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Integrating European retail payment systems: some economics of SEPA

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Abstract

Using a spatial competition model of retail payment networks, this paper discusses the likely economic consequences associated with the formation of the Single Euro Payments Area (SEPA). The model considers an expansion of positive network externalities on the demand side and adjustment cost on the supply side and reveals that the introduction of SEPA may not lead to a fully competitive and integrated retail payment markets. This is especially the case when the markets are segments before the introduction of SEPA. In such a scenario, the post-integrated markets are likely to remain segmented or will be characterised by a kinked equilibrium where no significant price competition takes place. In both outcomes, SEPA leads to increased prices, larger network sizes (ie increased number of customers) and a higher consumer surplus. Additionally, if the SEPA-induced adjustment costs for payment networks are not prohibitively high, SEPA may also lead to an increase in both profits and social welfare.

Vähittäismaksujärjestelmien integraatio Euroopassa: analyysiä SEPAn vaikutuksista

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Tiivistelmä

Tässä tutkimuksessa analysoidaan yhtenäisen euromaksualueen, SEPAn, muodostamisen vaikutuksia. Analyysivälineenä käytetään spatiaalisen kilpailun mallia, jota sovelletaan vähittäismaksujärjestelmien väliseen kilpailuun. Mallissa keskeisiä SEPAn vaikutuskanavia ovat positiiviset kysyntäpuolen ulkoisvaikutukset sekä tarjontapuolen kiinteät sopeutumiskustannukset. Tulosten mukaan SEPA ei itsessään näyttäisi johtavan täysin integroituneisiin ja kilpailullisiin vähittäismaksumarkkinoihin, jos markkinat ovat kansallisesti segmentoituneet ennen SEPAa. SEPAn jälkeiset markkinat ovat edelleenkin segmentoituneet, tai niitä luonnehtii ns. polveikas tasapaino, jossa maksuverkkojen välinen kilpailu ei ole intensiivistä. Näissä molemmissa tilanteissa SEPA johtaa korkeampiin hintoihin, mutta myös maksuverkkojen koko (asiakkaiden lukumäärä) ja kuluttajan ylijäämä kasvavat. Jos lisäksi SEPAn aiheuttamat sopeutumiskustannukset eivät ole kohtuuttoman suuret maksujärjestelmien voitot kasvavat, jolloin myös kokonaistaloudellinen hyvinvointi paranee.

Avainsanat: integraatio, SEPA, verkostovaikutukset, vähittäismaksut

JEL-luokittelu: G21, L14, L15

Contents

1   Introduction

The Single Euro Payments Area, SEPA, aims at creating one pan-European market for cashless retail payments in euro.[1] Current national retail payment systems will gradually migrate to SEPA from 2008 onwards. When completed, SEPA will have a huge influence on the European retail payments landscape: philosophically, it should do the same to non-cash retail payments what did the introduction of euro notes and coins to paying in cash. In this respect, SEPA can be seen as a natural progression to the introduction of euro and a further step in realising the full potential of the Single Market for Europe.[2]

Given the topicality of the SEPA-initiative and its potentially far-reaching implications for the retail payment industry in Europe, it is somewhat surprising that analytical studies on its implications are almost non-existent. In the present paper, we aim to make a contribution to this rather unexplored area by providing a simple industrial organisation analysis on the implications of SEPA. Our research question is straightforward: What are the economic effects of SEPA? We study this question in a spatial competition model of retail payment networks.

When analysing the potential SEPA-effects, it is important to pay attention to the initial conditions prevailing before the SEPA-introduction. In Europe, national retail payment systems were originally created by individual banks and banking communities to meet national requirements for handling payments in national currencies and are thus functioning on the national standards. Accordingly, the current European retail payments landscape is fragmented and procedures, instruments and services offered to customers are nationally diversified resulting in no interoperability between national payment schemes. By requiring common standards and harmonisation of core payment schemes, SEPA aims to remove this fragmentation and lead to interoperability and compatibility. This should benefit consumers through more potential usage points of compatible SEPA payment instruments, and it is also likely to have implications on competition between the currently segmented national payment systems through increased interoperability.

At a very general level, the SEPA-process can be characterised as follows: before the introduction of SEPA, national payment networks operate on national standards with no cross-border interoperability and, therefore, these networks act local monopolies on their national markets. The introduction of SEPA results in forced compatibility and interoperability between networks through common SEPA-standards. To adopt the common standards, payment networks have to

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[1] SEPA covers the 27 EU countries, the other three European Economic Area countries (Iceland, Liechtenstein and Norway) and Switzerland. SEPA is an initiative by the European banking sector with the European Payments Council as its decision making and coordinating body, see www.europeanpaymentscouncil.eu.

[2] For policy issues and an extensive collection of related links, see the webpage of the European Central Bank: www.ecb.int/paym/sepa/html/index.en.html.

update their systems which induces them fixed adjustment costs. Given this generalized framework, we construct a stylised spatial competition model of retail payment networks to illustrate and analyse the potential effects of the SEPA-formation. The main emphasis is on the demand side network externalities that will expand when SEPA is introduced.

In reality, SEPA is a big and many-faceted undertaking as it comprises all major non-cash retail payment instruments: credit transfers, direct debits and card payments. Accordingly, full-scale modelling of its effects is very complicated as these payment instruments have inherent differences and a wide variety of different stakeholders are involved in the process. Therefore, we take a narrower view and focus on payment system level issues by building a generic model to describe the SEPA-formation. To fix ideas, our preferred interpretation of the model deals with the SEPA-effects in national debit card markets. We call these markets 'payment cards markets' where national debit cards are used along with cash. While the model abstracts many important institutional details of the payment card markets, our focus can be grounded by our aim to highlight the fundamental change SEPA is manifesting: ie effects of 'forced' cross-border interoperability and compatibility in the previously fragmented retail payment markets. For capturing these effects, the national debit card markets that are segmented before the introduction of SEPA can serve as a demonstrative example.[3]

Our modelling of SEPA-formation can be summarised as follows. Before the introduction of SEPA, called Pre-SEPA period, consumers can use their payment cards only in their home network. After the introduction of SEPA, called Post-SEPA period, consumers can use their payment cards both in home and foreign network. In other words, SEPA will bring 'forced' cross-border interoperability between the payment networks and thus expand consumers' network utility through compatibility.[4] For service providers, the introduction of SEPA induces a fixed adjustment cost for updating their systems to become SEPA-compatible (ie being able to accept each others' cards). In this set-up, we apply a simple spatial competition model of payment card networks á la Hotelling and analyse the economic effects of the SEPA-formation by comparing prices, network sizes, profits, consumer surplus and total welfare in Pre- and Post-SEPA. To the extent,

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[3] In reality, the international card schemes, MasterCard and Visa, are already offering SEPA-compatible cards. We nevertheless abstract them from our modelling as our focus is on the effects of SEPA-induced compatibility on the currently fragmented national payment systems.
[4] Our model has a real life counterpart by displaying many characteristics that resemble the EAPS-initiative, the Euro Alliance of Payment Schemes. The EAPS is a joint initiative by the European Payment Schemes, enabling European cardholders and retailers to make card payments and cash withdrawals with payment cards across Europe's national boundaries. The EAPS aims to develop into a new pan-European card payment scheme based on the national schemes and their infrastructures, and, hence, act as a competitor to the international card schemes. For more information on the EAPS, see their homepage www.card-alliance.eu.

the issues related to compatibility and adjustment costs are relevant to other SEPA-instruments, credit transfers and direct debits, we also hope to provide some insights into the effects of SEPA on these instruments as well.

We find that the introduction of SEPA does not lead to the fully-competitive and integrated retail payment markets if the Pre-SEPA markets are segmented (ie payment networks are local monopolies). Instead, the Post-SEPA markets also remain segmented or are characterized by kinked equilibrium. Where no significant price competition between payment networks takes place. In both cases, SEPA leads to increased prices, larger market sizes and higher consumer surplus. Moreover, if the payment networks' SEPA-adjustment costs are not prohibitively high, SEPA also increases profits and social welfare. Accordingly, our results suggest that the overall effects of SEPA can be positive.

The rest of the study is organised as follows. Section 2 reviews the related literature. Section 3 presents the model and derives equilibria in the Pre- and Post-SEPA phases. It also defines the relevant parameter ranges for our SEPA-analysis. In Section 4, the analyses of SEPA-effects are carried out. Section 5 discusses limitations and possible extensions of the model. Finally, Section 6 concludes.

2   Literature review

At a general level, our model is related to network economics literature analysing network externalities and their implications. Beginning with the work of Farrell and Saloner (1985) and Katz and Shapiro (1985) (see Economides (1996) for a survey), there is large literature on the advantages related to large networks when consumers value being in the same network as other consumers. As retail payment industry can be viewed as a network industry, our model set-up builds on the basic principles of network economics.[5] In the SEPA-context, the expansion of positive network externalities for consumers through wider compatibility of payment instruments is important, and this network industry aspect is incorporated in our model. In our analysis, compatibility forced by SEPA is taken as 'mandatory' so that strategic standardisation and compatibility decisions commonly analysed in the literature are not dealt with.

Our model is also related to the literature on network competition utilising spatial models. Starting from the seminal works by Laffont et al (1998a, b) and Armstrong (1998), there is a vast literature on network competition in communication and other ICT-industries. In this literature, competition between the two horizontally-differentiated and interconnected networks is analysed by

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[5] Network effects in payment systems have been discussed and analysed eg in McAndrews (1997) and Milne (2006). Kemppainen (2003) provides a general survey of network issues in retail payment systems.

applying the Hotelling model of consumer choice. As there are inherent similarities between communication industry and payment industry, we also model network effects utilising similar type of spatial competition framework. In this respect, our framework has similarities to eg Mason (2000) who analyses competitive Internet pricing using the Hotelling model. Regarding retail payment systems, spatial competition models have been used eg in analysing ATM network compatibility (see Matutes and Padilla, 1994, for a seminal paper on the factors influencing banks' decision to share ATMs; and for a review of literature, see McAndrews, 2003).

Naturally, the literature on two-sided markets is very relevant for retail payment systems (for recent overviews, see eg Armstrong, 2006, and Rochet and Tirole, 2006). Models of two-sided markets are especially relevant in the payment card industry for studying the impact of interchange fees on user fees and volumes in payment networks.[6] Traditionally, this literature has analysed a single payment system case. Only recently, the case of competing payment systems has been studied by very few papers: Chakravorti and Roson (2006), Guthrie and Wright (2007), and Rochet and Tirole (2007). These papers have begun to give insights to a realistic situation where several payment systems compete and consumers have the choice between several non-cash payment instruments.

While recognizing the importance of the two-sided nature of retail payment systems, our modelling nevertheless abstracts from it as our ambition is limited to analyse SEPA-induced interoperability and compatibility at a more general payment network level. In other words, we view retail payment industry as a traditional network industry and study the economic effects of forced compatibility in the markets that are initially segmented. In this sense, our general framework resembles the example Rochet (2007) uses to demonstrate the impact of horizontal integration in a network industry. By applying a fully-covered market Hotelling model, he shows that mergers can benefit simultaneously firms and consumers in network industry. He argues that this is because positive network externalities increase with the size of the network, and play on the demand side a role similar to increasing returns to scale on the supply side.

Analytical literature related directly to our research question on the SEPA-implications is very scarce. To our knowledge, there only exists a contemporaneous work by Schaefer (2008) that formally analyses SEPA-effects. Schaefer uses a model of spatial bank competition to evaluate the economic effects of SEPA-formation. He focuses on the payment system in one country (other country assumed to be symmetric) and applies a fully-covered market Hotelling model where there are two banks located at the both ends of the unit

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[6] The literature on two-sided markets is relevant for analysing those payment instruments where one group of participants are payers and another group payees: eg cards and direct debits for consumer to retailer payments. It is likely to be less relevant for credit transfers where payers and payees cannot be so divided.

interval and consumers having unit demands for bank transactions are evenly distributed between them. In this framework, Schaefer evaluates the SEPA-regime with high initial investment cost against status quo regime with low initial investment cost and also considers cross-border competition among banks through an entry by a foreign bank. He concludes that potential welfare enhancing channels of SEPA, like cost reductions for cross-border transactions and higher efficiency due to more cross-border competition among banks, seem to be fairly ineffective as the share of cross-border transactions is small and cross-border competition in retail banking is low. Accordingly, he argues that expectations about the positive effects of SEPA may be exaggerated as most channels for enhancing social welfare seem rather weak but the SEPA-project maybe worth undertaking, if the cost of creating SEPA-compliant systems is reduced by extending the time frame for its implementation phase.

Our model can be seen complementary to the work of Schaefer: we also apply Hotelling model to study SEPA-effects, but certain differences can be detected. The main difference is that in our model there are two payment networks located in two countries and our starting point is segmented retail payment markets, whereas Schaefer's analysis focuses on one country (effects assumed to be similar in other country by symmetry) and fully-covered markets. In our approach involving explicitly two countries,[7] the segmented markets assumption is used to reflect the real-life initial conditions prevailing before the introduction of SEPA, ie the fragmented retail payment landscape in Europe. In addition, Schaefer analyses the SEPA-effects concentrating on the cost issues on the supply side, whereas our model focuses more on the demand side by introducing an expansion of positive network effects due to SEPA, and the supply side gets only a limited attention in the form of fixed SEPA-adjustment costs. Given our emphasis on the traditional network nature of retail payment systems, the main goal of our study is to analyse economic effects of SEPA-formation when compatibility and interoperability are forced into the retail payment markets that are initially segmented.

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[7] For similar reasons, segmented/partially-covered market Hotelling model applications have been used in the analysis of stock exchange industry, see eg Shy and Tarkka (2001) and Andersen (2005).

3 Model

3.1 Structure of the model

We develop in this section a Hotelling-type model with unit demand and overall positive network effects to examine the potential economic consequences associated with the formation of SEPA. In our model, we view retail payment systems as traditional network industry. This allows us to study the effects of SEPA-induced compatibility on retail payment markets in a tractable way. As pointed out earlier, we focus on the effects of the SEPA-formation at the general retail payment system level and use national debit card networks (called as 'payment card networks' hereafter) as demonstrative examples. Therefore, our model abstracts from the two-sided market literature that is undoubtedly very relevant in more comprehensive analysis of payment card industry.

The general structure of our model can be described as follows. We consider horizontally-differentiated payment card networks in two countries. These networks are owned by card issuers and acquirers that in practice are mainly banks. We do not model issuing and acquiring banks explicitly so we can think that payment cards are issued by the payment networks. Consumers are uniformly distributed along a Hotelling line with two payment card networks located at the two extremities of the segment [0,1]. Consumers have unit demands for payment cards and cash is assumed to be their alternative payment method. We also assume that consumers have a perfect foresight and can thus correctly anticipate how many consumers will be subscribing each payment card network. This perfect foresight assumption helps to circumvent the multiple equilibria problem (see eg Shy, 2001, or equivalent concept of 'fulfilled expectations equilibrium' used in Katz and Shapiro, 1985). Next, we present the main building blocks of the model and show how it can be applied to describe the SEPA-formation.

Demand side

A consumer, who is located at x_i possessing a payment card from network 1, has the following utility function, and respectively, for a consumer located at x_j possessing a payment card from network 2

$$U_1(x_i) = V - p_1 - tx_i + \varepsilon N_1 + \varepsilon N_2 k \qquad (3.1a)$$

$$U_2(x_j) = V - p_2 - t(1 - x_j) + \varepsilon N_2 + \varepsilon N_1 k \qquad (3.1b)$$

where V denotes a base utility or a basic value of having a payment card. V could represent the 'convenience value' a payment card brings along when making purchases (no need to have the exact amount of cash in hand), or 'security value' (no need to keep large amounts of cash in the wallet). p_1 and p_2 stand for prices (annual fees) charged by payment networks 1 and 2. $t > 0$ is the differentiation parameter. t can be thought of representing traditional transportation/travelling costs, when the interval over which the consumers are distributed could be given a geographic interpretation (of distance between the two payment networks). However, other interpretations of why some consumers prefer payment network 1 to payment network 2 or vice versa may also be given.[8] Following eg Mason (2000), ε is a positive network utility parameter measuring the strength of indirect network externality. N_1 and N_2 are the equilibrium sizes of networks (correctly anticipated by the consumers under perfect foresight assumption). Accordingly, εN_1 and εN_2 measure the indirect network utility: it is assumed that the cardholders get network utility based on the size of their card network so that bigger network size translates to more potential usage points for cards and hence more utility (ie the more consumers posses the payment card, the more merchants are willing to accept them). Finally, k is a measure of compatibility {0,1}, an indicator variable that determines whether the card can be used in other network or not: ie $k = 0$ indicates full incompatibility, and $k = 1$ full compatibility. The change in k captures the effect of SEPA-formation on the demand side in our simple model.

Before the introduction of SEPA, called Pre-SEPA, consumers can use their payment cards only in their home network and thus get network utility only from it. Accordingly, we set $k = 0$ in (3.1) yielding the following Pre-SEPA utility functions

$$U_1(x_i) = V - p_1 - tx_i + \varepsilon N_1 \tag{3.2a}$$

$$U_2(x_j) = V - p_2 - t(1 - x_j) + \varepsilon N_2 \tag{3.2b}$$

After the introduction of SEPA, called Post-SEPA, consumers can use their payment cards in both home and foreign network and get respectively network utility from both of them. Accordingly, we set $k = 1$ in (3.1) yielding the following Post-SEPA utility functions

$$U_1(x_i) = V - p_1 - tx_i + \varepsilon N_1 + \varepsilon N_2 \tag{3.3a}$$

$$U_2(x_j) = V - p_2 - t(1 - x_j) + \varepsilon N_2 + \varepsilon N_1 \tag{3.3b}$$

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[8] The parameter interpretations are discussed in Section 5, where also potential SEPA-effects on them are considered.

For our SEPA-analysis, we make the following two assumptions that will hold throughout the paper

Assumption 1. $V \leq t - \varepsilon$
Assumption 2. $t > 2\varepsilon$

Assumption 1 ensures that the Pre-SEPA markets are segmented to correspond to the real life situation. It requires that the base value of a payment card must be smaller than 'effective transportation cost', the difference between the transportation cost and network utility parameters.

Assumption 2, in turn, ensures that the Post-SEPA network sizes are positive. It requires that transportation cost parameter is twice as large as the network utility parameter. The assumptions will become clearer in the subsequent sections: Assumption 1 in Section 3.2 and Assumption 2 in Section 3.3.

Supply side

The supply side is very simple. The two payment networks are assumed to maximize their profits. For simplicity, it is assumed that their production costs are zero. Accordingly, their profits can be written as follows

Pre-SEPA: $\pi_i = p_i x_i$ (3.4)

Post-SEPA: $\pi_i = p_i x_i - a$ (3.5)

where a is fixed adjustment cost for service providers as they have to upgrade their systems for SEPA-compatibility (ie being able to accept each others' cards).

3.2   Pre-SEPA phase

Before the introduction of SEPA, it is assumed that the payment card markets are segmented meaning that the two card networks located at the two extremities of the segment [0,1] are local monopolies.[9] In the segmented markets, besides payment card subscribers, there are also consumers, located around the center of the Hotelling line, who do not want to have a payment card.

In Pre-SEPA, consumers get network utility only from their home network. Let x_1 denote a consumer who is indifferent of subscribing a payment card from

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[9] Assumption 1 defines the condition for Pre-SEPA segmented markets. It is derived at the end of this section.

network 1 and not having a card at all. Similarly, let x_2 denote a consumer who is indifferent of subscribing a payment card from network 2 and not having a card at all. This means that consumers between 0 and x_1 subscribe to network 1 (located at 0) while those between x_2 and 1 subscribe to network 2 (located at 1). As we assumed that consumers are uniformly distributed on the Hotelling line, we have that the equilibrium size of network 1 is $N_1 = x_1$ and the equilibrium size of network 2 is $N_2 = 1–x_2$. Then we can write Pre-SEPA utility functions (3.2) as follows

$$U_1 = V - p_1 - tx_1 + \varepsilon x_1 \tag{3.6a}$$

$$U_2 = V - p_2 - t(1 - x_2) + \varepsilon(1 - x_2) \tag{3.6b}$$

We assume that payment networks are symmetric and, in the following analysis, we focus on payment network 1. The results for payment network 2 can be derived similarly.

Letting (3.6a) be equal to zero determines payment network 1's market size as

$$x_1 = \frac{V - p_1}{t - \varepsilon} \tag{3.7}$$

Here, the term $t–\varepsilon$ measures 'the effective transportation cost', ie the difference between the transportation cost parameter t and network utility parameter ε, which is positive by Assumption 2.

When inserting (3.7) into (3.4), the Pre-SEPA profit for payment network 1 is

$$\pi_1 = p_1 \frac{V - p_1}{t - \varepsilon} \tag{3.8}$$

Profit maximisation yields the following equilibrium values for price, network size, profit, consumer surplus and welfare in symmetric Nash equilibrium

$$p_1 = \frac{V}{2} \tag{3.9}$$

$$x_1 = \frac{V}{2(t - \varepsilon)} \tag{3.10}$$

$$\pi_1 = \frac{V^2}{4(t - \varepsilon)} \tag{3.11}$$

$$CS = t\left(\frac{V}{2(t-\varepsilon)}\right)^2, \text{ and} \tag{3.12}$$

$$W = CS + 2\pi = (3t - 2\varepsilon)\left(\frac{V}{2(t-\varepsilon)}\right)^2 \tag{3.13}$$

We can now also derive the condition for Pre-SEPA segmented markets established in Assumption 1. Limiting the equilibrium market size equation (3.10) to be at maximum ½, ie $x_1 = \dfrac{V}{2(t-\varepsilon)} \leq \dfrac{1}{2}$ yields directly Assumption 1: $V \leq t - \varepsilon$.

This assumption sets the upper limit to the relation of payment card's base value to the 'effective transportation cost'. Because we have Pre-SEPA segmented markets as a starting point, Assumption 1 is important by determining the relevant parameter ranges for our analysis of SEPA-effects.

3.3   Post-SEPA phase

After the introduction of SEPA, the payment card networks become interoperable and consumers can use their cards in both home and foreign networks and get thus network utility from both of them. In Post-SEPA, payment networks face an adjustment cost a for upgrading their systems to be SEPA-compatible, ie updating their systems so that they are able to accept each others' cards.

In contrast to Pre-SEPA, where we had by Assumption 1 segmented markets as a starting point, in Post-SEPA, the market outcome is a priori not determined. Based on Salop (1979), Ireland (1987), and Economides (1984, 1988), we can establish three symmetric equilibria: (i) segmented market equilibrium ('local monopoly' or 'partially-covered market equilibrium'), (ii) fully-covered market equilibrium ('competitive' or 'duopoly equilibrium') and (iii) kinked equilibrium ('touching equilibrium') depending on the parameter values.[10]

Following similar steps as in Pre-SEPA case, the Post-SEPA utility function (3.3) can be rewritten as (again x_1 and x_2 refer to the 'last indifferent consumers' belonging to the network 1 and 2 and thus determining also the equilibrium sizes of networks)

$$U_1 = V - p_1 - tx_1 + \varepsilon x_1 + \varepsilon(1 - x_2) \tag{3.14a}$$

$$U_2 = V - p_2 - t(1 - x_2) + \varepsilon(1 - x_2) + \varepsilon x_1 \tag{3.14b}$$

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[10] We will show later that not all of them are relevant for our SEPA-analysis as we assumed Pre-SEPA segmented markets as the starting point.

As in the Pre-SEPA case, we assume symmetric payment networks and, in the following analysis, we focus on payment network 1. From the Post-SEPA utility function (3.14), we get that a consumer located at x_1 will obtain a payment card from payment network 1 if two conditions are met

$$U_1 = V - p_1 - tx_1 + \varepsilon x_1 + \varepsilon(1 - x_2) \geq 0 \qquad (3.15)$$

and

$$U_1 = V - p_1 - tx_1 + \varepsilon x_1 + \varepsilon(1 - x_2) \geq U_2 = V - p_2 - t(1 - x_2) + \varepsilon(1 - x_2) + \varepsilon x_1 \quad (3.16)$$

Condition (3.15) refers to the Post-SEPA segmented markets where the marginal consumer is indifferent between obtaining a payment card from network 1 and not obtaining a payment card at all. Condition (3.16), in turn, refers to the Post-SEPA fully-covered markets where the marginal consumer is indifferent between the two networks. Conditions (3.15) and (3.16) are respectively equivalent to

$$x_1 \leq \frac{Vt - (t - \varepsilon)p_1 - \varepsilon p_2}{t(t - 2\varepsilon)} \qquad \text{(Segmented markets)} \qquad (3.17)$$

and

$$x_1 \leq \frac{t - p_1 + p_2}{2t} \qquad \text{(Fully-covered markets)} \qquad (3.18)$$

We can now use conditions (3.17) and (3.18) to yield the demand function of payment card network 1 in Post-SEPA

$$x_1 = \min\left\{ \left(\frac{Vt - (t - \varepsilon)p_1 - \varepsilon p_2}{t(t - 2\varepsilon)} \right), \left(\frac{t - p_1 + p_2}{2t} \right) \right\} \qquad (3.19)$$

Given this Post-SEPA demand function, we follow Ireland (1987) and identify the different parameter ranges for the three symmetric Nash equilibria. More detailed derivations of the relevant equilibria needed in our SEPA-analysis are presented in the subsequent sections.

(i) Segmented market equilibrium

In the segmented market case, (3.17) holds as an equality and when inserting it into (3.5), the profit is

$$\pi_1 = p_1 \left(\frac{Vt - (t-\varepsilon)p_1 - \varepsilon p_2}{t(t-2\varepsilon)} \right) - a \qquad (3.20)$$

Maximising (3.20) with respect to p_1 gives the reaction function as

$$p_1 = \frac{1}{2} \frac{Vt - \varepsilon p_2}{t-\varepsilon} \qquad (3.21)$$

When assuming symmetric pricing, the equilibrium price is

$$p_1 = \frac{Vt}{2t-\varepsilon} \qquad (3.22)$$

and equilibrium market size

$$x_1 = \frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)} \qquad (3.23)$$

The right hand side of (3.23) is a second degree function of ε and t. In Appendix 1, it is shown that only the smaller root of ε (and bigger root of t) is feasible. In order to ensure positive network market size, Assumption 2 requiring $t > 2\varepsilon$ needs to hold indicating that transportation cost must be twice as large as the network utility parameter.

Segmented markets require that the network 1's market size $x_1 \leq \frac{1}{2}$, yielding the Post-SEPA segmented market condition

$$V \leq t - \varepsilon - \frac{t\varepsilon}{2(t-\varepsilon)}$$

Accordingly, the above defined solution for segmented markets is feasible since $\frac{Vt - (t-\varepsilon)p_1 - \varepsilon p_2}{t(t-2\varepsilon)}$ is the minimum of the demand schedules in (3.19).

18

(ii) Fully-covered market equilibrium

In the fully-covered markets case, with $\dfrac{t - p_1 + p_2}{2t} \leq \dfrac{Vt - (t-\varepsilon)p_1 - \varepsilon p_2}{t(t-2\varepsilon)}$, (3.18) holds as an equality and, when inserting it into (3.5), profit is

$$\pi_1 = p_1\left(\frac{t - p_1 + p_2}{2t}\right) - a \qquad (3.24)$$

Maximising (3.24) with respect to p_1 and assuming symmetric pricing, the equilibrium price is

$$p_1 = t \qquad (3.25)$$

and the equilibrium market size

$$x_1 = \frac{1}{2} \qquad (3.26)$$

Providing now that $\dfrac{Vt - (t-\varepsilon)p_1 - \varepsilon p_2}{t(t-2\varepsilon)} \geq \dfrac{1}{2}$, the above solution is consistent with the initial hypothesis of fully-covered market solution, and this condition is equivalent to $V \geq \dfrac{3}{2}t - \varepsilon$.

(iii) Kinked equilibrium

Between the segmented and fully-covered market equilibrium, there exists a kinked equilibrium, where all consumers are served but no significant price competition takes place. In parameter values $t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)} < V < \dfrac{3}{2}t - \varepsilon$, the kinked equilibrium[11] is a consistent solution with price equate $\dfrac{Vt - (t-\varepsilon)p_1 - \varepsilon p_2}{t(t-2\varepsilon)} = \dfrac{1}{2}$, which gives the equilibrium price

$$p_1 = V + \varepsilon - \frac{1}{2}t \qquad (3.27)$$

and market size is

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[11] The proof for the existence of the kinked equilibrium is outlined in Appendix 2.

$$x_1 = \frac{1}{2}$$

(3.28)

Accordingly, for Post-SEPA markets we have established three possible equilibria in different parameter areas:

- Segmented market monopoly equilibrium: $V \leq t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)}$

- Kinked equilibrium: $t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)} < V < \dfrac{3}{2}t - \varepsilon$

- Fully-covered market competitive equilibrium: $V \geq \dfrac{3}{2}t - \varepsilon$

Relevant parameter ranges

We defined in Assumption 1 the condition $V \leq t-\varepsilon$ under which the Pre-SEPA markets are segmented. When combining this Pre-SEPA starting point condition to the above Post-SEPA equilibria conditions, we are able to determine the relevant parameter ranges for our analysis of SEPA-effects. It can be directly seen that the Assumption 1 rules out the Post-SEPA fully-covered market equilibrium. In fact, this is one of the most fundamental results we get from our analysis. This result suggests that in our model SEPA as such is not enough to lead to fully-competitive and integrated retail payment markets. Full integration of the previously integrated retail payment markets would require eg an increase in V.

When having the segmented pre-SEPA markets as our starting point 1, we can establish the following two relevant parameter ranges for our SEPA-analysis

Parameter range 1) $V \leq V_1 = t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)}$

Parameter range 2) $V \in [V_1, V_2], V_2 = t - \varepsilon$

In parameter range 1, both the Pre-SEPA and Post-SEPA markets are segmented, and in parameter range 2, Pre-SEPA markets are segmented and Post-SEPA markets are in kinked equilibrium. Next we can assess the effects of SEPA in these two parameter ranges.

4 Analysis of SEPA-effects

4.1 SEPA-effects in parameter range 1

We first look at the SEPA-effects in the parameter range 1: ie $V \le V_1 = t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)}$.

In this parameter range, both the Pre-SEPA and Post-SEPA markets are segmented. Using (3.22) and (3.23), we get the Post-SEPA equilibrium profits, consumer surplus and welfare in the symmetric Nash equilibrium

$$\pi_1 = \pi_2 = \frac{t(t-\varepsilon)V^2}{(t-2\varepsilon)(2t-\varepsilon)^2} - a \tag{4.1}$$

$$CS = t\left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}\right)^2 , \text{ and} \tag{4.2}$$

$$W = \left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}\right)^2 \left(\frac{3t^2 - 5\varepsilon t}{t-\varepsilon}\right) - 2a \tag{4.3}$$

We can now assess the SEPA-effects by comparing the Pre- and Post-SEPA cases and establish the following proposition.

Proposition 1. *When payment card markets are segmented in both Pre- and Post-SEPA, the introduction of SEPA results in higher prices, network sizes, profits, consumer surplus and welfare when ignoring the SEPA adjustment costs for service providers.*

Proof. This can be verified by comparing the Pre- and Post-SEPA segmented market cases (and setting a to 0), ie comparing (3.9)–(3.13) with (3.22), (3.23) and (4.1)–(4.3).

$$p^{\text{Pre–SEPA}} = \frac{V}{2} < p^{\text{Post–SEPA}} = \frac{Vt}{2t-\varepsilon}$$

$$x_1^{\text{Pre–SEPA}} = \frac{V}{2(t-\varepsilon)} < x_1^{\text{Post–SEPA}} = \frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}$$

$$\pi_1^{\text{Pre–SEPA}} = \frac{V^2}{4(t-\varepsilon)} < \pi_1^{\text{Post–SEPA}} = \frac{t(t-\varepsilon)V^2}{(t-2\varepsilon)(2t-\varepsilon)^2} - a$$

$$CS^{Pre-SEPA} = t\left(\frac{V}{2(t-\varepsilon)}\right)^2 < CS^{Post-SEPA} = t\left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}\right)^2$$

$$W^{Pre-SEPA} = (3t-2\varepsilon)\left(\frac{V}{2(t-\varepsilon)}\right)^2 < W^{Post-SEPA} = \left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}\right)^2\left(\frac{3t^2-5\varepsilon t}{t-\varepsilon}\right) - 2a$$

∎

The underlying economic interpretation of this proposition is straightforward. The network effects in segmented markets equilibrium are equivalent to an increase in the base value of having a card, V, as there is a 'fixed' increase in the value of having a card when it becomes interoperable with the other network. Accordingly, the sizes of networks and consumer surplus as well as prices and profits all rise.

Moreover, we can find the threshold values for service providers' SEPA adjustment costs, a, that maintain Proposition 1

a_S^{Π} = a threshold value for service providers' adjustment cost parameter a for positive profit change

$$a_S^{\Pi} = \frac{t(t-\varepsilon)V^2}{(t-2\varepsilon)(2t-\varepsilon)^2} - \frac{V^2}{4(t-\varepsilon)} = \frac{\varepsilon V^2(4t^2-5t\varepsilon+2\varepsilon^2)}{4(t-\varepsilon)(t-2\varepsilon)(2t-\varepsilon)^2}, \text{ and}$$

a_S^{W} = a threshold value for service providers' adjustment cost parameter a for positive welfare change

$$a_S^{W} = \frac{1}{2}\left[\left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)}\right)^2\left(\frac{3t^2-5\varepsilon t}{t-\varepsilon}\right) - (3t-2\varepsilon)\left(\frac{V}{2(t-\varepsilon)}\right)^2\right]$$

Given the nature of fixed adjustment costs, the existence of these threshold values is rather trivial so we only note that $a_S^{W} > a_S^{\Pi}$. Naturally, if $a > a_S^{\Pi}$, the payment card networks would be making lower profits compared to Pre-SEPA, but given the 'mandatory' role of SEPA they would still have needed to do necessary SEPA-investments. Similarly, if the adjustment costs were even higher, ie $a > a_S^{W}$, also the total welfare would be lower.

In the Post-SEPA segmented market case, the SEPA introduction results in higher prices, network sizes, profits, consumer surplus and welfare; for profits and welfare, an additional condition is that the adjustment cost a is below the threshold values a_S^{Π} and a_S^{W}. In Post-SEPA, the number of consumers who are willing to have a payment card increases as they are able to get network utility from both networks and consequently the sizes of networks grow. Payment networks can charge higher prices and earn higher profits (provided that $a < a_S^{\Pi}$)

22

in Post-SEPA as entry of new payment networks is not considered in the model. Despite the higher prices, consumer surplus increases as the network utility expands and covers both 'grown' networks in Post-SEPA. Provided that the SEPA-adjustment costs are not prohibitively high, also total welfare increases due to the higher consumer surplus and profits.

In addition, an interesting effect of the SEPA-formation is worth pointing out: the pricing decisions of two payment networks become interconnected in Post-SEPA. This can be directly seen when looking at the reaction function in (3.21) for payment network 1

$$p_1 = \frac{1}{2} \frac{Vt - \varepsilon p_2}{t - \varepsilon}$$

and respectively for payment network 2 $p_2 = \frac{1}{2} \frac{Vt - \varepsilon p_1}{t - \varepsilon}$.

Here the annual fees of the two networks are strategic complements, even though the Post-SEPA markets are still segmented. This is so because the network externality connects their demands, and, in this respect, the 'interconnectedness' between the payment networks inevitably increases with the SEPA-formation.

'Forced market integration'-case

In the previous case, the introduction of SEPA led to the situation where the Post-SEPA payment card markets were still segmented. However, if the political goal of SEPA is to have integrated markets, we can study if this could also be achieved in the previous set-up. When authorities would like to eliminate the segmentation of the markets in the parameter range 1, one plausible possibility, given the past EU regulatory actions in the pricing of telecommunications and retail payments (the Regulation 2560/2001), would be to implement a price regulation in order to ensure market coverage. In our model framework, this regulated price can be defined as the price that would make the consumer in the middle of the Hotelling line indifferent between obtaining a payment card or not. In terms of the indifferent consumer's utility function, this can be formulated as follows

$$U = V + \varepsilon - \frac{1}{2} t - p^R = 0$$

yielding the regulated price[12]

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[12] It should be noted that, although the regulated price (4.4) and the kinked equilibrium price (3.27) are seemingly identical, they are defined in the different parameter ranges.

$$p^R = V + \varepsilon - \frac{1}{2}t \tag{4.4}$$

Market size is naturally

$$x_1(p^R) = \frac{1}{2} \tag{4.5}$$

Under this regulated price, profits, consumer surplus and welfare are as follows

$$\pi(p^R) = \frac{1}{2}\left(V + \varepsilon - \frac{1}{2}t\right) - a \tag{4.6}$$

$$CS(p^R) = \frac{1}{4}t \text{ and} \tag{4.7}$$

$$W(p^R) = V + \varepsilon - \frac{1}{4}t - 2a \tag{4.8}$$

We can now evaluate this 'forced market integration' -case against Post-SEPA segmented market case and establish the following proposition.

Proposition 2. *If authorities would like to have fully-integrated payment card markets by imposing a price regulation, this would result in lower prices and profits, but larger market sizes, higher consumer surplus and welfare compared to the unregulated Post-SEPA segmented market case.*

Proof. This can be verified by comparing the 'forced market integration case' with the post-SEPA segmented market case, ie comparing (4.4)–(4.8) with (3.22), (3.23) and (4.1)–(4.3).

$$p^R = V + \varepsilon - \frac{1}{2}t < p^{\text{Post-SEPA}} = \frac{Vt}{2t - \varepsilon}$$

$$x_1(p^R) = \frac{1}{2} > x_1^{\text{Post-SEPA.}} = \frac{(t - \varepsilon)V}{(t - 2\varepsilon)(2t - \varepsilon)}$$

$$\pi_1(p^R) = \frac{1}{2}\left(V + \varepsilon - \frac{1}{2}t\right) - a < \pi_1^{\text{Post-SEPA}} = \frac{t(t - \varepsilon)V^2}{(t - 2\varepsilon)(2t - \varepsilon)^2} - a$$

$$CS(p^R) = \frac{1}{4}t > CS^{Post-SEPA} = t \left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)} \right)^2$$

$$W(p^R) = V + \varepsilon - \frac{1}{4}t - 2a > W^{Post-SEPA} = \left(\frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)} \right)^2 \left(\frac{3t^2 - 5\varepsilon t}{t-\varepsilon} \right) - 2a \quad \blacksquare$$

If authorities resorted to the price regulation to have integrated markets in the Post-SEPA phase, this would result in lower prices and lower profits but market sizes, consumer surplus and welfare would increase. In this case, the price regulation would be beneficial for consumers because of lower prices and larger network sizes, and consumer surplus would thus inevitably increase. Even though the profits of payment card networks would be lower, the total welfare would rise because the increase in consumer surplus could dominate.

Naturally, the above economic interpretation of the Proposition 2 should be viewed cautiously. Given our assumption of 'two networks acting as local monopolies', the regulated prices, lower than the unregulated prices freely chosen by monopolists, will surely increase consumer surplus and welfare. However, this assumes away a lot of important issues in the economics of regulation of monopolies: namely, how to ensure that incentives to improve efficiency and to invest are not excessively reduced. In addition, alternative authority tools, like measures to reduce barriers to entry are surely of relevance in practical authority considerations. Finally, the price regulation considered above should not be mixed up with the prevailing real-life Regulation 2560/2001 on cross-border payments in euro stipulating that the equivalent domestic and cross-borders payment must be priced similarly. Accordingly, the above 'forced market integration -case' regulation is stronger and differs from the Regulation 2560 as it sets a direct price cap on payment prices.[13]

4.2   SEPA-effects in parameter range 2

We look next at the SEPA-effects in parameter range 2. In parameter range 2, Post-SEPA markets are in the kinked equilibrium where all consumers subscribe a payment card but the marginal consumer is indifferent between subscribing a card or not. We already established the kinked equilibrium prices and market sizes in equations (3.27) and (3.28). Utilising these, we can define the kinked equilibrium profits, consumer surplus and welfare in the symmetric Nash equilibrium as follows

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[13] For a partially related analysis and discussion on the need for authority regulatory intervention in securities settlement business, see Milne (2005).

$$\pi(p^K) = \frac{1}{2}\left(V + \varepsilon - \frac{1}{2}t\right) - a \tag{4.9}$$

$$CS(p^K) = \frac{1}{4}t \text{ and} \tag{4.10}$$

$$W(p^K) = V + \varepsilon - \frac{1}{4}t - 2a \tag{4.11}$$

As before, we can evaluate the SEPA-effects by comparing the Pre- and Post-SEPA equilibrium values and establish the following proposition.

Proposition 3. *When payment card markets are segmented in Pre-SEPA and in kinked equilibrium in Post-SEPA, the introduction of SEPA results in higher prices, network sizes, profits, consumer surplus and welfare when ignoring the SEPA adjustment costs for service providers.*

Proof. This can be verified by comparing Pre-SEPA segmented markets and Post-SEPA kinked equilibrium cases (and setting a to 0), ie comparing (3.9)–(3.13) with (3.27), (3.28) and (4.9)–(4.11).

$$p^{\text{Pre–SEPA}} = \frac{V}{2} < p^K = V + \varepsilon - \frac{1}{2}t$$

$$x_1^{\text{Post–SEPA}} = \frac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)} < x_1(p^K) = \frac{1}{2}$$

$$\pi_1^{\text{Pre–SEPA}} = \frac{V^2}{4(t-\varepsilon)} < \pi_1(p^K) = \frac{1}{2}\left(V + \varepsilon - \frac{1}{2}t\right) - a$$

$$CS^{\text{Pre–SEPA}} = t\left(\frac{V}{2(t-\varepsilon)}\right)^2 < CS(p^K) = \frac{1}{4}t$$

$$W^{\text{Pre–SEPA}} = (3t - 2\varepsilon)\left(\frac{V}{2(t-\varepsilon)}\right)^2 < W(p^K) = V + \varepsilon - \frac{1}{4}t - 2a \quad \blacksquare$$

The underlying economic interpretation of this proof is similar to Proposition 1: ie network effects in the kinked equilibrium are equivalent to an increase in the base

value of having a card, V, as there is a 'fixed' increase in the value of having a card when it is interoperable with the other network.

As before, we can also find the threshold values for service providers' SEPA adjustment costs, a, that maintain Proposition 3

a_K^Π = a threshold value for service providers' adjustment cost parameter a for positive profit change

$$a_K^\Pi = \frac{1}{2}\left(V + \varepsilon - \frac{1}{2}t\right) - \frac{V^2}{4(t-\varepsilon)} = \frac{2(t-\varepsilon)(V + \varepsilon - \frac{1}{2}t) - V^2}{4(t-\varepsilon)}$$

a_K^W = a threshold value for service providers' adjustment cost parameter a for positive welfare change

$$a_K^W = \frac{1}{2}\left[V + \varepsilon - \frac{1}{4}t - (3t - 2\varepsilon)\left(\frac{V}{2(t-\varepsilon)}\right)^2\right].$$

As before, the existence of these threshold values is rather trivial so we only note that $a_K^W > a_K^\Pi$. Naturally, if $a > a_K^\Pi$, the payment card networks would be making lower profits compared to Pre-SEPA, but given the 'mandatory' role of SEPA they would still have needed to make necessary SEPA-investments. Similarly, if the adjustment costs were even higher, ie $a > a_K^W$, also the total welfare would be lower.

Also in the Post-SEPA kinked equilibrium case, the SEPA-introduction results in higher prices, network sizes, profits, consumer surplus and welfare when ignoring the fixed adjustment costs. When including the adjustment costs, an additional condition for increase in profits and welfare is that these costs are below the threshold values a_K^Π and a_K^W. In the Post-SEPA kinked equilibrium case, the market is just covered and both payment card networks have half of the market. Compared to Pre-SEPA, consumers can get network utility from both of the networks. Therefore, even though the prices are higher in Post-SEPA, consumers benefit via increased network utility and consumer surplus grows. Also the payment networks' profits are higher if the SEPA-adjustment costs are below the threshold value. Accordingly, total welfare also increases if the fixed SEPA-adjustment costs are not prohibitively high.

5   Discussion and future research

Our model analysed economic effects of SEPA-formation by applying a spatial competition model of retail payment networks. The model allowed us to examine the effects of SEPA-induced compatibility at the payment system level in a simple and tractable way: starting from Pre-SEPA local monopoly retail payment systems with no interoperability resulting into Post-SEPA interoperable systems due to compatibility standards. Because of the 'mandatory nature' of SEPA, our model did not deal with strategic standardisation and compatibility decisions commonly analysed in the network literature. A further step to this direction could be to adapt models of strategic standardisation like eg Gandal and Shy (2001) who analyse governments' incentives to recognise foreign standards and to form standardisation unions when there are potentially both network effects and conversion costs. Their three-country, three-firm spatial competition model could be modified to analyse also the formation of standardisation unions in the retail payments field, like SEPA in the European context.

Regarding the present model framework, we discuss next more thoroughly parameter interpretations and potential SEPA-effects on them. First, as in any spatial competition model, the interpretation of the differentiation parameter t plays an important role. In our analysis, we maintained the traditional interpretation: ie t measuring costs of travelling to obtain a payment card from payment networks located at the two extremities of the segment. When having this geographic interpretation, we are inclined to think that SEPA does not affect t because the travelling costs stay the same in both Pre- and Post-SEPA phases. Alternatively, when considering that t would measure the differentiation of the two payment cards as products, the formation of SEPA is likely to have an effect on it. In this case, the differentiation between the two payment cards can be thought to diminish in Post-SEPA as they can be used in both networks offering same services. In our framework, this would increase competition and reduce the likelihood that Post-SEPA markets remain segmented. In practise, however, other inherent differences, like language and culture aspects related to ancillary card services, could still play a role and make consumers to prefer their home country network.[14]

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[14] A further possible interpretation of t could be related to the consumers' preference of using different payment media. In this case, t could be thought of measuring 'disutility of card over cash' so that the consumers located around the center of the Hotelling line would strongly prefer cash in a symmetric way in both countries. Also in this case, SEPA would not affect t. This preference interpretation has, however, some drawbacks: eg why would a consumer who does not want to have a payment card from his home country network dislike even more the foreign card network in Post-SEPA? This interpretation would need to be complemented by eg the language or culture differences in order to be viable.

Secondly, the formulation of network utility in our model was rather simplistic. It was assumed that the cardholders get indirect network utility based on the size of their card network so that bigger network size translates to more potential usage points for cards and hence more utility (the more there are consumers who have the payment card, the more merchants are willing to accept them). Concerning the network utility parameter, ε describing the strength of this indirect network externality, we assumed it to be the same in Pre- and Post-SEPA. In the case of payment cards, this can be thought to be realistic: cardholders' network utility depends only on the acceptance of the cards at the points of sales. Therefore, the introduction of SEPA should not have an effect on ε. In the same vein, also the base utility of having a card, V, can be assumed to be the same in Pre- and Post-SEPA. In this case, it is natural that convenience value of the card (no need to have the exact amount of cash in hand for the purchase at the point of sales) or security value (no need to carry excess money balances) do not change with the introduction of SEPA.

In sum, the above potential parameter interpretations (besides 'the pure product differentiation' interpretation of t) suggest that SEPA would not have an effect on them. Therefore, our results, derived treating the parameters t, V, and ε constant, should be reasonable. However, one could also think of other more versatile formulations of consumers' utility, like eg in de Palma and Leruth (1996) where the consumers are differentiated in their willingness to pay for the network externality, or in Baake and Boom (2001) where the consumer's evaluation of a product depends both on its inherent quality and on its network size. With these types of demand formulations, SEPA-effects are likely to become less straightforward.

In our present framework, we can also consider the potential SEPA-induced compatibility effects on other SEPA payment instruments. Recalling the general utility function (1) from Section 2

$$U_1(x_i) = V - p_1 - tx_i + \varepsilon N_1 + \varepsilon N_2 k$$
$$U_2(x_j) = V - p_2 - t(1 - x_j) + \varepsilon N_2 + \varepsilon N_1 k$$

where we had k as indicator variable for compatibility {0,1}: k=0 for Pre-SEPA incompatibility and k=1 for Post-SEPA full compatibility. We can briefly discuss how this generic framework would apply to other SEPA-instruments. In the case of national debit cards, Pre-SEPA full incompatibility and Post-SEPA full compatibility have real-life counterparts: in Pre-SEPA, national debit cards can be used only in home network; and, in Post-SEPA, in both networks.

Regarding direct debits, we can apply a similar type of reasoning: in Pre-SEPA, consumers can make a direct debit contract only in their home country, whereas in Post-SEPA this possibility expands also to the foreign country. In

addition the indirect network utility could be thought to function in a similar way as in the payment card case: the larger 'the network size of direct debit users' (the more consumers have made direct debit agreements), the more debtors are willing to offer this payment instrument. Accordingly, at a general level the analysis for direct debits could be conducted in a similar way as we did with the national payment cards. Naturally, the institutional details of direct debit, like mandate handling, suitability of unit demand formulation etc., should be carefully considered but our basic philosophy of the expansion of positive network externalities due to the SEPA-induced compatibility seems to be applicable to direct debits as well.

Regarding credit transfers, the case is different as they could already be made cross-border even before the SEPA-introduction eg through correspondent banks or pan-European clearing house (and the Regulation 2560/2001 on cross-border payments in euro ensures the same pricing with domestic payments). SEPA brought nevertheless common standards for credit transfers as well. When considering credit transfers in terms of our modelling, we could think that the variable k for compatibility can take other values than zero and one, ie $k \in [0,1]$. For example, we could think that $k > 0$ in Pre-SEPA (as credit transfers can already be made cross-border but with some inconvenience compared to domestic ones) and $k = 1$ in Post-SEPA under common standards. This could be an interesting extension of the current model. Moreover, one could also try to better take on board the fact that network externalities associated with credit transfers are likely to be more like direct network externalities, eg in the style of network externalities á la Laffont et al (1998a, b).

Naturally, also the cost issues on the supply side are of importance. In our model, we deliberately left out production costs of payment card services besides the fixed SEPA-adjustment costs for service providers to update their system. Generally speaking, these costs can be high. Based on the consultant studies conducted, Schmiedel (2007) reports that SEPA-related investments for the European banking industry at the aggregate level range between 5.2 and 7.7 billion euros. If these SEPA-induced costs are mainly costs related to updating the systems of service providers to become SEPA-compliant, these costs can be thought as 'fixed adjustment cost' as we did. Then relaxing the zero production cost assumption and adding marginal costs that do not change as a result of the SEPA-formation would not affect our results.

However, SEPA may also yield cost reductions if potential economies of scale can be realised. Bolt and Humphrey (2007) estimate card and other payment network scale economies for European payment systems and verify their existence. Their results indicate that substantial cost efficiency gains could be achieved if processing was consolidated across borders rather than 'piggy-backed' onto existing national operations. In our framework, consolidation was not dealt

30

with but, if declining marginal costs were included, 'smaller scale' cost reductions could have been achievable because of the growing payment network sizes as a result of SEPA. Obviously, reduced marginal costs due to SEPA would strengthen the potential positive effects of the SEPA-formation. Anyway, inclusion of these potential cost reduction considerations could be an interesting extension to our model. An alternative way to deal with cost issues could be eg to adapt Gandal and Shy (2001) framework and include conversion costs in the Pre-SEPA phase when payment networks operate under national standards in contrast to common retail payment standards in the Post-SEPA.

Finally, also the market structure of retail payment systems is of the essence when analysing the effects of SEPA. In our analysis, we wanted to have a set-up to correspond to the current fragmented European retail payments landscape. Therefore, we had the Pre-SEPA segmented retail payment markets as our starting point thereby determining the relevant parameter areas for our SEPA-analysis. Theoretically, all the other possible parameter ranges could also be analysed for the sake of completeness. Accordingly, we could relax our Assumption 1 (Pre-SEPA segmented markets) and look at the SEPA-formation starting from other possible Pre-SEPA market configurations: ie kinked equilibrium and fully-covered Pre-SEPA markets. In this paper, we concentrated only on the case close to the reality and we leave these extensions for future work.

6   Summary and conclusions

The formation of the Single Euro Payments Area is posing a big challenge to the current fragmented European retail payment systems. Undoubtedly, its potentially far-reaching implications on the retail payments industry offer important and topical research questions. In this paper, we applied a simple spatial competition model of retail payment networks to study the likely economic consequences of the SEPA-formation. The model focused on some key ingredients in the SEPA-process: namely, i) the expansion of positive network externalities on the demand side and, ii) the SEPA-adjustment cost on the supply side. Given this stylised focus, we tried to find answers to a fundamental question in the SEPA-process: What are the economic effects when compatibility is forced into the retail payment markets that are initially segmented? We used the currently segmented national debit card markets as a demonstrative example in our analysis.

Some of our results are worth highlighting. Let us first consider the authorities' view on the final SEPA goal

'The Commission and the ECB see SEPA as an integrated market for payment services which is subject to effective competition and where there is no distinction between cross-border and national payments within the euro area.'[15]

When assessing this goal in the light of our results, the following can be said. If we have, corresponding quite closely to the real life situation, segmented Pre-SEPA retail payment markets as starting point, we do not enter in our model set-up into the competitive duopoly situation where retail payment markets are fully-integrated and effective price competition takes place. In other words, our model suggests that SEPA as such is not enough to lead to full-scale integration of retail payment markets. Instead, the possible market outcomes in Post-SEPA were segmented markets or markets characterised by kinked equilibrium.

In both Post-SEPA segmented markets and kinked equilibrium cases, the introduction of SEPA resulted in increased prices, larger network sizes and higher consumer surplus, but also profits and welfare increased if the SEPA-adjustment cost for payment networks were ignored. Furthermore, we were able to find threshold values for these adjustment costs under which payment networks' profits and total welfare would also rise. Accordingly, our results suggest that the overall effects of SEPA seem to be positive if the fixed SEPA-adjustment costs are not prohibitively high.

However, even though our model indicated that consumer surplus would always be higher in Post-SEPA, the resulting rising prices (annual fees in our model) could be problematic in real life. Consumers seem to expect lower prices as a result of the SEPA: a recent report[16] by the Dutch central bank argued that the most important reason for Dutch consumers to shift to SEPA debit card would be lower annual fees. The second most important reason was broader acceptance abroad which is in line with our model structure. Accordingly, it can be said that consumers do value the broader cross-border acceptance but the pricing issues seem to be even more important. In real life, the pricing issue can be crucial: for SEPA to become a success, it is the consumers as end-users who need to adopt the SEPA-payment instruments. In the extreme case, increased fees of payment instruments in Post-SEPA could have negative effects on the practical adoption decisions by consumers.

On the supply side, costs of SEPA have been under debate, and especially the payment service provider sector has emphasised their potential high magnitude. Admittedly, our modelling focused more on the demand side effects and potential cost issues on the supply side were given only a limited attention. Our model did not include production costs; we had only fixed adjustment costs payment

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[15] Joint statement by the European Commission and the ECB 4th of May 2006.
[16] Jonker and Kosse (2008).

networks face when updating their payment systems to become SEPA-compliant. These adjustment costs played only a trivial role in our model: we established threshold values for these costs under which profits and total welfare would be always higher in Post-SEPA. However, besides inducing fixed adjustment costs, SEPA can also have an effect on marginal costs. Studies have suggested that there exist significant economies of scale in the European retail payment systems. If these scale economies can be realised eg through consolidation, this would strengthen the potential favourable effects of SEPA-formation.

All in all, our simple model suggests that the overall effects of SEPA can be positive. Despite the higher prices consumers gain because of increased network utility, and also payment networks' profits and social welfare increase if the SEPA-adjustment costs are not prohibitively high. Naturally, one should be cautious not to draw too definitive conclusions on the desirability of the SEPA as it is in reality very complex and many-faceted undertaking including many stakeholders in addition to payment networks and consumers focused on our model. In this sense, our model could only give a limited view on the potential economic effects of SEPA when emphasising the expansion of demand side network externalities and fixed SEPA-adjustment costs on the supply side. Accordingly, further research covering wider range of relevant aspects, like the better treatment of cost side, competition between payment instruments etc., on the topical issue of SEPA-formation is warranted.

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Appendix 1

In the Post-SEPA segmented market case, it can be shown that only the smaller root of ε is valid when Assumption 2, requiring $t > 2\varepsilon$, holds.

Based on the Post-SEPA equilibrium market size equation $x_1 = \dfrac{(t-\varepsilon)V}{(t-2\varepsilon)(2t-\varepsilon)} \leq \dfrac{1}{2}$, the condition for Post-SEPA segmented markets is $V \leq t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)}$.

When letting $V = t - \varepsilon - \dfrac{t\varepsilon}{2(t-\varepsilon)}$, we get $2(t-\varepsilon)V = 2(t-\varepsilon)^2 - t\varepsilon$. Solving it for ε yields

$$\varepsilon = \frac{-2V + 5t \pm \sqrt{(2V-5t)^2 - 16t(t-V)}}{4} = \frac{-2V + 5t \pm \sqrt{4V^2 - 4Vt + 9t^2}}{4}.$$

Assumption 2 requires that $t > 2\varepsilon$, ie $\varepsilon < \dfrac{1}{2}t$. Let us now claim that the bigger root $\varepsilon = \dfrac{-2V + 5t + \sqrt{4V^2 - 4Vt + 9t^2}}{4} > \dfrac{1}{2}t$, which can be rearranged $\sqrt{4V^2 - 4Vt + 9t^2} > 2V - 3t$.

This inequality can be further examined by

1) assuming that $2V - 3t > 0$. Then by squaring both sides, we have $4V^2 - 4Vt + 9t^2 > (2V - 3t)^2$ to yield $8Vt > 0$, which always holds.

2) assuming that $2V - 3t < 0$. Then $\sqrt{4V^2 - 4Vt + 9t^2} > 2V - 3t$, when $4V^2 - 4Vt + 9t^2 > 0$, which is always true as it reaches its minimum at $V = 1/2t$ yielding to $8t^2 > 0$.

Accordingly, this results in a contradiction to Assumption 2 (ensuring positive network sizes in Post-SEPA segmented markets) requiring $t > 2\varepsilon$. Therefore, we can conclude that only smaller root of ε is valid: $\varepsilon = \dfrac{-2V + 5t - \sqrt{4V^2 - 4Vt + 9t^2}}{4}$.

Following similar steps, it can be shown that only the bigger root of t is valid.

Appendix 2

We can proof the existence of the kinked equilibrium by evaluating the first-order conditions for the Post-SEPA segmented and fully-covered markets equilibrium at the kinked equilibrium price

$$p^K = V + \varepsilon - \frac{1}{2}t$$

We first look at the Post-SEPA segmented markets case and then the Post-SEPA fully-covered market case and finally show that undercutting is not profitable in the kinked equilibrium. As in the main text, we assume that payment networks are symmetric, and we focus on network 1.

Post-SEPA segmented markets

The constrained profit maximisation problem for Post-SEPA segmented markets can be written as follows

$$\text{Max}\pi_1 = p_1 x_1 - a = p_1 \left(\frac{Vt - (t - \varepsilon)p_1 - \varepsilon p_2}{t(t - 2\varepsilon)} \right) - a$$

s.t. $p_1 \geq p^K$.

Taking the first-derivative yields

$$f(p) = \left(\frac{Vt - (t - \varepsilon)p_1 - \varepsilon p_2}{t(t - 2\varepsilon)} \right) - \frac{p_1(t - \varepsilon)}{t(t - 2\varepsilon)}$$

We want to show that $f(p) < 0$, when evaluating it at $p_1 = p_2 = p^K$. This yields

$$f(p^K) = \left(\frac{Vt - (t - \varepsilon)p^K - \varepsilon p^K}{t(t - 2\varepsilon)} \right) - \frac{p^K(t - \varepsilon)}{t(t - 2\varepsilon)} < 0$$

By rearranging and multiplying by $t(t - 2\varepsilon)$ that is positive by Assumption 2, we get $Vt - p^K(2t - \varepsilon) < 0$, and when inserting the kinked equilibrium price p^K in, we have

$$Vt - (V + \varepsilon - \frac{1}{2}t)(2t - \varepsilon) < 0$$

38

$$V > t - \varepsilon - \frac{t\varepsilon}{2(t-\varepsilon)}$$

Accordingly, we can conclude that $f(p^K) < 0$, when $V > t - \varepsilon - \frac{t\varepsilon}{2(t-\varepsilon)}$. In this case, optimal price is $p_1 = p_2 = p^K$.

Post-SEPA fully-covered market

The constrained profit maximisation problem for Post-SEPA fully-covered markets can be written as follows

$$\mathrm{Max}\pi_1 = p_1 x_1 - a = p_1 \frac{t - p_1 + p_2}{2t} - a$$
s.t. $p_1 \leq p^K$

Taking the first derivative yields

$$g(p) = \frac{t - 2p_1 + p_2}{2t}$$

We want to show that $g(p) > 0$, when evaluating it at $p_1 = p_2 = p^K$. This yields

$$g(p^K) = \frac{t - 2p^K + p^K}{2t} > 0$$

By rearranging and multiplying by 2t that is positive, we get

$$t - p^K > 0$$

and when inserting the kinked equilibrium price p^K in, we get

$$t - V - \varepsilon + \frac{1}{2}t > 0$$

$$V < \frac{3}{2}t - \varepsilon$$

Accordingly, we can conclude that $g(p^K) > 0$, when $V < \frac{3}{2}t - \varepsilon$. In this case, optimal price is $p_1 = p_2 = p^K$.

Undercutting

With linear transportation costs, an additional condition for the existence of the kinked equilibrium is that a network cannot capture its competitor's entire market by undercutting. To prove that undercutting is not profitable, recall the utility functions (3.1) in the main text

$$U_1(x_i) = V - p_1 - tx_i + \varepsilon N_1 + \varepsilon N_2 k$$
$$U_2(x_j) = V - p_2 - t(1 - x_j) + \varepsilon N_2 + \varepsilon N_1 k$$

Let us now assume that network 2 sets price $p_2 = p^K$. If network 1 deviates to capture the whole market, a necessary condition for a consumer $x_i = 1$ to join network 1 is $U_1(x_i = 1) \geq 0$.

Accordingly, a consumer $x_i = 1$ joins network 1, if

$$V - p_1 - t + \varepsilon \geq 0 \iff p_1 \leq V - (t - \varepsilon)$$

By Assumption 1, we have $V \leq t - \varepsilon$ so that $p_1 \leq 0$ proving that undercutting is not profitable.

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