SEPA, Efficiency, and Payment Card Competition

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Abstract

This paper analyzes the welfare implications of creating a Single Euro Payments Area. We study the effects of increased network compatibility and payment scale economies on consumer and merchant card fees and its impact on card usage. In particular, we model competition among debit cards and between debit and credit cards. We show that competitive pressures dampen merchant fees and increase total card acceptance. The paper argues that there is room for multilateral interchange fee arrangements to achieve optimal consumer and merchant fees, taking safety, income uncertainty, default risk, merchant's pricing power, and the avoided cost of cash at the retailers side into account. Consumers and merchants are likely to benefit the most from the creation of SEPA when sufficient payment card competition alleviates potential monopolistic tendencies.

Key Words: SEPA, card network competition, optimal pricing, economic welfare

JEL Codes: L11, G21, D53

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1 Introduction and Motivation

One of the most significant long-term trends in the way we pay and merchant sell goods and services has been a continuing shift away from the use of cash and checks towards more innovative and electronic means of payment. Today, payment cards are indispensable in most advanced economies. For Europe, the number of payment cards increased by 140 percent across 11 countries during the period 1987-2004 (Bolt and Humphrey, 2007), and by now payment cards have become the most used non-cash payment instrument in Europe. Focusing on 13 countries, Amromin and Chakravorti (2009) find that greater usage of debit cards has resulted in lower demand for small-denomination bank notes and coins that are use to make change. Furthermore, apart from high growth rates, payment cards have also been proven to be a simple, safe, and cost-efficient payment instrument.

At the European level, the realization of the Single Euro Payments Area (SEPA) represents a major step towards closer European integration. Within SEPA all euro payments in the euro area are treated as domestic payments. SEPA may bring substantial economic benefits and opportunities as it will foster competition and innovation, and improve conditions for consumers and merchants (Schmiedel, 2007). Owing to strong scale economies in the payment industry, it is likely that SEPA will spur substantial consolidation of payment networks, infrastructures and processing operations across borders to allow banks, merchants and consumers to benefit from these cost efficiencies (Beijnen and Bolt, 2009; Bolt and Humphrey, 2007).

Payment cards play an important role in the overall success of SEPA. Yet, at the current stage, the "cards dossier" is facing unfavorable developments. In particular, the European cards market continues to be still very fragmented along national borders and there is a risk of decreased competition when only a few payment schemes are likely to "survive". The developments within SEPA for cards have called for the need of an European-led initiative to create at least one additional European card scheme. This new card scheme is envisaged to function in addition to and in competition with two already existing international schemes that have well-established positions at the European level. Complementing the political motivations to maintain or regain strategic control over the European cards market, it is expected that an additional European card scheme brings economic benefits not only arising from industry consolidation and standardization, but also from increased competitive pressures and the increased use of cards.

Against this background, the present paper studies whether positive welfare effects can be expected from the creation of SEPA. In our analysis we assume that increased compatibility between card systems across countries and economies of scale in card processing are the main economic drivers for SEPA. We study the effects of increased compatibility and scale economies on consumer and merchant fees of debit and credit cards and their usage. Moreover, the paper analyzes potential impact of the emergence of an additional European card scheme on pricing decisions by card networks and merchant acceptance, as well as its implications for economic welfare. Payment cards offer benefits to consumers and merchants in terms of safety and income insurance.[1] Moreover, by accepting cards, merchants avoid costs of cash handling and cash management. Clearly, the use of cash is not a free lunch. Ultimately, consumers and merchants must tradeoff increased consumption possibilities and avoided cost against payment fees for using cards. This tradeoff between cards versus cash determines the ability of card network to extract surplus from consumers and merchants and is reflected in the level of the payment fees. In this paper, as a potential market outcome of SEPA, we also model two competitive payment networks which set payment prices to consumers and merchants in their pursuit of market share and profit. Competitive pressures dampen the merchant fee and hence affect multilateral interchange fee (MIF) arrangements between issuers and acquirers. The importance of the merchant fee and MIF has been revived by Mastercard's recent decision to cut their cross-border MIFs in order to comply with EU antitrust rules.[2]

Many important contributions in the academic literature have addressed key issues surrounding card payment networks in general and payment pricing and interchange fees in particular (e.g., Baxter, 1983; Rochet and Tirole, 2002; Schmalensee, 2002; Wright, 2004; Chakravorti and To, 2007). These studies differ in their various assumptions about consumers, merchants, technology, and market structure. Although a number of important findings have emerged from this literature, they have not yet provided much guidance for

[1] Our analysis draws upon on a model by Bolt and Chakravorti (2008a), although they do not study the effects of compatibility and competition on payment prices.

[2] In December 2007 the EC ruled that the MIFs charged for cross-border transaction made with MasterCard violated EC Treaty regulations.

the current policy debate regarding the creation and integration of future European retail payment markets. In particular, the existing literature is silent about the potential effects of SEPA for payment cards and about the economic implications of competitive card schemes for consumer and merchant welfare.[3] This imbalance in the literature is even more surprising when seen in the light of the potentially large economic benefits that SEPA offers to banks, non-banks, corporations, consumers, and society as a whole (European Commission, 2008; Schmiedel, 2007). This paper attempts to start filling this gap.

Our analysis shows that increased compatibility and payment scale economies dampen optimal merchant fees. This increases merchant acceptance of payment cards, which in turn raises the consumer willingness to pay for cards. Higher cost of cash increases the potential for card networks to extract economic surplus by raising merchant fees. Due to payment externalities, socially optimal merchant fees and profit-maximizing merchant fees need not be equal. In particular, with relatively high processing costs and large default risk, socially optimal merchant fees can even be higher than profit-maximizing ones in order to deter merchants from accepting. Our results would indeed suggest that MIFs—as a function of the merchant fee—may be necessary to optimally balance the two sides of the payment market. Competition between debit and credit cards dramatically decreases merchant fees for both types of cards, which indicates that creating an additional European payment scheme within SEPA will boost merchant acceptance and card usage, but does not necessarily lead to the "best" outcome for economic welfare.

The remainder of this paper is structured as follows: Section 2 provides an overview of recent developments in European payment markets with a special focus on card payments and the emergence of additional European card schemes. Section 3 discusses and puts into perspective most recent studies related to payment networks and payment competition as well as expected economic impact of the SEPA project. Section 4 presents a model of SEPA and payment cards. Section 5 and 6 focus on price and welfare comparisons of different market outcomes of SEPA. The final section contains a summary and conclusions.

[3] See e.g. Armstrong (2006) and Rochet and Tirole (2003b) for a first analysis of competition in two-sided markets.

2 Recent developments in European payment markets

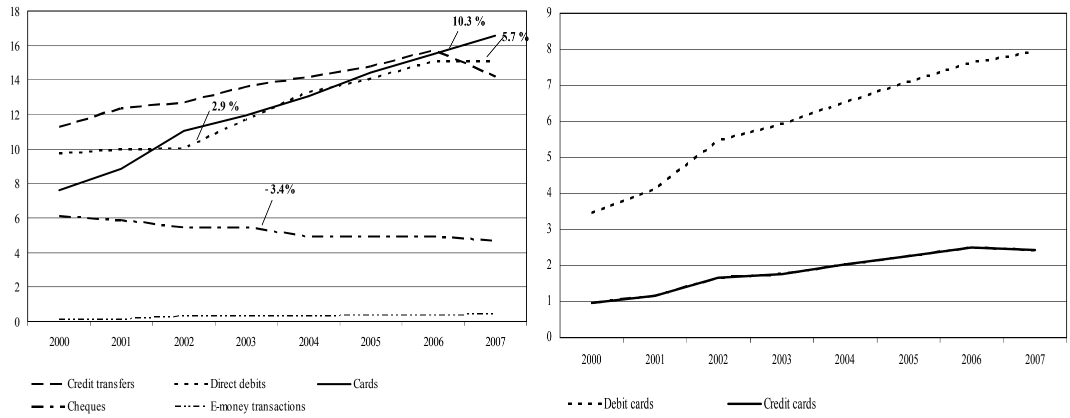
2.1 Significance of card payments in Europe

A well-functioning financial system allows an economy to fully exploit its growth potential, as it ensures that the best real investment opportunities receive the necessary funding (ECB, 2009). Similar to other financial innovations, cashless transactions make financial markets more complete, allow transaction costs to be low and, most importantly, facilitate the exchange of goods and services. Against this background significant changes in the use of cashless payments have taken place over time on a global scale; the number of cashless transactions, e.g. credit transfers, direct debit, card payments and e-money payments, has risen in many advanced economies over time. Over the last few years, volumes of cashless payments in the European Union have increased by about 6 percent per year. In Europe, as the left panel of Figure 1 demonstrates, card payments experienced the highest growth of more than 10 percent and have become the most used non-cash payment instrument, with over 25 billion payments per year. In particular, considering card payments in the euro area the use of debit card payments show the strongest growth and development over time compared to credit card transactions as shown in the right panel of Figure 1.

Despite similar trends of cashless payments at a global level, the European retail payments market is still fragmented and national payment habits differ leading to substantial asymmetries in cashless payment usage. As shown in Figure 2, within the euro area, the Austrians, Finns and Dutch are the most frequent users of cashless payments, while the Portuguese, Spanish, Italians and, in particular, Greeks are the least frequent ones.

Although in the future different preferences for payment instruments may remain, customers' habits when purchasing goods and services are changing. More competition, more choice and new business opportunities, for example in the cards market, will influence their habits and could encourage a greater use of cards. Innovative payment solutions, such as online payments, are also likely to change customers' habits. Overall, recent developments and changes in the payments market reveal great opportunities and potential for non-cash payments. In particular, cards are becoming the most important payment instrument in the euro area. Only cash is used more frequently, but generally for only small payments.

Figure 1: Payment instrument usage in the euro area, 2000-2007 (in bln. transactions)



Note: Euro area includes all EU countries that have adopted the euro. In the left panel, cards include all payment cards issued in the euro area except for cards with an e-money function. The shown percentages are the mean of the compound annual growth rates (CAGR) of transactions. In the right panel, debit cards include cards with a debit function and credit cards include cards with both a credit function and a credit combined with delayed debit function. All cards are issued in the euro area. *Source:* ECB.

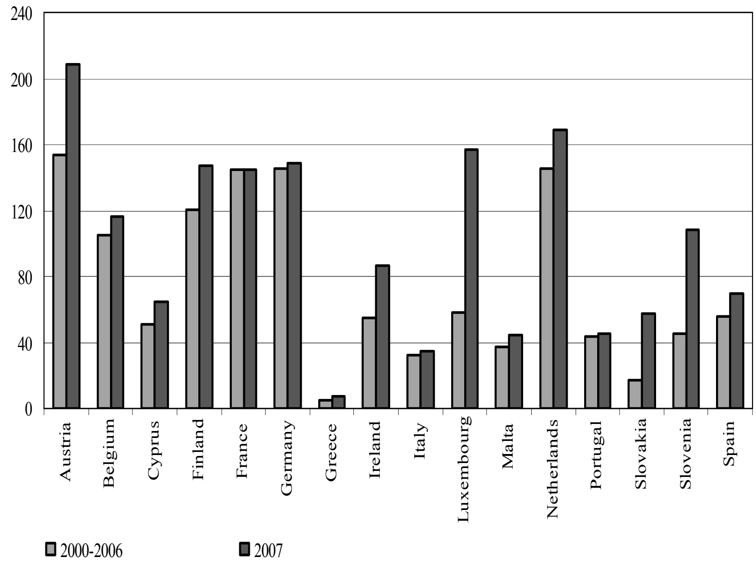
Besides their widespread usage, cards are also a safe, efficient and reliable payment instrument. There is still a considerable growth potential for cards in many countries. Reducing the use of cash in favor of cards is likely to benefit not only banks, but also consumers and merchants. Naturally, society as a whole is best off when it relies more heavily on the most efficient payment system.

2.2 Emergence of additional European card schemes

At the European level, the realization of the Single Euro Payments Area aims at removing the technical, legal and commercial barriers. SEPA makes non-cash euro payments as easy, efficient and safe as it is today within one country. SEPA may bring substantial economic benefits and opportunities from potential economies of scale and scope, thereby increasing the overall economic efficiency of the payments industry. Moreover, SEPA entails shifts in service levels and the development of new, innovative payment products for consumers and merchant. Payment cards play here an important role.

SEPA for cards is motivated via gradual standardization and the opening of domestic markets to increase the opportunities of more card usage. Through more choice and cost-

Figure 2: Number of non-cash payments per capita in the euro area, 2000-2007



Note: Number of non-cash transactions per capita by non-MFIs including credit transfers, direct debits, card payments and e-money payment transactions. The 2000-20006 number is the average over the period 2000-2006. *Source:* ECB.

efficiency, competition should be introduced and increased in the areas of card schemes, issuing, acquiring, acceptance and processing. However, it is observed that the European cards market is still very fragmented along national borders and that the market for cross-border card transactions is almost served exclusively by two international card schemes. National card schemes, which have been proven to deliver efficient solutions to domestic payment needs, are at risk of "extinction" as banks are reconsidering their participation. As a result, there is the possibility that the future perspective for cards entails limited competition when only a duopoly of international schemes are active.

These developments within SEPA regarding payment cards have called for support to create an additional European card scheme that meets the requirements of cardholders, banks, merchants, public and competition authorities. At least three European, market-led initiatives have emerged and are currently discussed at the political and commercial level. The Euro Alliance of Payment Schemes (EAPS), the Monnet initiative, and the PayFair initiative have entered the payment arena. EAPS is based on interlinkages between six card schemes from Germany, Italy, Spain, Portugal, the UK and EUFISERV. It foresees that cards of the

Table 1: Overview MasterCard's MIF level

MIF level [% per transaction]	2007	2009
Credit cards	0.8%-1.9%	0.3%
Debit cards	0.4%-0.75%	0.2%

issuers network will be accepted at all terminals of participating card acquirers. The Monnet initiative targets the creation of a new scheme and is currently driven by German and French banks. Payfair is a private initiative comprising a merchant-oriented debit card scheme.

Without favoring any of these proposed new European card scheme solutions and initiatives, this paper explores whether potential social welfare gains can be expected from additional competition between card schemes. Despite the efforts of the above mentioned market initiatives to create an additional European card scheme, further clarity may be needed on the set-up, determination and level of a possible multilateral interchange fee (MIF) for such new card schemes.

In fact, recently the European Commission took note of MasterCard's decision to apply a new methodology which results in reduced average weighted MIF levels compared initial levels which were violating EU antitrust rules. As indicated in the table 1, the maximum weighted average MIF is cut to 0.30% for consumer credit cards and to 0.20% for consumer debit cards. For comparison, depending on the card, MasterCard's cross-border MIFs ranged from 0.8% to 1.90% in 2007. Debit card cross-border MIFs ranged from more than 0.40% to more than 0.75%. From an economic perspective, the present paper explores the implications of an approach towards MIF that would allow banks to offer card products to cardholders and merchants that can truly compete with cash.

3 Literature review

Over recent years the economic literature has witnessed an abundance of theoretical analyses regarding payment pricing and interchange fees. From an antitrust perspective, many authors have analyzed the potential competitive effects of the collective setting of interchange fees within payment card schemes (Baxter, 1983; Carlton and Frankel, 1995, Frankel, 1998; Chang and Evans, 2000; Balto, 2000; Schmalensee, 2002; Rochet and Tirole, 2002, 2003b; Wright, 2003).[4] Formal models have been developed that focus on the role and nature of interchange fees—which is to reallocate funds between the two sides of the market—and on volumes of activity in payment card networks. These models have been developed drawing parallels with other (two-sided) network industries like internet, media, video games and software (Rochet and Tirole, 2003, 2006; Wright, 2004; Armstrong, 2006). Essentially, these models differ in their various assumptions about consumers, merchants, technology, and market structure.

Retail payment systems bear important characteristics of two-sided markets (Rochet, 2007). That is, the consumption of card payment services involves two sides of the transaction—a consumer and a merchant—each of whom takes actions, enjoys benefits, and incurs costs. Economic theory has shown that setting the right price structure (e.g., the ratio of the consumer fee and merchant fee) is crucial for consumer card usage, merchant acceptance decisions, and resulting levels of economic welfare and efficiency. Interchange fees can be viewed as instruments to attain this optimal price structure, and to provide necessary incentives to guarantee the participation of all parties in the card payment system. An important lesson of this analysis is that the socially optimal consumer, merchant and interchange fee will depend on both benefits and costs realized by each side of the transaction. Theoretically, purely cost-based merchant fees or zero MIFs are unlikely to attain full efficiency. Profit-maximizing payment fees can be heavily skewed to one side of the market (e.g., Bolt and Tieman, 2008). Typically, merchants are less price-elastic than cardholders, and often bear the full burden of joint payment cost. However, this does not necessarily contradict a socially efficient market outcome, as long as the ability to extract surplus does not turn into abusive and socially wasteful rent seeking.

The European Commission (2008) points out that the potential benefits from SEPA in the European payment markets alone could exceed EUR 123 billion over the next six years. Further benefits are possible if SEPA can be used as a platform for electronic invoicing. Similarly under the condition that more electronic payments will be promoted in SEPA, Kemppainen (2008) and Schaefer (2008) state that SEPA is overall beneficial. Schmiedel (2007) concludes that banks within SEPA may significantly reduce their payment costs, but will face increased competition putting downward pressure on prices and revenues. Further empirical evidence by Bolt and Humphrey (2007) supports the view that harmonization and

[4] See Bolt and Chakravorti (2008b) for a recent survey of the economic literature on payment cards.

standardization of retail payments payment instruments across the euro area are likely to result in economies of scale in providing payment services in Europe. Similar economies of scale effects are to be realized in the European payment processing industry and that significant cost efficiency gains can be expected from continued consolidation across borders (Beijnen and Bolt, 2009).

Our analysis draws upon a model by Bolt and Chakravorti (2008a). They study the ability of banks and merchants to influence the consumer's payment instrument choice when they have access to three payment forms—cash, debit card, and credit card. Their analysis combines elements of "two-sided" models that stress price structure with those that consider consumers' liquidity constraints and security concerns. In addition, they consider how banks set prices when they participate in multiple payment networks ("payment substitution"). Our paper differs in the sense that compatibility issues, avoided cost of cash, economies of scale and competition between card networks are explicitly modeled and analyzed. These elements are important to assess the welfare implications of creating SEPA. To our knowledge, this has not yet been done in the literature. This paper attempts to start filling this gap.

4 A Model of SEPA and Payment Cards

The model consider two countries, A and B. In country A (a "debit card" country), consumers may use cash or debit cards to pay for their purchases. In contrast, in country B (a "credit card" country) consumers may only use cash and credit cards. In both countries, there are three types of agents—consumers, merchants, and a monopolist card network.[5] All agents are risk neutral. There is a (mass one) continuum of (ex ante identical) consumers and a (mass one) continuum of merchants that have (some) market power. Merchants in each country are differentiated by the type of good they sell and the profit margin they realize when serving each customer. Countries A and B are of equal size, N.

We assume that consumers in each country are willing to buy one unit of good from the merchant that they are matched to. A consumer receives utility $v_0 = v - p$ from purchasing the good at price p, where $v_0 \geq 0$. At the break of day consumers have no available funds,

[5] In our model, we have combined the issuer and acquirer into one entity so as to abstract from the interchange fee decision between issuers and acquirers. A four-party network is mathematically equivalent to a three-party network when issuing or acquiring is perfectly competitive. In that case, the optimal interchange fee is directly derived from the optimal consumer and merchant fee (e.g. Bolt, 2006).

so that they need additional income to shop. Consumers are subject to three shocks. First, income arrives in the morning with probability ϕ_1, or at night with probability ϕ_2, where $\phi_1 + \phi_2 \leq 1$. Second, before shopping, each consumer is randomly matched to a merchant selling a unique good. With probability β the consumer is matched to a domestic merchant, with probability $1 - \beta$ to a foreign merchant. Third, a cash-carrying consumer may be mugged in transit to the merchant with probability $1-\rho$, resulting in complete loss of income and utility. These probabilities $(\phi_1, \phi_2, \beta, \rho)$ are given exogenously, and for convenience assumed equal across both countries.[6] Consumers maximize expected (linear) utility and they only have positive utility when consuming goods sold by the merchant they are matched to. Consumption can only occur during the day, income that remains after fixed fees have been deducted renders no utility.

Merchant heterogeneity is based on the type of good that they sell and their profit margin. Each merchant i realizes a unique exogenously given profit margin $\pi^j(i)$, $j = A, B$. We assume that merchant profit margins on a sold unit of good are uniformly distributed on a line segment from 0 to p. That is, although each merchant sells its good at unit price p, merchants have different profit margins due to different underlying production costs. We make this assumption to capture merchant pricing power heterogeneity in the economy in a tractable model. Extraction of consumer surplus through merchant pricing is measured by v_0. Local monopolists will not leave any consumer surplus and set $v = p$, so that $v_0 = 0$. More competitive market structures are characterized by $v_0 > 0$. Without loss of generality we normalize $p = 1$. When accepting a card payment, the merchant avoids a (per-transaction) cash handling cost h (assumed equal in both countries), but incurs a per-transaction fee (or so-called merchant discount) f^j, $j = A, B$, charged by the card network.

It is throughout assumed that cash services in each country are supplied (by a central bank) at zero cost and that access to cash is without charges for consumers. Besides cash, the monopolist card network provides additional payment services. Debit cards offer consumers protection against theft whereas credit cards hedge against both theft and (temporary) insufficient income. The supply of card services by each card network increases the states of

[6] The Financial Times (FT, July 1, 2009) recently reported that losses on US credit cards hit a record of more than 10 percent in June, 2009. In our model this would translate to $\phi_1 + \phi_2 = 0.9$. If none of the losses would ever be recovered on these loans, we may set $\phi_2 = 0$. With respect to safety, based on Italian crime statistics, Alvarez and Lippi (2007) estimate the probability of cash theft around 2 percent in Italy in 2004, implying $\rho = 0.98$ in our model.

Table 2: Variables in the Model

Exogenous variables:	
v_0	utility for consumer
ϕ_1	probability of receiving income early
ϕ_2	probability of receiving income late
β	probability of being matched to domestic merchant
ρ	probability of safe transit when carrying cash
h	per-transaction merchant handling cost of cash
π^j	merchant-specific profit margin, $j = A, B$
p	price for retail good (normalized to $p = 1$)
c^j	per-transaction card processing cost, $j = A, B$
N	country size
Endogenous variables:	
α^j	proportion of domestic merchants accepting cards, $j = A, B$
F^j	fixed consumer fee for having a card, $j = A, B$
f^j	per-transaction merchant fee for a card payment, $j = A, B$

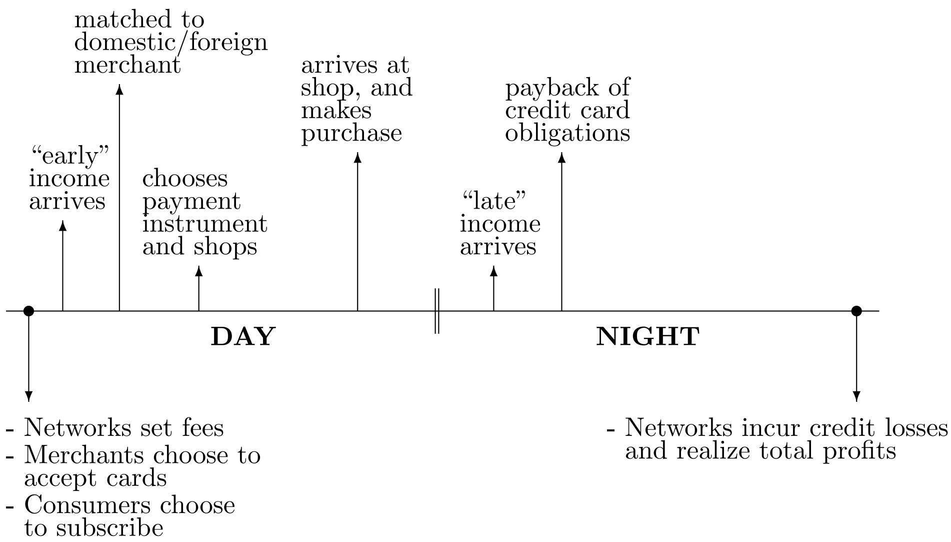
the world where consumption occurs. The card network incurs a processing cost $c^j \geq 0$, $j = A, B$, where we assume $c^A \leq c^B$ per card transaction. That is, we assume that credit card processing takes more resources than debit card processing due to increased monitoring and screening activities by the network. Credit cards also carry more default risk than debit cards—modeled through the probability of late income arrival ϕ_2, with $0 \leq \varphi_2 \leq 1 - \varphi_1$.

For convenience, we assume that the card network can only charge non-negative payment fees to consumers and merchants.[7] Each card network charges consumers membership fees to use payment cards, $F^j \geq 0$, $j = A, B$, and sets merchant per-transaction fees, $f^j \geq 0$, $j = A, B$, for card transactions.[8] Consumers that choose to participate in a card network sign fully enforceable contracts stipulating that fixed fees are automatically transferred when income arrives. For convenience, we consider one merchant fee for all merchants, although, in reality, different merchants face different fees for payment services. In line with pay-

[7]Our model is able to consider negative fees in a straightforward way. However, allowing negative fees makes the analysis more complex without gaining additional insight. Note, that negative merchant fees do not increase merchant acceptance any further, so that network profit will only decrease for larger negative fees under the no-surcharge rule. Therefore, allowing negative fees will not affect optimal pricing, see also Bolt and Chakravorti (2008a).

[8]This fee structure captures what we observe in many countries. Generally, consumers do not pay per-transaction fees when using their payment cards, but merchants generally do pay the bulk of their payment service fees on a per-transaction basis. In addition, banks can use a strategy to price cash as well. We ignore this aspect primarily because of the complexity of solving a model with six different prices for payment services. However, banks generally do not charge for cash withdrawals from their own automated teller machines in advanced economies.

Figure 3: Timing of events



ment industry common practices, we assume that merchants are prohibited from surcharging consumers who pay by card (the so-called No Surcharge Rule).

For reference, we list the exogenous and endogenous variables that appear in our model in table 2. The timing of events is depicted in figure 3. In the early morning, card networks post their fees for payment services, merchants announce their acceptance of card services, and consumers choose whether to subscribe to the card network. Next, some consumers realize their income and are matched with a specific merchant—domestic or foreign. Consumers decide which payment instrument to use before leaving home based on merchant acceptance. During the day, consumers go shopping. At night, consumers that did not receive income in the morning may receive income and pay back their (potential) card obligations.

5 Pre-SEPA phase: Incompatibility

The pre-SEPA phase is characterized by an incompatibility friction. We assume that payment card systems are not compatible across countries A and B. That is, debit cards issued in country A cannot be used for payment in country B, and vice versa, credit cards issued in country B cannot be used in country A. Therefore, foreign purchases (that occur with probability $1-\beta$ for each consumer) must be paid by cash, and hence require sufficient funds and are subject to theft.

5.1 Country A: debit card pricing

Country A is a debit card country. When compared to cash, debit cards are more secure for consumers to carry than cash because cash-carrying consumers have some probability of being mugged. We endogenously determine the proportion of merchants in country A that accepts debit cards and denote it as α^A. Because debit cards may not be accepted by all merchants, consumers must use cash for some purchases. Moreover, foreign purchases must be paid for in cash. Consumers can consume in an additional $\beta\alpha^A(1-\rho)$ states of nature.

Consumers are willing to participate in a debit card network if the fixed fee, F^A, is less than or equal to the expected utility from additional consumption. On the one hand, shopping with cash requires income in the morning and runs the risk of getting mugged. On the other hand, shopping with debit cards guarantees safe transit to the merchant who accepts the card, but still requires early income. The fixed fee for subscribing to the card network must balance these opposing effects. In other words, the following inequality must be satisfied:

$$\phi_1 \rho v_0 \leq \phi_1((1-\beta\alpha^A)\rho + \beta\alpha^A)v_0 - (\phi_1+\phi_2)F^A. \tag{1}$$

This inequality yields the maximum debit card fee, F^A_{max}, that consumers are willing to pay as a function of exogenous parameters, ρ, ϕ_1, ϕ_2, β, and v_0, and endogenous parameter, α^A. Note that income may never arrive at all, so that the fixed fee cannot be paid and the network bears the full cost of issuing the debit card. Given that consumers must commit to the membership fee before being matched to a merchant, all consumers purchasing from stores that accept debit cards will always use their debit cards and leave home without cash, because they face a positive probability of being mugged when carrying cash.

Merchants must make at least as much profit from accepting debit cards than only accepting cash. Per domestic customer (expected) profits for merchant i in country A when accepting cash, $Z^A_{cash}(i)$, are:

$$Z^A_{cash}(i) = \phi_1\beta\rho(\pi^A(i) - h),$$

and when accepting domestic debit cards, $Z_d^A(i)$:

$$Z_d^A(i) = \phi_1 \beta \left(\pi^A(i) - f^A\right).$$

Note that by accepting debit cards merchants attract additional sales because of safe transit of domestic consumers. Merchants accept debit cards only when $Z_{cash}^A(i) \le Z_d^A(i)$.[9] This inequality yields a threshold profit margin $\bar{\pi}^A$, above which merchants accept debit cards for payment. Hence, the proportion of merchants in country A willing to accept debit cards is:

$$\alpha_{opt}^A(f^A) = Pr[\pi^A(i) \ge \bar{\pi}^A] = 1 - \bar{\pi}^A = 1 - \frac{f^A - \rho h}{1 - \rho}. \tag{2}$$

We observe that $\alpha_{opt}^A \in [0,1]$ if and only if $f^A \in [\rho h, 1 - \rho(1-h)]$. The decision to accept domestic debit cards is independent from foreign sales, since card acceptance does not change revenues from a foreigner who must pay in cash.

Lemma 1 *The maximum debit card fixed fee,* F_{max}^A*, is:*[10]

$$F_{max}^A(f^A) = \frac{\beta\left(1 - f^A - \rho(1-h)\right)}{\phi_1 + \phi_2} v_0. \tag{3}$$

Equation (3) expresses the highest fixed fee, F_{max}^A, as a proportion of v_0, that consumers are willing to pay for holding a debit card. The consumer fixed fee internalizes the network effect that consumers are willing to pay more for the card when merchant acceptance increases. When $f^A = \rho h$, debit card acceptance is complete, $\alpha^A = 1$, and therefore F_{max}^A is set at its highest level, $F_{max}^A = \beta(1-\rho)/(\phi_1 + \phi_2)v_0$. In contrast, when $f^A = 1 - \rho(1-h)$, acceptance is zero, $\alpha^A = 0$, and the fixed fee must also be zero, $F_{max}^A = 0$. Furthermore, when foreign sales are relatively common, the value of holding a card diminishes, since cross-border payments need to be effected in cash, i.e. $F_{max}^A \to 0$ as $\beta \to 0$. Debit cards also lose their value to consumers when merchants have full pricing power and completely extract consumer surplus. That is, if $v_0 = 0$, then $F_{max}^A = 0$.

Now, we solve the card networks's profit maximization problem for the consumer and

[9] Our model does not capture business stealing incentives as a driver for card acceptance. See Rochet and Tirole (2003) and Wright (2004).

[10] All proofs of lemmas and propositions are in the appendix. We used Mathematica 7.0 for algebraic calculations, these are available upon request.

merchant fees. The network maximizes its expected per-consumer profit:

$$\Pi_N^A(F^A, f^A, \alpha^A) = \phi_1\beta\alpha^A(f^A - c^A) + (\phi_1 + \phi_2)F^A,$$
$$\text{subject to:} \quad F^A = F^A_{max}(f^A), \quad \alpha^A = \alpha^A_{opt}(f^A).$$

Proposition 1 *The debit card merchant fee f_A^* that maximizes the debit card network's profit is given by:*

$$f_A^* = \frac{1}{2}(c^A + 1 - \rho(1-h)) - \frac{1}{2}(1-\rho)v_0. \tag{4}$$

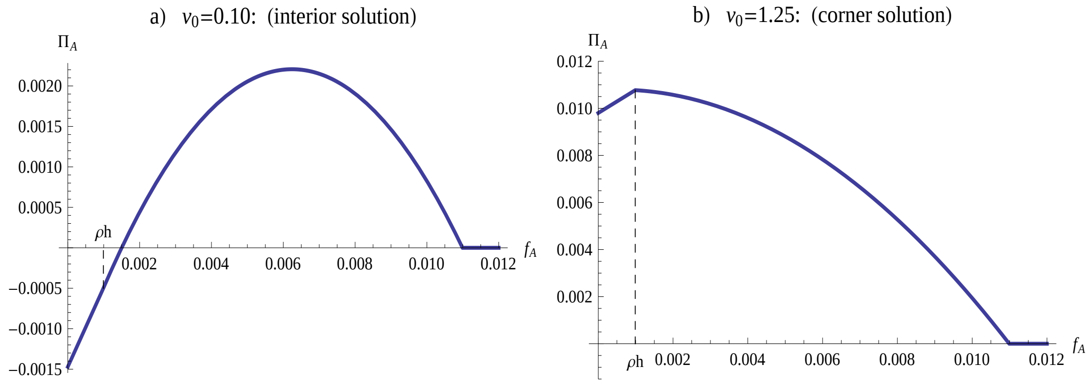
The optimal debit card fee f_A^* results in an optimal merchant acceptance, $\alpha_A^* = \alpha^A_{opt}(f_A^*)$, and an optimal consumer's fixed debit card fee, $F_A^* = F^A_{\max}(f_A^*)$. When the processing cost, c^A, and cash handling cost, h, increases, the optimal merchant fee, f_A^*, increases. An increase in the safety probability, ρ, generally decreases the merchant fee, since safer transit reduces the need for debit cards yielding lower merchant fees. Observe that optimal merchant fees do not depend on foreign sales (through β), since domestic card acceptance does not change revenues from foreign sales.

The card network tries to capture merchant and consumer surplus through appropriate pricing of both sides. When merchant extraction of consumer surplus is low, the card network will try to capture the remaining consumer surplus by setting low merchant fees, thereby increasing acceptance which allows higher consumer fixed fees. In particular, if $v_0 \geq \overline{v}_d = 1 + h - (h - c^A)/(1-\rho)$, the card network's pricing problem is characterized by a corner solution with $f_A^* = \rho h$ and $\alpha^A_{opt}(\rho h) = 1$. Strong pricing power by merchants leaves little room to extract from consumers by the card network, and hence fixed fees will be lower and merchant fees higher. Hence, the degree of merchant pricing power shifts the balance of payment fees. When $v_0 < \overline{v}_d$, proposition 1 characterizes an interior solution with incomplete acceptance. Figure 4 illustrates these two possible cases.

5.2 Country B: credit card pricing

Country B is a credit card country. Compared to debit cards, credit cards do not only protect against theft but they also offer an insurance against insufficient funds before shopping. Consumers benefit from additional consumption possibilities, and also merchants benefit from making sales to those consumers without funds in the morning. However, running a

Figure 4: Merchant pricing power and debit card profit



Note: In left panel, interior solution $v_0 < \bar{v}_d$ with $f_A^* > \rho h$ and $\alpha_A^* < 1$; in right panel, corner solution $v_0 \geq \bar{v}_d$ with $f_A^* = \rho h$ and $\alpha_A^* = 1$. Chosen parameter values: $c^A = 0.0025$, $\rho = 0.99$, $\phi_1 = 0.99$, $\phi_2 = 0.005$, $h = 0.001$, $\beta = 0.99$, and $N = 1$. These values yield: $\bar{v}_d = 1.15$.

credit card system is more costly than a debit card system due to higher default risk and higher processing costs (including monitoring and screening activities).[11] We endogenously determine the proportion of merchants in country B that accepts credit cards and denote it as α^B. Because credit cards may not be accepted by all merchants, consumers must use cash for some purchases, including foreign sales. Consumers can consume in an additional $\beta\alpha^B(1-\rho)+ \beta\alpha^B(1-\phi_1)$ states of nature.

Consumers are willing to hold a credit card if the fixed fee F^B, is less than or equal to the expected utility from additional consumption. Their participation constraint is:

$$\phi_1 \rho v_0 \leq (\phi_1(1-\beta\alpha^B)\rho + \beta\alpha^B)v_0 - (\phi_1+\phi_2)F^B. \tag{5}$$

Solving (as an equality) yields the maximum debit card fee, F^B_{max}, that consumers are willing to pay as a function of exogenous parameters, ρ, ϕ_1, ϕ_2, β, and v_0, and endogenous parameter, α^B.

Merchants must make at least as much profit from accepting credit cards than only accepting cash. Per domestic customer (expected) profit for merchant i in country B when

[11] In our model, default risk is assumed exogenous and fully taken by banks. Although banks price default risk in their merchant fees, this set-up may generate moral hazard on the side of banks. This issue is not further pursued here.

accepting cash, $Z^B_{cash}(i)$, is:

$$Z^B_{cash}(i) = \phi_1 \beta \rho (\pi^B(i) - h).$$

Per domestic customer (expected) profit for merchant i in country B from accepting credit cards, $Z^B_c(i)$, is:

$$Z^B_c(i) = \beta \left(\pi^B(i) - f^B \right).$$

Merchants accept credit cards only when $Z^B_{cash}(i) \leq Z^B_c(i)$. This inequality yields a threshold profit margin $\bar{\pi}^B$, above which merchants accept credit cards for payment. Hence, the proportion of merchants in country B willing to accept credit cards is:

$$\alpha^B_{opt}(f^B) = Pr[\pi^B(i) \geq \bar{\pi}^B] = 1 - \bar{\pi}^B = 1 - \frac{f^B - \rho\phi_1 h}{1 - \rho\phi_1}. \tag{6}$$

Note that $\alpha^B_{opt} \in [0, 1]$ if and only if $f^B \in [\rho\phi_1 h, 1 - \rho\phi_1(1 - h)]$, and that the decision to accept domestic credit cards is not influenced by the proportion of domestic vs. foreign sales, β.

Lemma 2 *The maximum credit card fixed fee, F^B_{max}, is:*

$$F^B_{max}(f^B) = \frac{\beta \left(1 - f^B - \rho\phi_1(1 - h)\right)}{\phi_1 + \phi_2} v_0. \tag{7}$$

Equation (7) expresses the highest fixed fee, F^B_{max}, that consumers are willing to pay given the probability of safe transit, ρ, the probabilities of receiving income, ϕ_1 and ϕ_2, the handling cost of cash, h, and the merchant fee, f^B. Merchant acceptance of credit cards is higher when f^B is lower, which increases the consumer willingness to pay higher fixed fees. Domestic credit cards offer no value added when consumers are never matched to domestic merchants, or when merchants have already extracted all consumer surplus by setting high prices $p = v$. Hence, when $\beta = 0$ or $v_0 = 0$, credit cards must be zero priced for consumers.

Now, we solve the card networks's profit maximization problem for the consumer and merchant fees. The network maximizes its expected per-consumer profit:

$$\Pi^B_N(F^B, f^B, \alpha^B) = \beta\alpha^B(f^B - c^B) + (\phi_1 + \phi_2)F^B - (1 - \phi_1 - \phi_2)\beta\alpha^B.$$

$$\text{subject to:} \quad F^B = F^B_{max}(f^B), \quad \alpha^B = \alpha^B_{opt}(f^B).$$

Proposition 2 *The credit card merchant fee f_B^* that maximizes the credit card network's profit is given by:*

$$f_B^* = \frac{1}{2}(c^B + 1 - \rho\phi_1(1-h)) + \frac{1}{2}(1 - \phi_1 - \phi_2) - \frac{1}{2}(1-\rho\phi_1)v_0. \tag{8}$$

Proposition 2 characterizes an interior solution (with incomplete merchant acceptance) if $v_0 \in [0, \overline{v}_c)$, with $\overline{v}_c = 1 + h - (h - c^B + (1 - \phi_1 - \phi_2))/(1 - \rho\phi_1)$. For $v_0 \geq \overline{v}_c$, a corner solution determines the pricing problem yielding $f_B^* = \rho\phi_1 h$ and $\alpha_{opt}^B(\rho\phi_1 h) = 1$.

5.3 Price and welfare comparison

Compared to profit-maximizing debit card merchant fees, optimal credit card merchant fees take into account additional default risk (through $1 - \phi_1 - \phi_2$) and income insurance (through ϕ_1). Given their profit margins, merchants need to trade off these additional benefits of credit cards against higher fees. Consumers are equally well off, their remaining surplus is completely extracted by both card networks in both countries. Table 3 indicates that, grosso modo, debit cards are cheaper than credit cards for merchants. This price differential relative to the probability of early income determines whether card acceptance is higher in country A or in country B. In the high cost case, due of low turnover, the credit card network of country B makes less profit than the debit card network of country A. Further, an increase in merchant pricing power (lower v_0) is accompanied by higher merchant fees. That is, diminished opportunities to extract from consumers forces card networks to set higher merchant fees, which dampens card acceptance. Higher merchant pricing shifts the balance of prices from consumers towards merchants. This is illustrated in the table by lower price ratios F_{max}^*/f^* when v_0 decreases.

The welfare consequences of a cash-only economy are potentially severe. Consumers cannot consume if they are mugged on the way to the merchant or if their income arrives at night. Moreover, merchants' cash handling cost may also be considerable. These costs can (partly) be avoided when payment cards are introduced, but their benefits must also be weighed against increased processing cost and default risk.

As a benchmark, in a cash-only environment, the expected consumption of a consumer is $\phi_1\rho v_0$ and the average merchant profit is $\phi_1\rho(1/2 - h)$. Card networks make no profit in a

Table 3: Price comparison between country A and B

	Country A (debit card)				Country B (credit card)			
	$v_0 = 0$		$v_0 = 0.10$		$v_0 = 0$		$v_0 = 0.10$	
	$c^A = 0$	$c^A = c^A_H$	$c^A = 0$	$c^A = c^A_H$	$c^B = 0$	$c^B = c^B_H$	$c^B = 0$	$c^B = c^B_H$
f^*	0.0055	0.0067	0.0050	0.0062	0.0129	0.0167	0.0119	0.0157
$F_{max}(f^*)$	0.0000	0.0000	0.0006	0.0005	0.0000	0.0000	0.0009	0.0005
$\alpha_{opt}(f^*)$	0.5495	0.4245	0.5995	0.4745	0.3990	0.2106	0.4490	0.2606
F^*_{max}/f^*	0.0000	0.0000	0.1182	0.0748	0.0000	0.0000	0.0744	0.0329
$\Pi(f^*)$	0.0030	0.0018	0.0035	0.0022	0.0031	0.0009	0.0040	0.0013
$W(f^*)$	0.4908	0.4896	0.5894	0.5880	0.4918	0.4893	0.5908	0.5878

Note: We set: $c^A_H = 0.0025$ and $c^B_H = 0.0075$. Other parameter values set to $h = 0.001$, $\rho = 0.99$, $\phi_1 = 0.99$, $\phi_2 = 0.005$, $\beta = 0.99$, $v_0 = 0.10$, and $N = 1$.

cash only economy. Total welfare in a cash-only economy is thus given by

$$W_{cash} = \phi_1 \rho (v_0 + 1/2 - h). \tag{9}$$

Expected total welfare of debit card usage in country A is derived by summing up expected consumer utility,

$$W^A_C = \phi_1((1 - \beta\alpha^A)\rho + \beta\alpha^A)v_0 - (\phi_1 + \phi_2)F^A,$$

expected merchant profits,

$$W^A_M = \phi_1 \left((1 - \beta\alpha^A)\rho \left(\frac{1 - \alpha^A}{2} - h \right) + \beta\alpha^A \left(\frac{2 - \alpha^A}{2} - f^A \right) \right),$$

and expected card network profits,

$$W^A_N = \phi_1 \beta\alpha^A (f^A - c^A) + (\phi_1 + \phi_2)F^A.$$

That is, in the debit card environment of country A total welfare is given by:

$$W^A(f^A, \alpha^A) = W^A_C + W^A_M + W^A_N. \tag{10}$$

Observe that in our model the fixed fee is a pure transfer from the consumer to the card network, and hence drops out in the social welfare calculation. If the social planner in country A is able to only set merchant fees, it should maximize total welfare W^A under the merchant's participation constraint $\alpha^A_{opt}(f^A) = 1 - (f^A - \rho h)/(1-\rho)$.

For country B we follow a similar analysis. We calculate:

$$W^B(f^B, \alpha^B) = W^B_C + W^B_M + W^B_N, \tag{11}$$

where

$$W^B_C = (\phi_1(1-\beta\alpha^B)\rho + \beta\alpha^B)v_0 - (\phi_1+\phi_2)F^B,$$

$$W^B_M = \phi_1(1-\beta\alpha^B)\rho\left(\frac{1-\alpha^B}{2} - h\right) + \beta\alpha^B\left(\frac{2-\alpha^B}{2} - f^B\right),$$

$$W^B_N = \beta\alpha^B(f^B - c^B) + (\phi_1+\phi_2)F^B - (1-\phi_1-\phi_2)\beta\alpha^B.$$

Country B's social planner should maximize total welfare W^B subject to the merchant's participation constraint $\alpha^B_{opt}(f^B) = 1 - (f^A - \rho\phi_1 h)/(1-\rho\phi_1)$.

Proposition 3 *The debit card and credit card merchant fees f_A^{SW} and f_B^{SW} that maximize social welfare in country A and B are given by:*

$$f_A^{SW} = c^A + \frac{(1-\beta)\rho}{2\beta} - (1-\rho)v_0, \quad and \tag{12}$$

$$f_B^{SW} = c^B + \frac{(1-\beta)\rho\phi_1}{2\beta} + (1-\phi_1-\phi_2) - (1-\rho\phi_1)v_0. \tag{13}$$

We observe that socially optimal merchant fees are partly cost-based. Both debit card and credit card merchant fees incorporate processing cost, "incompatibility" cost (as measured by $(1-\beta)/2\beta$), and potential default risk. Consumer surplus extraction by card networks lowers the merchant fees so as to increase card acceptance. With full pricing power by merchants ($v_0 = 0$), the card network cannot charge consumers at all (zero fixed fees) and merchants bear the full cost of card usage. In this latter case, two-sidedness of the market disappears and socially optimal merchant fees become "fully" cost-based.

While profit-maximizing card networks do not take the cost of cross-border payments into account in their pricing behavior (see (4) and (8)), the social planner recognizes the diminishing card value to both consumers and merchants when the event of being matched to a foreign merchant—a sale that requires cash—becomes more likely. Card usage becomes relatively expensive and translates into higher merchant fees. Depending on processing cost,

Table 4: Price and welfare comparison between country A and B

	cash	Country A (debit card) monopoly	Country A (debit card) max welfare	Country B (credit card) monopoly	Country B (credit card) max welfare
f^*		0.0062	0.0065	0.0157	0.0155
$F_{max}(f^*)$		0.0005	0.0000	0.0005	0.0000
$\alpha_{opt}(f^*)$		0.4745	0.4490	0.2606	0.2724
F^*_{max}/f^*		0.0748	0.0000	0.0329	0.0000
$\Pi(f^*)$	0.0000	0.0022	0.0018	0.0013	0.0008
$W(f^*)$	0.5871	0.5880	0.5881	0.5878	0.5878

Note: Other parameter values set to $h = 0.001$, $c^A = 0.0025$, $c^B = 0.0075$, $\rho = 0.99$, $\phi_1 = 0.99$, $\phi_2 = 0.005$, $\beta = 0.99$, $v_0 = 0.10$, and $N = 1$.

handling cost of cash, potential default risk, and the likelihood of cross-border payments, socially optimal merchant fees may turn out to be higher than profit-maximizing merchant fees, dampening socially optimal card usage. Moreover, while the handling cost of cash does not affect the socially optimal merchant fee, it does so through merchant acceptance. Lower handling cost of cash decreases merchant acceptance but not the merchant fee—all else being equal.

Table 4 illustrates some of these findings. The table shows that the socially optimal merchant fee is higher than the profit-maximizing one in country A. This suggests that debit cards are overused in country A. Note that social welfare is neutral with respect to the consumer fixed fee. The social planner's choice is effectively bounded by the consumer's participation constraint $F^A_{max}(f^{SW}_A)$. Setting zero fixed fees results in lowest profit for the card network. As shown in the table, the reverse finding is true for country B, where the socially optimal merchant fee is lower than the profit-maximizing one. Debit card usage in country A generates higher social welfare than credit card usage in country B. Higher processing cost and default risk make credit card usage less attractive from a social point of view. Both card systems improve on cash-only. Avoiding getting mugged and temporary insufficient funds renders adequate social return.

6 Market outcomes of SEPA

The creation of SEPA can be associated with different market outcomes. When all payments are treated as domestic—without national fragmentations—it is likely that strong scale effects spur substantial consolidation of payment networks and payment infrastructures across countries, so that ultimately only a few card networks survive. We study three different scenario's. First, we analyze be a monopolistic credit card network for the complete area A and B with $2N$ consumers. Second, we study a competitive duopolistic situation where a credit card and debit card networks compete for business in a (heterogeneous) Bertrand fashion. Third, we analyze the case of two competitive debit card networks. In a SEPA environment all payment cards are compatible so that the need to carry cash when matched to a foreign merchant disappears. Hence, less payments are potentially lost through theft. Moreover, scale effects dampen processing cost, which makes running a large card system more cost efficient.

6.1 Compatible monopolistic credit card network

The pricing problem where only one credit card network operates in the entire region of size $2N$ is very similar to credit card pricing in country B in the pre-SEPA phase. The only difference is that the probability of being matched to a foreign merchant, $1-\beta$, becomes irrelevant, since all cards have become compatible. All else being equal, this implies that the optimal consumer fixed fee changes but not the optimal merchant fee. We further assume that due to positive scale effects, the SEPA processing cost of a credit card payment, c_c, is lower than in the pre-SEPA phase (but not lower than a debit card payment), that is, we assume $c^A \leq c_c < c^B$.

Based on previous analysis, we retrieve:

Proposition 4 *Under SEPA, the monopolist credit card network charges a merchant fee*

$$f_M^* = \frac{1}{2}(c_c + 1 - \rho\phi_1(1-h)) + \frac{1}{2}(1-\phi_1-\phi_2) - \frac{1}{2}(1-\rho\phi_1)v_0. \tag{14}$$

The socially optimal merchant fee induces an optimal card acceptance $\alpha_M^{opt}(f_M^*)$ and results in a fixed fee $F_M^{\max}(f^*)$. With lower processing cost and no foreign card incompatibility, it is obvious that SEPA implies lower optimal merchant fees and greater card acceptance in country B. Merchants in country A might be facing higher payment fees which must be traded off against (expected) additional sales by accepting credit cards (instead of debit cards in the pre-SEPA phase). Consumers are indifferent, their surplus is always completely extracted by paying maximum fixed fees in every state of the world.

6.2 Competition between a credit card and a debit card network

Although positive scale effects makes card payments more efficient relative to cash, monopolistic pricing potentially reduces the pass through of these benefits to consumers and merchants. Consumers and merchants are likely to benefit the most from the creation of SEPA when sufficient competition in the card payments market alleviates potential monopolistic tendencies.

We analyze the case where a debit card and a credit card network compete for business to maximize their profits. We critically assume here that consumers fully "multihome" in the sense that they subscribe to both networks and holding both cards (or alternatively an integrated one with both a debit and a credit functionality), but that merchants "singlehome" in the sense that they only accept one card—debit or credit.[12] Only merchants with high profit margins accept credit cards, intermediate merchants accept debit cards, and low-end merchants only accept cash.

The credit card network charges f_c to merchants and F_c to consumers, and the debit card network charges f_d and F_d. We assume that $c_d \leq c_c$, suggesting that a debit card network is cheaper to operate than a credit card network.

Consumers are willing to hold both cards when:

$$\phi_1 \rho v_0 \leq (\phi_1((1-\alpha)\rho + \alpha) + (1-\phi_1)\alpha_c)v_0 - (\phi_1 + \phi_2)F_T, \tag{15}$$

where F_T denotes the total fixed fee that consumers are willing to pay for holding both cards, α denotes the proportion of merchants that accept either a debit card or a credit card, and α_c the proportion that only accept credit cards. Debit card acceptance follows from $\alpha - \alpha_c$.

The thresholds between cash versus debit, $\bar{\pi}_d$, and between debit versus credit, $\bar{\pi}_{dc}$, are given by

$$\bar{\pi}_d(f_d) = \frac{f_d - \rho h}{1-\rho} \quad \text{and} \quad \bar{\pi}_{dc}(f_d, f_c) = \frac{f_c - \phi_1 f_d}{1-\phi_1}. \tag{16}$$

[12] In payments, multihoming on both the consumer and merchant side is often observed. However, this case is very difficult to analyze without imposing further restrictions on users' behavior, see e.g. Armstrong (2006), Bolt and Soramäki (2008), Chakravorti and Roson (2006), and Guthrie and Wright (2007).

This implies acceptances $\alpha^{opt}(f_d) = 1 - \bar{\pi}_d(f_d)$ and $\alpha_c^{opt}(f_d, f_c) = 1 - \bar{\pi}_{dc}(f_d, f_c)$.[13]

Given these acceptance criterions we can solve for the maximum total fixed fee that the consumer is willing to pay for holding both cards.

Lemma 3 *The maximum total card fee, $F_T^{\max}$, that consumers are willing to pay for both cards, is:*

$$F_T^{\max}(f_d, f_c) = \frac{1 - f_c - \rho\phi_1(1-h)}{\phi_1 + \phi_2} v_0. \tag{17}$$

The total fee that a consumer is willing to pay does not depend on the debit card merchant fee. Debit cards and credit cards are effectively the same instruments when income arrives in the morning, only when income is late holding a credit card allows consumption. Given the acceptances of debit and credit cards, we can also calculate the individual contributions to the total fee. That is $F_T^{\max}(f_d, f_c) = F_d^{\max}(f_d, f_c) + F_c^{\max}(f_d, f_c)$. These individual contributions will depend on both f_d and f_c. We verify:

$$F_c^{\max}(f_d, f_c) = \frac{(1 - f_c - \phi_1(1 - f_d))(1 - \rho\phi_1)}{(1-\phi_1)(\phi_1 + \phi_2)} v_0, \text{ and}$$

$$F_d^{\max}(f_d, f_c) = \frac{\phi_1((1-\rho)f_c - (1-\rho\phi_1)f_d + (1-\phi_1)\rho h)}{(1-\phi_1)(\phi_1 + \phi_2)} v_0.$$

The credit card network tries to maximize:

$$\Pi_c(F_c, f_c, \alpha_c) = \alpha_c(f_c - c_c) + (\phi_1 + \phi_2)F_c - (1 - \phi_1 - \phi_2)\alpha_c$$
$$\text{subject to:} \quad F_c = F_c^{\max}(f_d, f_c), \quad \alpha_c = \alpha_c^{opt}(f_d, f_c),$$

while the debit card network maximizes:

$$\Pi_d(F_d, f_d, \alpha_d) = \phi_1\alpha_d(f_d - c_d) + (\phi_1 + \phi_2)F_d$$
$$\text{subject to:} \quad F_d = F_d^{\max}(f_d, f_c), \quad \alpha_d = \alpha^{opt}(f_d) - \alpha_c^{opt}(f_d, f_c).$$

Solving first-order conditions for f_c and f_c gives reaction functions

$$f_c^R(f_d) = \frac{1}{2}(c_c + 1 - \phi_1(1 - f_d)) + \frac{1}{2}(1 - \phi_1 - \phi_2) - \frac{1}{2}(1 - \rho\phi_1)v_0, \quad \text{and} \tag{18}$$

[13]Note that we must check in equilibrium that debit card usage is larger than credit card usage otherwise they would not co-exist.

$$f_d^R(f_c) = \frac{1}{2}\left(\frac{(1-\rho\phi_1)c_d + (1-\phi_1)\rho h + (1-\rho)f_c}{(1-\rho\phi_1)}\right) - \frac{1}{2}(1-\rho\phi_1)v_0, \tag{19}$$

which then yield unique equilibrium merchant fees (f_c^*, f_d^*) (see appendix).

Proposition 5 *Under SEPA, heterogeneous competition between a debit card and credit card network yields merchant fees* (f_c^*, f_d^*)*, acceptances* $\alpha_d^* = \alpha^{opt}(f_d^*) - \alpha_c^{opt}(f_d^*, f_c^*)$ *and* $\alpha_c^* = \alpha_c^{opt}(f_d^*, f_c^*)$*, and a total fixed fee* $F_T^{\max}(f_d^*, f_c^*)$*.*

6.3 Competition between two debit card networks

Another possible SEPA scenario might involve two (identical) debit card networks competing for the enlarged payment market with compatibility across borders. Obviously, if they could tacitly collude, they would split the market among themselves, setting monopoly merchant fees, equally dividing total consumer fixed fees, thereby evenly sharing monopoly profits. Naturally, this is not a stable outcome, the threat of undercutting is a credible disruptive force.

Suppose an initial situation with identical merchant fees so that the merchant side of the market is equally divided among the two networks. Undercutting on the merchant fee by one of the networks will attract all the debit card accepting merchants, leaving zero transaction volume to the opposing network. This will trigger a "Bertrand" sequence of undercuts until debit card profits are zero. This determines the equilibrium merchant fee and corresponding total consumer fixed fee. Note that we assume here that consumers hold both debit cards, but that merchants only accept one—the least expensive.[14]

Assume that both debit card networks incur equal processing cost, c_d. They charge merchant fees, f_d^i, $i = 1, 2$. Consumers are willing to pay a total fixed fee F_d^{max} for holding both cards. Undercutting merchant fees by the two networks drives profits down to zero. Assuming $f_d^i < f_d^j$, debit card profits are zero when:

$$\Pi_d^i(F_d^{max}, f_d^i, \alpha_d) = \phi_1\alpha_d(f_d^i - c_d) + (\phi_1 + \phi_2)F_d^{max} = 0,$$

$$\text{subject to:} \quad F_d^{max}(f_d^i) = \frac{1 - f_d^i - \rho(1-h)}{\phi_1 + \phi_2}v_0, \quad \alpha_d(f_d^i) = 1 - \frac{f_d - \rho h}{1-\rho}, \quad i = 1, 2.$$

[14]When both sides multihome, the standard undercutting argument does not apply anymore. Undercutting on one side while compensating the other might be a successful price strategy.

Solving for f_d^i yields $f_d^{**} = c_d - (1-\rho)v_0$. Both debit card networks receive $F^{max}(f_d^{**})/2 = v_0\phi_1(1 - c_d + (1-\rho)v_0 - \rho(1-h))/(2(\phi_1+\phi_2))$ in consumer fixed fees, and each network serves half of the market in terms of accepting merchants, $\alpha_d(f_d^{**})/2$.

Proposition 6 *Under SEPA, homogeneous competition between two debit card networks yields merchant fee* $f_d^1 = f_d^2 = f_d^{**} = c_d - (1-\rho)v_0$*, acceptances* $\alpha_d^1 = \alpha_d^2 = \alpha_d(f_d^{**})/2$ *and consumer fixed fees* $F_d^1 = F_d^2 = F_d^{\max}(f_d^{**})/2$*. The merchant fee* f_d^{**} *is socially optimal.*

Note that f_d^{**} is equal to the socially optimal debit card fee as derived in section 5.3, proposition 3, when $\beta = 1$. Hence, in our model, homogeneous Bertrand competition between two debit card networks yields a socially optimal outcome. The social planner is however not concerned with the distribution of surplus among agents. In this competitive case, the networks charge a fixed fee to consumers extracting all their surplus.

6.4 Welfare comparison

Under SEPA, cross-country network incompatibility disappears and economies of scale in processing dampen operating cost. We already showed that homogeneous debit card competition yields socially optimal outcomes. However, under a monopolistic credit card SEPA regime, consumers and merchants may suffer from excessive rent extraction by the monopolistic card network. Socially optimal pricing when only credit cards are issued is qualitatively equal to country B's social welfare pricing problem subject to the restriction of full compatibility, $\beta = 1$. Hence, the socially optimal credit card merchant fee is given by:

$$f_M^{SW} = c_c + (1 - \phi_1 - \phi_2) - (1 - \rho\phi_1)v_0. \tag{20}$$

The socially optimal SEPA merchant fee when only credit cards are issued is smaller than the monopolistic merchant fee (14) when processing costs are sufficiently small.

When both debit cards and credit cards are issued in a SEPA environment (where consumers multihome and merchants singlehome), the social planner must take care that credit cards and debit cards are not over- or underused. Total expected welfare is now given by

$$W_{SEPA}(f_c, f_d, \alpha, \alpha_c) = W_C + W_M + W_N, \tag{21}$$

where

$$W_C = (\phi_1((1-\alpha)\rho + \alpha) + (1-\phi_1)\alpha_c)v_0 - (\phi_1 + \phi_2)F_T,$$

$$W_M = \phi_1(1-\alpha)\rho\left(\frac{1-\alpha}{2} - h\right) + \phi_1(\alpha - \alpha_c)\left(\frac{2-\alpha-\alpha_c}{2} - f_d\right) + \alpha_c\left(\frac{2-\alpha_c}{2} - f_c\right),$$

$$W_N = \phi_1(\alpha - \alpha_c)(f_d - c_d) + \alpha_c(f_c - c_c) + (\phi_1 + \phi_2)F_T - (1 - \phi_1 - \phi_2)\alpha_c.$$

The social planner should maximize W_{SEPA} subject to $\alpha = 1 - (f_d - \rho h)/(1-\rho)$ and $\alpha_c = (f_c - \phi_1 f_d)/(1-\phi_1)$.

Proposition 7 *Under SEPA, when both debit cards and credit cards exist, the merchant fees f_d^{SW} and f_c^{SW} that maximize total social welfare are given by:*

$$f_d^{SW} = c_d - (1-\rho)v_0, \quad \textit{and} \tag{22}$$

$$f_c^{SW} = c_c + (1 - \phi_1 - \phi_2) - (1 - \rho\phi_1)v_0. \tag{23}$$

Observe that the socially optimal SEPA merchant fees (22)-(23) are qualitatively equal to the pre-SEPA merchant fees (12)-(13), except for the cost of incompatibility as measured by β. Naturally, potential economies of scale $c_d \leq c^A$ and $c_c \leq c^B$ will have a dampening effect on merchant fee levels. Note that $v_0 = 0$ induces fully cost-based merchant fees. When extracting from consumers becomes impossible for the social planner, the merchants will bear all the cost of card usage. Without any feedback from merchant acceptance to a higher consumer willingness to pay, the market becomes effectively one-sided, where marginal cost equals marginal revenue in a social optimum (when $v_0 = 0$).

Table 5 compares prices and social welfare across countries during the pre-SEPA phase and under SEPA. The table shows that introducing competition dramatically decreases merchant fees for both debit and credit cards in both competitive scenario's. In our example, total card usage under SEPA increases to around 44+28=72 percent in the debit vs credit case, and even to 95 percent for debit vs debit. In contrast, card acceptance in country A and country B was only down to only 47, respectively, 26 percent in the pre-SEPA phase. Not surprisingly, due to competition, total card network profits are less than before. Under SEPA, as the table shows, debit card acceptance is higher than credit card acceptance when credit cards compete with debit cards, although this result may be reversed when default risk and/or processing cost

Table 5: Price and welfare comparison for pre-SEPA and SEPA

	pre-SEPA phase				SEPA					
	Country A		Country B		credit		debit vs credit		debit vs debit	
	monop	welfare	monop	welfare	monop	welfare	comp	welfare	comp	welfare
f_d	0.0062	0.0065					0.0037	0.0015	0.0015	0.0015
f_c			0.0157	0.0155	0.0144	0.0080	0.0108	0.0080		
F_d	0.0005	0.0000					0.0004	0.0000	0.0009	0.0000
F_c			0.0005	0.0000	0.0006	0.0000	0.0006	0.0000		
α_d	0.4745	0.4490					0.4427	0.6015	0.9490	0.9490
α_c			0.2606	0.2724	0.3234	0.6467	0.2839	0.3475		
s	0.0748	0.0000	0.0329	0.0000	0.0448	0.0000	0.0523	0.0000	0.6295	0.0000
Π	0.0022	0.0018	0.0013	0.0008	0.0021	-0.0013	0.0018	-0.0013	0.0000	-0.0009
W	0.5880	0.5881	0.5878	0.5878	0.5902	0.5912	0.5919	0.5921	0.5915	0.5915

Note: We define $s = F/f$ and set $c^A = c_d = 0.0025$, $c^B = 0.0075$ and $c_c = 0.005$. Other parameter values set to $h = 0.001$, $\rho = 0.99$, $\phi_1 = 0.99$, $\phi_2 = 0.005$, $\beta = 0.99$, $v_0 = 0.1$, and $N = 1$.

differentials become small. Social welfare peaks when both types of cards are competitively issued under SEPA. High-end merchants prefer to accept credit cards to increase sales when some consumers have not yet received income. If default risk is not too high, this mix of issued debit and credit cards raises social return. Relatively low socially optimal merchant fees for debit and credit cards would increase total card acceptance in our example to 60+35=95 percent. Observe that heterogeneous competition does not yield socially optimal merchant fees, while homogeneous competition does. We also notice that under SEPA with zero fixed fees, total card network profit is less than zero. One way to solve this profitability problem is to transfer funds from consumers to card networks, for example through charging fixed fees to consumers.[15] One can show that setting $F_T = F_T^{max}(f_d^{SW}, f_c^{SW})$ yields a Ramsey pricing outcome, where card networks just break even.

7 Conclusion

The creation of SEPA will have a decisive influence on Europe's future payments landscape. SEPA is making an important contribution to the European internal market, as it is expected to not only foster competition and innovation, but also improve business conditions

[15] We implicitly assume that any funds needed to cover the card networks' losses can be raised in a non-distortionary manner. To the extent that these funds are costly, they increase the social cost which should be incorporated.

for customers. By increasing Europe's competitiveness, SEPA is aimed at making an important contribution to the implementation of the Lisbon agenda. Economic literature has already shown that economic benefits can be expected from standardization of retail payment instruments and consolidation in the payment processing industry.

Payment pricing and competitive efficiency has recently attracted a lot of attention and controversy among academics and policymakers. Payment cards are widespread in Europe and became the most used non-cash payment instrument in the euro area. But there are some dark clouds on the horizon. Although SEPA is intended to increase general customer satisfaction and economic efficiency, it is giving rise to the discontinuation of widely accepted card schemes. And despite SEPA's efforts to support the competitiveness of Europe, there is the actual risk of decreased competition when only a few payment schemes are likely to "survive". This has called for an European-led initiative to create at least one additional European card scheme.

In the light of these developments, this paper studies the pricing and welfare implications of creating SEPA. We examine three different SEPA market outcomes: a credit-card monopoly, and two competitive scenario's, debit vs credit and debit vs. debit. In these duopolistic environments, a debit card network and a credit card network strive for market share and profit. In our analysis, payment cards create additional possibilities to consume and avoid the merchant cost of cash. However, these benefits must be optimally traded off against processing cost and potential default risk. Generally, the socially optimal tradeoff is not equal to the profit-maximizing one.

In this paper, the main economic drivers for SEPA are network compatibility and economies of scale. Compatible systems increase the value of cards and reduce the use of cash. Economies of scale lower processing cost making large card systems more cost efficient. The emergence of a new European card scheme could provide a decisive push to solve interoperability problems and overcome costly current fragmentation in the European cards market. The paper concludes that increased competition drives down merchant fees and increases card acceptance. However, heterogeneous competition between debit and credit cards need not yield socially optimal outcomes. Consumers and merchants are likely to benefit the most from the creation of SEPA when sufficient competition in the card payments market alleviates potential monopolistic tendencies.

The paper argues that there is room for a MIF to achieve optimal consumer and merchant fees, taking safety, income uncertainty, default risk, merchant's pricing power, and the avoided cost of cash at the retailers side into account. Our analysis may provide a first basis for further study of the main questions underlying SEPA: which existing payment card business models will survive, and which new business models will emerge? Without favoring any particular proposed new European card scheme solution, this paper suggests that the emergence of at least one additional European card scheme would be a viable way forward to achieve an efficient, competitive and integrated European card payments market.

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Appendix

Proof of Lemma 1:
Solving (1) as an equality yields maximum debit card fee, F^A_{max}, as a function α^A and exogenous parameters. Substituting acceptance decision $\alpha^A_{opt}(f^A)$, see (2), gives $F^A_{max}(f^A)$ of Lemma 1.

Proof of Proposition 1:
Substituting $F^A_{max}(f^A)$ and $\alpha^A_{opt}(f^A)$ in profit function $\Pi^A_N(F^A, f^A, \alpha^A)$ and solving for f^A (uniquely) yields f^*_A.

Proof of Lemma 2:
Solving (5) as an equality yields maximum credit card fee, F^B_{max}, as a function α^B and exogenous parameters. Substituting acceptance decision $\alpha^B_{opt}(f^B)$, see (6), gives $F^B_{max}(f^B)$ of Lemma 2.

Proof of Proposition 2:
Substituting $F^B_{max}(f^B)$ and $\alpha^B_{opt}(f^B)$ in profit function $\Pi^B_N(F^B, f^B, \alpha^B)$ and solving for f^B (uniquely) yields f^*_B.

Proof of Proposition 3:
Substituting $\alpha^A_{opt}(f^A)$ in welfare function $W^A(f^A, \alpha^A)$ and solving for f^A (uniquely) yields f^{SW}_A. Note that the fixed fee F^A drops out in the calculations. The same logic applies to the derivation of f^{SW}_B.

Proof of Proposition 4:
See proof of proposition 2, setting $\beta = 1$.

Proof of Lemma 3:
Solving (15) as an equality yields maximum total fee, F^B_T, as a function α and α_c and exogenous parameters. Substituting acceptance decisions $\alpha^{opt}(f_d)$ and $\alpha^{opt}_c(f_d, f_c)$, see (16), gives $F_T(f_d, f_c)$ of Lemma 3.

Proof of Proposition 5:
The intersection of reaction functions $f^R_c(f_d)$ and $f^R_d(f_c)$ yields (f^*_c, f^*_d), where

$$f^*_c = \frac{(2\text{cc} + v((3\rho - 1)\phi - 2)))(1 - \rho\phi) - \phi(-\text{cd}(1 - \rho\phi) + (4 - h)\rho(1 - \phi) - 2\rho\phi 2 + 4) + 2(2 - \phi 2)}{4 - 3\rho\phi - \phi}$$

$$f^*_d = \frac{\text{cc}(1 - \rho) + \rho(2(1 - \text{cd})\phi + 2h(1 - \phi) + 3v((1 - \rho)\phi + 1) + \phi 2) + 2\text{cd} - 3v - 2(\rho + \phi - 1) - \phi 2}{4 - 3\rho\phi - \phi}$$

Proof of Proposition 6:
First, no network can set a merchant fee higher than its opponent, otherwise it would attract no business from merchants who all singlehome. Therefore, the best reply to f^j_d is $f^i_d = f^j_d - \epsilon$. Second, undercutting the merchant fee drives profits down to zero. Third, zero profits are obtained when $f^{**}_d = c_d - (1 - \rho)v_0$. There is no better reply than to set an equal merchant fee f^{**}_d by both networks. They equally share the market and receive half of the fixed fee revenues. Note that the merchant fee can be negative, this would not qualitatively change the equilibrium outcome.

Proof of Proposition 7:
Substituting $\alpha = 1 - (f_d - \rho h)/(1 - \rho)$ and $\alpha_c = (f_c - \phi_1 f_d)/(1 - \phi_1)$ in welfare function $W_{SEPA}(f_c, f_d, \alpha, \alpha_c)$ and solving for f_c and f_d (uniquely) yields f_d^{SW} and f_c^{SW}. Note that the total fixed fee F_T drops out in the calculations.