interchange fees lead to high merchant fees that are passed on to customers in the form of higher prices. This mark-up usually applies to all customers, not only those paying by card (Schuh, Shy and Stavins, 2010, p. 1). The main beneficiaries of these reward programs are high-income households.

As Schuh, Shy and Stavins (2010, p. 1) point out, this perverse distributional effect would not materialize if merchants would "*recoup the merchant fee only from consumers who pay by credit card*". But they argue that surcharges on card payments are often ruled out by Non Discrimination Rules (NDR) of the card companies. Furthermore, in places were surcharging is allowed, it is not used very much by merchants.[2] Therefore, they conclude that the

[1] See, for instance, Berkovich (2009). A discussion of the literature can be found in Schuh, Shy and Stavins (2010) and Semeraro (2009).
[2] See IMA (2000) and ITM (2000). In Australia, the share of merchants applying surcharges seems to be rising, however. See RBA (2012, p. 25-6).

prevalent case is one with a general mark-up for all customers, independent of the payment instrument used.

The estimates of Schuh, Shy and Stavins (2010) lend further support to recent regulatory activities such as new restrictions on debit card interchange fees in the Dodd-Frank Act or the regulatory action of the European Commission against MasterCard and Visa.[3]

While it is certainly true that explicit surcharging cannot be widely observed, this does not mean that merchants are unable to recover card costs from card holders. The size of the perverse distribution effect estimated by Schuh, Shy and Stavins (2010) crucially depends on the assumption that all groups of customers, low income and high income, card holders and non-card holders purchase a single good (or basket of goods) with a uniform price. In an updated version of the paper Schuh, Shy and Stavins (2011) show that the perverse distribution effect is reduced when low and high income groups shop at different places.[4]

Cash users and card users may not only shop at different shops, they may also buy different goods at the same shop, in particular goods of differing quality. Therefore, below a model of product differentiation is used to show that it may be much more difficult than is commonly assumed to estimate such distributional effects and that card users may, in fact, pay a large portion of their rewards themselves. This result is based on a form of 'implicit surcharging'. If merchants practise such implicit surcharging, they may recover card costs from card users without resorting to an explicit surcharge.

2 Merchant market power in a model with product differentiation

2.1 The standard model of product quality and market power

Product differentiation seems to be widely used by merchants. In particular, different qualities with different prices seem to be a fact of life. In the standard model of vertical product

[3] See Dodd-Frank Act (2010) and European Commission (2007), (2009), (2010) and (2013).

[4] There are other distributional effects, arising from differences in interest payments, float and redistributed profits, that remain even in this case. See Schuh, Shy and Stavins (2011, p. 27).

differentiation (see Mussa and Rosen, 1978; Cooper, 1984), a monopolist offers good X at different levels of quality q with $q \in [0, \infty]$. The fixed costs of quality are sunk and the variable costs are constant in the output level (x) but increasing in quality:

$$(1)\ C(x,q) = c(q)x, \qquad \frac{\partial c(q)}{\partial q} > 0; \qquad \frac{\partial^2 c(q)}{\partial q^2} > 0$$

In the discrete version of the standard model, there are just two groups of customers: type 1 and type 2 – each buying a given quantity with a choice of quality q.

Type 1: users with low willingness to pay for quality $u_1(q)$

Type 2: users with high willingness to pay for quality $u_2(q)$ [5]

The utility functions of the two types are quasi-linear in a numeraire good.

$$(2)\ u_i(w,q) = w + v_i(q) \quad for\ \ i = 1,2$$

where w is the numeraire good.

The utility functions for types 1 and 2 are satisfying the following conditions

$$(3)\ u_1(q) < u_2(q)$$

$$(4)\ 0 < \frac{\partial u_1}{\partial q} < \frac{\partial u_2}{\partial q}$$

$$(5)\ \frac{\partial^2 u_i}{\partial q^2} \leq 0 \quad for\ \ i = 1,2$$

Users face a two-step decision. First, they have to decide whether to buy the product or not. Second, if they chose to purchase the product, they have to select the level of quality.

If consumer surplus is positive for both quality levels, consumers select the level that provides a higher consumer surplus (self-selection constraint).

[5] In the law review literature there is some evidence supporting the assumption that prices and margins may be rising with quality. See Kelman (1984, p. 313-318) and FTC v. Whole Foods Mkt. (2008).

Since costs are constant in output, under competition, there would be no profits and the price of quality would be equal to the costs of quality.

(6) $p(q_i) = c(q_i) \quad i=1,2$

Consumers would maximise utility at a point where the marginal cost (marginal price) of quality is equal to the marginal utility of quality (Mussa and Rosen, 1978, p. 303). A perfectly discriminating monopolist would sell the same qualities as under competition, however, at a higher price – extracting all consumer surplus.

However, if discrimination is not feasible, the self-selection constraint comes into play. If type 2 consumers have the option to buy quality 1 at the price $p(q_1) = u_1(q_1)$ they will do so. Therefore, the monopolist has to lower the price of quality 2 by $[u_2(q_1) - c(q_1)]$. Thus, in a separating equilibrium (SE) we get the following pair of prices:

(7) $p(q_1) = u_1(q_1)$

(8) $p(q_2) = u_2(q_2) - [u_2(q_1) - u_1(q_1)]$

As equation (8) shows, offering low quality in addition to high quality implies a cost in terms of lower profit margins on the sale of high quality. If the monopolist offered only q_2 he could charge $p(q_2) = u_2(q_2)$ ('high-quality equilibrium', HPE).[6] In this case, only one group of customers is served.

In the SE, profits are given by (9):

$$(9) \quad \pi^S = n_1\left[u_1\left(q_1^S\right) - c\left(q_1^S\right)\right] + n_2\left[u_2\left(q_2^S\right) - c\left(q_2^S\right) - \left[u_2\left(q_1^S\right) - u_1\left(q_1^S\right)\right]\right]$$

where n_1 (n_2) is the number of type 1 (type 2) customers.

In the SE, the monopolist offers q_1^S at a price that extracts all consumer surplus of type 1 customers and q_2^S at the incentive compatible price.

Conditions for a profit maximum are

[6] A 'pooling strategy', i.e. one quality offered at a uniform price for both types of customers, would be another option. Acharyya (1998) claims that in certain cases a pooling equilibrium may yield higher profits than either a SE or HPE. It can be shown, however, that if there is no upper limit for quality the monopolist always prefers a separating equilibrium to a pooling equilibrium (see appendix).

(10) $$\frac{\partial \pi^S}{\partial q_2^S} = n_2\left[\frac{\partial u_2\left(q_2^S\right)}{\partial q_2^S} - \frac{c\left(q_2^S\right)}{\partial q_2^S}\right] = 0$$

(11) $$\frac{\partial \pi^S}{\partial q_1^S} = n_1\left[\frac{\partial u_1\left(q_1^S\right)}{\partial q_1^S} - \frac{\partial c\left(q_1^S\right)}{\partial q_1^S}\right] - n_2\left[\frac{\partial u_2\left(q_1^S\right)}{\partial q_1^S} - \frac{\partial u_1\left(q_1^S\right)}{\partial q_1^S}\right] = 0$$

In the high-price equilibrium, the monopolist offers quality q^H at a uniform price.[7] The price is determined by the utility of type 2 customers. Thus, type 1 customers will not buy the good.

(12) $$\pi^H = n_2\left[u_2\left(q^H\right) - c\left(q^H\right)\right]$$

The condition for a profit maximum in a high-price equilibrium (HPE) is

(13) $$\frac{\partial \pi^H}{\partial q^H} = n_2\left[\frac{\partial u_2\left(q^H\right)}{\partial q^H} - \frac{\partial c\left(q^H\right)}{\partial q^H} = 0\right]$$

Equations, (10) and (13) imply that the profit maximising quality offered to type 2 customers in a separating equilibrium is the same as the profit maximising level of quality offered in a high-price equilibrium.[8]

(14) $$q_2^S = q^H = q_2^*$$

where an asterisk denotes optimal values under perfect competition.

The resulting prices and qualities are depicted in Figure 1.

[7] The HPE basically corresponds to the case of separated shopping considered in Schuh, Shy and Stavins (2011).
[8] A result derived already in Mussa and Rosen (1978).

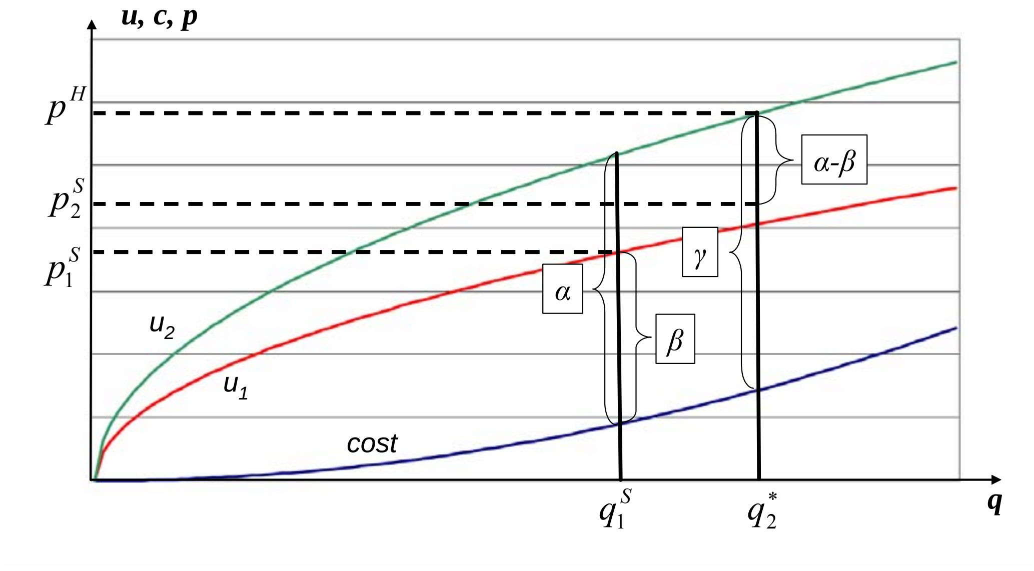


Figure 1: Quality levels and prices in the separating and the high-price equilibrium

u_1, u_2 : utility of type 1 and type 2 consumers, p^H : price in high-price equilibrium, p_1^S (p_2^S): price for low (high) quality in a separating equilibrium, q_1^S : low quality in separating equilibrium, q_2^*: high quality in a separating equilibrium or in a high-price equilibrium; $\alpha \equiv u_2(q_1^S) - c(q_1^S)$; $\beta \equiv u_1(q_1^S) - c(q_1^S)$; $\gamma \equiv u_2(q_2^*) - c(q_2^*)$

2.2 Card acceptance under the NDR

If a merchant with market power introduces card acceptance, some customers will continue paying with cash whereas others will be paying by card. Empirical research on payments shows that card users have higher income, on average, and that the average card transaction has a higher value than the average cash transaction.[9] Thus, it seems plausible that users of cards will be mostly type 2 customers and users of cash will be type 1 customers.

For type 2 customers cards provide a certain benefit. Thus, the utility of buying a good of a certain quality is higher when paying with cards then when paying with cash. The utility when paying with cards is denoted as u^c. The card benefit is equal to b^c .

$$(15) \quad u^C(q_i) = u(q_i) + b^c(q_i) \geq u(q_i)$$

[9] Data for the US can be found in Schuh, Shy and Stavins (2010) p.8 and p.16, data for Germany in Krueger, Leibold and Smasal (2008) and in Deutsche Bundesbank (2009, p. 48 and p. 57). The results of these studies are discussed in section 2.3.

In addition, it is assumed that the card benefit is a positive function of q. The assumption can be rationalised with the observation that the utility of card usage is likely to rise with prices and that the price of a good usually is a positive function of its quality.

(16) $$\frac{\partial u^C(q_i)}{\partial q_i} = \frac{\partial u(q_i)}{\partial q_i} + \frac{\partial b^c}{\partial q_i} \geq \frac{\partial u(q_i)}{\partial q_i}$$

For type 1 customers, cards do not provide any (net) benefit. Consequently, type 2 customers will prefer, ceteris paribus, to pay by card whereas type 1 customers will use cash as means of payment. If a merchant starts to accept card payments the utility of type 2 customers is increased for any q.

Finally, it is assumed that card usage has a stronger effect on marginal card benefits of card holders than on marginal card costs of merchants. To justify this assumption, it can be pointed out that it would not be profitable for merchants to accept card payments if marginal costs (net of any card benefit for merchants) were higher than marginal utility.[10]

(17) $$\frac{\partial b^c}{\partial q} > \frac{\partial c^{cp}}{\partial q} \quad \textit{with } c^{CP} = \text{costs of card payment}$$

Proposition 1: Card acceptance increases the quality offered to type 2 customers and lowers the quality offered to type 1 customers. Correspondingly, the price paid by type 1 customers falls and the price paid by type 2 customers rises.

For type 2 customers, the profit maximising condition becomes

(18) $$\frac{\partial \pi^{CS}}{\partial q_2^{CS}} = n_2 \left[\frac{\partial u_2^C\left(q_2^{CS}\right)}{\partial q_2^{CS}} - \frac{c^c\left(q_2^{CS}\right)}{\partial q_2^{CS}} \right] = 0$$

[10] This assumption is in line with the results of Rochet and Tirole (2011) and Wright (2010). Under various assumptions regarding the nature of competition they find that merchants will accept cards only if the sum of merchant benefits and net card holder benefits is larger than merchant costs. See also Katz (2001, p. 10-11) who stresses that the perceptions of a single merchant and all merchants collectively have to be distinguished.

where the superscript ‘CS’ indicates a separating equilibrium with card acceptance. Given the assumption that marginal card benefit rises faster than marginal card costs, card acceptance induces merchants to raise quality in order to equate marginal costs and marginal utility.

Thus we get

$$(19) \quad q_2^{CS} > q_2^S$$

Profits are given by:

$$(20) \quad \pi^{CS} = n_1\left[u_1\left(q_1^{CS}\right) - c\left(q_1^{CS}\right)\right] + n_2\left[u_2^C\left(q_2^{CS}\right) - c^C\left(q_2^{CS}\right) - \left[u_2^C\left(q_1^{CS}\right) - u_1\left(q_1^{CS}\right)\right]\right]$$

The profit maximising condition for low quality becomes:

$$(21) \quad \frac{\partial \pi^{CS}}{\partial q_1^{CS}} = n_1\left[\frac{\partial u_1\left(q_1^{CS}\right)}{\partial q_1^{CS}} - \frac{\partial c\left(q_1^{CS}\right)}{\partial q_1^{CS}}\right] - n_2\left[\frac{\partial u_2^C\left(q_1^{CS}\right)}{\partial q_1^{CS}} - \frac{\partial u_1\left(q_1^{CS}\right)}{\partial q_1^{CS}}\right] = 0$$

Re-arranging yields:

$$(22) \quad \frac{\partial u_1\left(q_1^{CS}\right)}{\partial q_1^{CS}} - \frac{\partial c\left(q_1^{CS}\right)}{\partial q_1^{CS}} = \frac{n_2}{n_1}\left[\frac{\partial u_2^C\left(q_1^{CS}\right)}{\partial q_1^{CS}} - \frac{\partial u_1\left(q_1^{CS}\right)}{\partial q_1^{CS}}\right]$$

Because, at the optimal quality level q_1^s (the optimal q_1 before card acceptance), card acceptance raises marginal utility of type 2 users, the right-hand side of equation (22) must be larger than the left-hand side. To restore equilibrium of both sides of the equation, quality has to be lowered (raising the left-hand side and lowering the right-hand side). Consequently, card acceptance lowers the optimal value of q_1 (see Figure 2).

$$(23) \quad q_1^{CS} < q_1^S < q_1^*$$

where an asterisk denotes values under perfect competition.

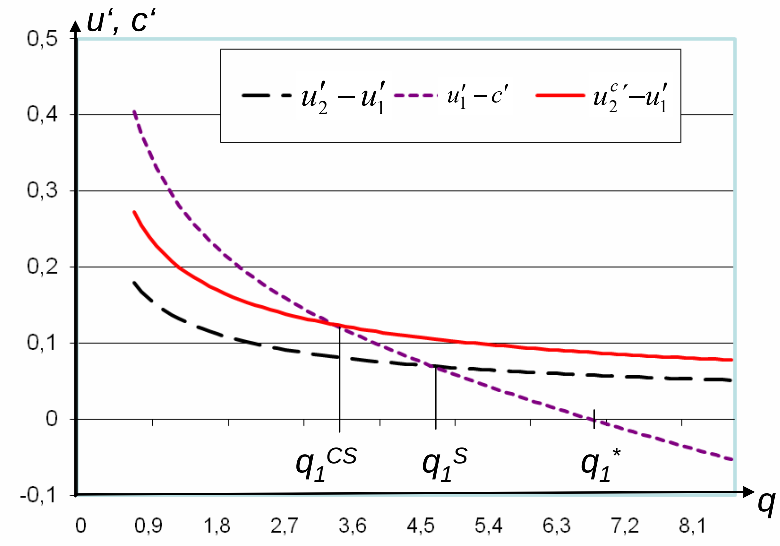


Figure 2: Change of q_1 due to the introduction of card acceptance

u'_1, u'_2: marginal utility of type 1 and type 2 consumers, $u^c_2{}'$: marginal utility of type 2 consumers when paying with card, c': marginal costs, q^s_1 (q^{cs}_1): low level of quality in separating equilibrium without (with) card acceptance; n_1/n_2 has been set to one.

Thus, card acceptance shifts the two quality levels further apart. The level of quality offered to type 1 customers falls. Therefore, card acceptance does not raise prices for them – rather it lowers them. For type 2 customers, card acceptance increases quality and price.

The new price posted for high quality goods purchased by card holders (type 2 customers) is:

$$(24) \quad p_2^{CS} = u_2^C\left(q_2^{CS}\right) - \left[u_2^C\left(q_1^{CS}\right) - u_1\left(q_1^{CS}\right)\right]$$

Proposition 2 If the quantity demanded is inelastic, card holders are paying for card rewards themselves.

In a SE, before and after card acceptance, merchants extract all surplus from type 1 customers. Thus, net utility ($u(q_1) - p_1$) remains constant. Since the quality q_1 is lowered after card acceptance, the price of q_1 falls. This fall of quality goes hand-in-hand with a lower profit margin.

Type 2 customers are paying a higher price after the introduction of card acceptance. The price increase is due to

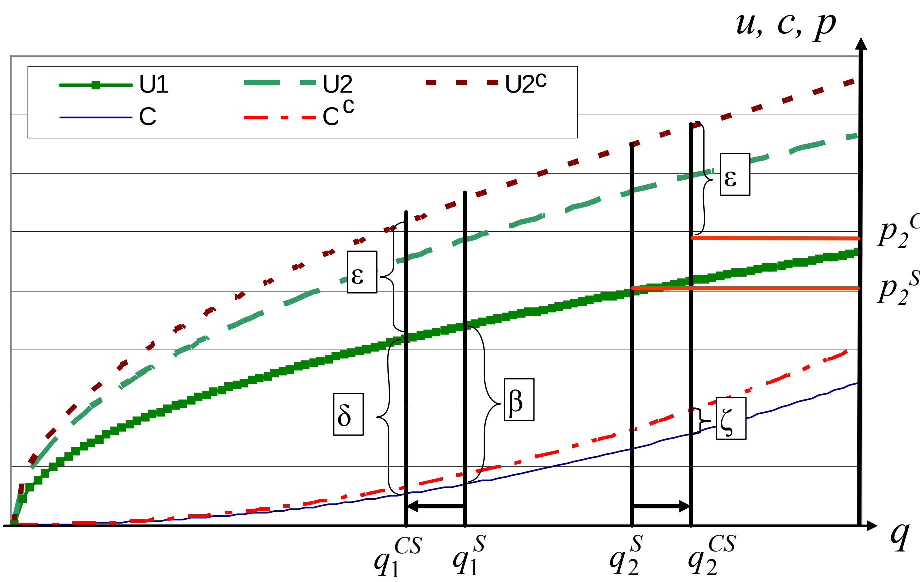
- increased utility due to card usage
- higher quality q_2
- lower quality q_1

The resulting price increase could be larger or smaller than the costs of card acceptance. However, as has been shown above, the margin on sales to type 1 customers falls. Merchants will be willing to introduce card acceptance only if it does not lead to lower profits. Therefore, prices on high quality have to rise by more than the costs of cards. Otherwise, merchants will not accept cards.[11]

Card acceptance will increase profits for a merchant if the following condition is met:

$$(25) \quad p_2^{CS} - p_2^{S} > \left[c^c\left(q_2^{CS}\right) - c\left(q_2^{S}\right)\right] + u_1\left(q_1^{S}\right) - c\left(q_1^{S}\right) - \left[u_1\left(q_1^{CS}\right) - c\left(q_1^{CS}\right)\right]$$

If this condition is not fulfilled, merchant profits will be higher without card acceptance. Thus, if cards are accepted, the costs of card acceptance – including costs of reward program – are carried by card users.



[11] As shown by Rochet and Tirole (2011) and Wright (2010). See footnote 9.

Figure 3: The effects of card acceptance on pricing of high quality

u_1, u_2 : utility of type 1 and type 2 consumers; c (c^c): cost of quality without (with) card acceptance; p_1 (p_2): price of low (high) quality, q_1 (q_2): level of low (high) quality; superscript 'S': separating equilibrium; superscript 'C': equilibrium with card acceptance; $\beta \equiv u_1(q_1^S) - c(q_1^S)$; $\delta \equiv u_1(q_1^{CS}) - c(q_1^{CS})$; $\varepsilon \equiv u_2(q_1^{CS}) - u_1(q_1^{CS})$ $\varsigma \equiv c^c(q_2^{CS}) - c(q_2^{CS})$

Again, the analysis of the high-price scenario is fairly straight forward. For type 2 customers, the profit maximising condition becomes

$$(26) \quad \frac{\partial \pi^{CH}}{\partial q_2^{CH}} = n_2 \left[\frac{\partial u_2^C \left(q_2^{CH}\right)}{\partial q_2^{CH}} - \frac{c\left(q_2^{CH}\right)}{\partial q_2^{CH}} \right] = 0$$

where the superscript CH indicates a high price equilibrium with card acceptance

This is the same condition as in the case of a separating equilibrium. Therefore, the quality q_2 is the same in both cases.

$$(27) \quad q_2^{CH} = q_2^{CS} > q_2^H = q_2^S$$

The new price is in the HPE is equal to total utility of type 2 customers. Thus, merchants are able to extract the entire card benefit from type 2 customers.

2.3 Card users and cash users: Summary of the evidence

The results derived in this paper strongly depend on the assumption that merchants can separate card users and non-users. There is little hard evidence to support this point. However, some empirical evidence exists, showing that card holders and non-holders differ and that the average value of card transactions is higher than the average value of cash transactions.

Data of the 2007 Survey of Consumer Finances (reported in Schuh, Oz and Stavins, 2010, p. 8) show that in the US, card ownerships and card spending are rising with income (see Table 1). Only 42% of households with an annual income under $20,000 owned a credit card.

For households with an income of more than $100,000 market coverage was almost complete (96%).

Annual income	Credit card ownership	Average monthly credit card charge by adopters	Share of credit card spending in consumption
Under $20,000	42%	$447	8.4%
$20,000-49,999	67%	$478	9.3%
$50,000-79,999	87%	$714	12.8%
$80,000-99,999	92%	$1,026	15.7%
$100,000-119,999	93%	$1,293	17.9%
$120,000-149,999	97%	$1,642	20.9%
Over $150,000	97%	$4,696	27.6%
Under $100,000	68%	$616	11.3%
Over $100,000	96%	$2,966	24.8%
Whole sample	73%	$1,190	16.9%

Table 1: Households' credit card adoption rates and new monthly charges by annual household

Source: Schuh, Oz and Stavins (2010, p. 8).

As Table 2 shows, low income households are predominantly cash users. When looking at the number of transactions, the data show that cash is still the dominant means of payment for low and high income households. However, low income households use cards for only 14% (8/58s) of their transactions whereas high income households use cards for 31% (13/42s) of their transactions.

	Distribution of Households			Distribution of Transactions		
	Low income	High income	Total	Low income	High income	Average
Cash buyers	70	13	83	50	29	79
Card buyers	12	6	17	8	13	21
Total	81	19	100	58	42	100

Table 2: Distribution of households and transactions (percentage of total)

Source: Schuh, Oz and Stavins (2010, p. 16). Cut-off level between low and high income: $100,000.

In Germany, credit cards are not as ubiquitous as in the United States. Most credit cards cost a fee (with an average fee of about 20 EUR) and issuers are requiring a minimum credit standing of new customers. Since almost everyone has a giro (checkable) account which comes with a (usually free) debit card, there is also less demand for credit cards. As a consequence, in a population of 80 million inhabitants, there are only about 20 million credit card holders and the average credit card holder has a higher income than the average non-card holder.

Credit card ownership	Yes	No
Average income (EUR)	46.379	22.500
Number of respondents	1461	469

Table 3: German consumer survey of internet payments (IZV9)

Source: Krueger, Leibold and Smasal (2008).

Table provides empirical evidence from a German internet survey conducted in 2008. Participants were asked whether they owned a credit card and what their income was. As the results show, the average income of the holder of a credit card is more than twice as high as the income of respondents not holding a credit card.

A similar picture emerges from the results of a household survey published by the Deutsche Bundesbank in 2009. The survey shows that only 27% of respondents own a credit card and that only 8% used a credit card at least once during the last 7 days (Deutsche Bundesbank, 2009, p. 42-3). The survey also shows, that the educational level of card holders is above average and that card ownership strongly rises with household income (see Table 4).

	Income		
Income	<1,500 EUR	1,500-3,000 EUR	>3,000 EUR
Share of credit card payments	0.5%	4.1%	5%

Table 4: Household income and credit card payments in Germany

Source: Deutsche Bundesbank (2009, p. 57).

The survey of the Bundesbank also shows that the average card transaction is higher than the average cash transaction. Within the group of card payments, credit card transactions exhibit higher average value than debit card transactions.

	Average	Median
Cash	20	10
Debit card	62	46
Credit card	77	55

Table 5: Average transaction values (EUR) in Germany

Source: Deutsche Bundesbank (2009, p. 48).

The data presented suggest that card holders are indeed different and that merchants may use product differentiation in order to extract consumer surplus from card holders. To formally test the proposition of this paper, better data would be required; for instance, data on the average margin earned from sales to card holders as compared to the average margin on sales to non-card holders.

3 Conclusion

If merchants engage in product differentiation and apply different margins to different levels of quality, the "Reverse-Robin-Hood-Cross-Subsidy-Effect" may not be effective. If card holders predominantly buy high quality goods and cash holders low quality goods, card holders end up paying their own rewards.[12] This points to a more general problem: If we compare interchange fees to a tax, it is by no means clear who carries the ultimate economic burden: merchants, the average consumer, particular consumer groups, … Under the assumption of a fixed (inelastic) demand card users have to carry the burden. With elastic demand this is likely to be different. Schwartz and Vincent (2006) find that with elastic demand, cash payers may have to carry some of the burden. Whether such a result would also be true when product differentiation is used, is a topic for future research.

The results of the model presented in this paper are also important with respect to the welfare effects of surcharging. It has been shown that surcharging may be inefficient if

[12] Others have criticised the Reverse-Robin-Hood-Cross-Subsidy hypothesis on the grounds that merchant benefits of card acceptance may be larger than the costs of cards acceptance (Semeraro, 2009).

merchants have market power (see Wright, 2003). Therefore, a case can be made for NDRs. However, the results above suggest that merchants with market power may be able to use implicit surcharging. Thus, the existence or non-existence of NDRs may not matter much for them.

Finally, implicit surcharging may also help to explain the empirical observation that merchants often do not implement surcharging even if it is allowed (IMA, 2000; ITM, 2000).[13]

4 References

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[13] In Australia, regulators prohibited NDRs in 2003. Initially, merchants made little use of the right to surcharge. This was in line with the results of the studies cited in the text. Recently, however, the share of merchants using surcharging has been rising. See RBA (2012).

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Appendix

Suppose the monopolist has implemented a pooling strategy offering quality q^P at a uniform price $p^P = u_1\left(q^P\right)$ with

(1*) $\frac{\partial u_1}{\partial q^P} = \frac{\partial c}{\partial q^P}$

Profits are given by

(2*) $\pi^P = \left(n_1 + n_2\right)\left[u_1\left(q^P\right) - c\left(q^P\right)\right]$

In this case, given the assumptions of the basic model, the monopolist will always be better off offering q_2^S to type 2 customers at the optimal price for high quality derived for the separating equilibrium. Profits in this modified separating equilibrium (with q^P *and* q_2^S) are given by:

(3*)
$$
\begin{aligned}
\pi^{S*} &= n_1\left[u_1\left(q^P\right) - c\left(q^P\right)\right] + n_2\left[u_2\left(q_2^S\right) - c\left(q_2^S\right) - \left[u_2\left(q^P\right) - u_1\left(q^P\right)\right]\right] \\
&= n_1\left[u_1\left(q^P\right) - c\left(q^P\right)\right] + n_2\left[u_1\left(q^P\right) - c\left(q^P\right)\right] - n_2\left[u_2\left(q^P\right) - c\left(q^P\right)\right] + n_2\left[u_2\left(q_2^S\right) - c\left(q_2^S\right)\right] \\
&= \pi^P - n_2\left[u_2\left(q^P\right) - c\left(q^P\right)\right] + n_2\left[u_2\left(q_2^S\right) - c\left(q_2^S\right)\right] \\
&= \pi^P + n_2\left[u_2\left(q_2^S\right) - u_2\left(q^P\right)\right] - n_2\left[c\left(q_2^S\right) - c\left(q^P\right)\right]
\end{aligned}
$$

Given the assumptions about costs and utility, at q^p marginal utility of type 2 customers is higher than marginal costs. Therefore, the change in utility is larger than the change in costs and thus π^{S*} is larger than π^P.
Moreover, the monopolist could further raise profits by lowering the quality of goods offered to type 1 customers and charging higher prices to type 2 customers.

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