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Links between securities settlement systems:

An oligopoly theoretic approach

Suomen Pankin keskustelualoitteita
Finlands Banks diskussionsunderlag

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Links between securities settlement systems: An oligopoly theoretic approach

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Abstract

This paper presents a duopoly model of the securities settlement industry. Because pooling a large amount of payments can help in using liquidity efficiently, issuers prefer systems where a large number of securities are issued. If the central securities depositories establish a mutual link that enables investors to make transactions with foreign securities, cost savings can be achieved. However, these links may have unexpected effects on CSDs' pricing, and the issuers' share of the fee burden can increase substantially. It is not advisable to ban additional fees for using the link, as the CSDs might simply increase the fee for domestic transactions.

Key words: oligopoly, securities settlement systems

JEL classification numbers: L13, G20

Arvopaperiselvitysjärjestelmien linkittäminen Oligopoliteoreettinen lähestymistapa

Suomen Pankin keskustelualoitteita 27/2002

Karlo Kauko
Tutkimusosasto

Tiivistelmä

Tässä keskustelualoitteessa esitetään arvopaperiselvitysjärjestelmiä kuvaava duopolimalli. Koska maksujen keskittäminen yhteen järjestelmään auttaa käyttämään likviditeettiä tehokkaasti, liikkeeseenlaskijat suosivat järjestelmiä, joissa on runsaasti arvopapereita. Jos arvopaperikeskukset perustavat keskinäisen linkin, jonka kautta sijoittajat voivat selvittää transaktioita ulkomaisilla arvopapereilla, voidaan saavuttaa kustannussäästöjä. Toisaalta tällaisilla linkeillä voi olla yllättäviä vaikutuksia arvopaperikeskusten hinnoitteluun – ja liikkeeseenlaskijoiden osuus maksuista voi kasvaa. Ei ole suositeltavaa vaatia arvopaperikeskuksia perimään samoja maksuja kotimaisilta ja kansainvälisiltä transaktioilta; arvopaperikeskukset saattaisivat vain nostaa kotimaisten transaktioiden hintoja.

Avainsanat: oligopoli, arvopapereiden selvitysjärjestelmät

JEL-luokittelu: L13, G20

Contents

1 Introduction

The key functions in secondary markets for securities are trading, clearing and settlement. In conducting trades, agents simply agree (make a deal) on buying and selling securities. The deals are executed in the clearing and settlement process. To put it simply, clearing entails the matching and verification of deals and computation of obligations. In the settlement process, monetary payments from buyers to sellers are executed and securities are delivered from sellers to buyers. Securities transactions are usually settled a few days after the deal.

Modern securities settlement systems are often highly centralised. At the heart of the system there is a central institution that runs the system, such as the national Central Securities Depository (CSD). A relatively small number of institutions participate directly in the process. These participants are called members or clearing parties. Members of a settlement system are financial institutions, such as banks and investment service companies (ISCs). Government treasuries and central banks may also be members. A typical investor uses services provided by a member of the settlement system.

The European securities market infrastructure will most likely undergo a historically exceptional upheaval in the near future. The existing structure appears to be outdated. There is a large number of non-integrated national systems. Most of these were established before launch of the EMU, and in many cases before the country joined the union. Most of the securities traded in these systems are issued by domestic entities. As to clearing and settlement, the European securities market is highly fragmented. Even though remote access from abroad to trading has become commonplace, remote participation in securities settlement systems is still exceptional. The Giovannini report (2001) discusses the practical problems related to cross-border clearing and settlement in the EU. These difficulties include national differences in technical requirements, differences in market practice, and problems concerning taxation and lack of legal certainty.

In recent years several mergers have taken place between securities markets infrastructure institutions. This consolidation has been both vertical and horizontal. To a large extent consolidation has taken place at the national level. However, a few international mergers have also occurred between EU member countries.

Links between CSDs are another relatively new arrangement aimed at improving the possibilities to settle cross-border transactions. These links are established by bilateral agreements between securities settlement systems. The customers of a securities settlement system can hold securities in another system through the domestic service provider. The domestic service provider opens an omnibus account in a foreign book-entry system, and the holdings of its customers are pooled in this account. The investors' domestic CSD keeps detailed records on holdings at the investor level.

This paper analyses the oligopolistic competition between two settlement systems in a fragmented market. The focus is on pricing and inter-linking the two systems. The systems operate in a platform industry as defined by Rochet and Tirole (2001), and they have to attract both issuers and investors.

The basic version of the model is presented in sections 2 and 3. Issuers have to choose between two CSDs, and securities registered in a CSD cannot be settled via its competitor. It turns out that the whole fee burden is borne by investors. In section 4 it is assumed that the two CSDs are linked. If the two central securities depositories establish a mutual link that enables investors to make transactions with foreign securities, significant cost savings can be achieved in both the use of liquidity and in operative costs of cross-border transactions. Moreover, pricing is affected. Competition for issuers is relaxed, and their fee burden increases, whereas investors can get domestic services even at no cost. In section 5 it is demonstrated that it is not advisable to ban additional fees for using the link because this may simply lead to higher prices for domestic services. The main conlcusions and suggestions for further research are discussed in the section 6.

The model implies a network externality in monetary payments; pooling a large number of securities in the same system improves the possibilities to reduce costly liquidity usage. This effect differs from the equilibrium price externality, which has been analysed in earlier literature (Economides and Siow (1988)). Even though there are earlier analyses on network effects and oligopolistic competition between stock exchanges (Di Noia (1999), Shy and Tarkka (2001)), these focus on trading activities. It is difficult to find much literature on oligopolistic competition between book-entry registers and settlement systems.

2 Assumptions of the basic model

There is a very large number of bond issuers, each of whom issues I bonds in the primary market. The issuers are numbered 0,1,2,…,M. The bonds are in book-entry form. Issuers try to maximise the difference between value of bonds in the primary market and cost of registering and issuing them. The bonds are sold to investors at a price equal to the difference between a constant and the expected value of secondary market settlement costs paid by bondholders who buy bonds in the primary market. The issuer pays all fees related to issuance.

Investors live in two countries, denoted 1 and 2. In each country these investors are divided into two groups, A and B. These groups could eg be households and institutional investors. The two categories exist in both countries.

There is a profit maximising central securities depository (CSD) in each country. Each CSD operates on both sides of the market, as platform industry à la Rochet and Tirole (2001), because they need two types of customers that need to interact – issuers and investors.

CSD is the registrar of the book-entry system. Registering new issues is costfree. The same institution runs the securities settlement system. All the securities in its registers are settled in its system. Running the settlement process generates costs. The unit cost – per transaction, sale or purchase – of the centre of the country j is denoted z_j.

Bonds are distributed among investors in the primary market so that the proportion of bondholders of issuer i living in country 1 is (M–i)/M. Every issuer knows beforehand where its investors live.

All the original bondholders of any given issue belong to the same investor category. Half of the issues are subscribed by category A investors, half by category B investors. The bond number is not related to the category of the investor buying the bonds in the primary market. In most cases not all the bondholders live in the same country, but the two categories exist in both countries.

There is a secondary market for bonds. Deals made in the secondary market are settled in systems operated by the CSDs. Investors must use investment service companies (ISCs) to settle transactions in the CSDs. There are four ISCs in each country, each of which offers services to one category of investors, A or B. In each country there are two ISCs competing for category A investors and two competing for category B investors.

ISCs cannot become members of the foreign securities settlement system. If both traded bond issues are registered in the same country, no investor uses more than one ISC. If the two bonds are registered in different countries, each investor must choose one ISC in each country.

The ISCs achieve turnover via pricing of their services to investors. The price charged by an ISC (v) must be the same for both transaction types, sale and purchase. The ISCs have linear cost functions with constant returns to scale. The cost of processing a transaction is y, which is an exogenous constant, common to all the ISCs. One deal, consisting of a sale and corresponding purchase, is now defined as two transactions.

The ISCs Bertrand-compete with identical services.

Only two of the bond issues are traded; which ones is determined randomly by mechanisms that are not analysed in this model. Every bond issue is equally likely to be traded. The two traded bonds are originally held by investors of different categories. The bondholders of these two firms exchange securities. Every investor is simultaneously a seller and a buyer. An issue previously held by category A investors comes to be held by category B investors, and vice versa. Price formation and trading are ignored. The price of every security in the secondary market is the same, and does not depend on settlement costs. In the real world, high settlement costs reduce both supply and demand, and the total impact on price would be unclear. Because each investor is simultaneously seller and buyer, the sum of monetary payments made and received by him is zero, except for the ISC's fee.

Monetary payments between securities settlement systems and ISCs are based on netting.[1] The ISCs prefer situations where they intermediate both sales and purchases and need not make gross payments to the ISC. If gross payments are made, the ISCs may need large and costly cash balances. Secondly, the ISC might be unable to acquire liquidity to cover its net payment obligations, which could result in sanctions. Thirdly, clearing parties with net obligations may have to post some assets as collateral. Collateral requirements may force the clearing parties to hold larger portfolios, eg of government securities, than they would otherwise prefer. Moreover, by pledging an important part of its assets the clearing party weakens its own creditworthiness in non-collateralised borrowing, because collateralised assets cannot be freely liquidated to cover debts in case of bankruptcy. This probably affects the price of external funding.

The expected total cost and disutility of being a clearing party with a gross payment obligation is α per security purchase to be intermediated. The analysis is restricted to cases where $2h > \alpha$. In section 3.2 it will be seen that there is no meaningful equilibrium with two participating CSDs if this condition is not satisfied.

Things happen in the following order.

1) Profit maximising CSDs set their prices, including a price to be paid by the issuer (p_I for the CSD based in the country i) and a unit price per bond to be paid by clearing parties (b_i).
2) Issuers choose between the CSDs. Bonds are issued. Every issuer tries to maximise its own wealth by minimising the expected value of the sum of fees paid by the company itself and its primary market investors.
3) Profit maximising ISCs decide simultaneously their fees (v's).
4) The two bond issues to be traded are determined.
5) Investors choose ISCs and try to minimise settlement costs.
6) The trades are settled, net payments are made, and securities are transferred.

[1] This assumption of net payments can be a satisfactory approximation of many gross settlement systems. In a typical gross settlement system no settlement counterparty is obliged to make all the outgoing payments during a day before getting any incoming payments. Instead, automatic chaining procedures applied in many systems guarantee that incoming payments can be used in an efficient way as a source of funding for outgoing payments.

All the agents can immediately observe every decision and random outcome. All the agents are risk neutral.

It is possible to interpret the model in such a way that steps 4, 5 and 6 describe a day. These three steps are repeated hundreds of times every year. This would not be a supergame because the CSDs and ISCs make no decisions at these stages. If one asumes that stages 4–6 are repeated over and over again, the expected values analysed in the following sections are simply multiplied by the number of repetitions. This would have no fundamental impact on optimal decisions by CSDs and ISCs.

3 Solving the model

3.1 Competition between ISCs

Bertrand competition with identical services implies that the fee charged by an ISC (v_i) must equal the marginal cost of serving an additional customer. The marginal cost is the sum of the unit fee charged by the CSD (b_j), the marginal processing cost for the ISC (y), and the expected value of the per-transaction cost of gross payments (F_i).

$$v_i = F_i + b_j + y \tag{1}$$

Gross payment costs are the only complicated component of the marginal cost. If two bond issues, i and j, are traded, the cost of gross payments (α) materialises as a part of country 1's ISC cost in two possible cases. (Terms in parentheses are respective probabilities.)

Bond i is registered in domestic country (Γ_1) and bond j in the foreign country (Γ_2). The ISC represents half of the buyers.

Bond i is registered in the foreign country (Γ_2) and bond j in the domestic country (Γ_1). The ISC represents half of the buyers.

Hence, the expected value of the total gross payment cost is

$$\alpha \cdot \left(\frac{\Gamma_1 \Gamma_2}{2} + \frac{\Gamma_2 \Gamma_1}{2} \right) = \alpha \cdot \Gamma_1 \Gamma_2 \tag{2}$$

A certain part of the fee corresponds to this expected value of the cost of gross payments. According to equation 1 the expected value of this cost factor must equal the expected value of the corresponding fee revenue.

The expected value of the number of transactions is the sum of two components

– The ISC collects fees if one of the two securities to be traded is registered in the ISC's home country. Every customer must pay the fee once to the CSD. The probability of this equals $2\Gamma_1\Gamma_2$.
– The ISC charges fees if both issues to be traded are registered domestically. The probability that both bond issues to be settled are registered in the country 1 equals Γ_1^2. In this case each customer has to pay the same fee twice because he presents two settlement orders to the same ISC.

In expected value terms, the part of the fee revenue that corresponds to gross payment costs equals

$$F_1 \cdot \left(2 \cdot \Gamma_2\Gamma_1 + 2 \cdot \Gamma_1^2\right) \tag{3}$$

The expected value of fee revenue related to gross payment costs (3) must equal the expected cost of making gross payments (2)

$$\begin{aligned} &\alpha\Gamma_j\Gamma_i = F \cdot \left(2 \cdot \Gamma_j\Gamma_i + 2 \cdot \Gamma_i^2\right) \\ &\Rightarrow F_i = \frac{\alpha\Gamma_j}{2} \end{aligned} \tag{4}$$

This result is essentially intuitive. If the market share of the domestic CSD of country 1 is marginal ($\Gamma_1 \approx 0$), it is almost certain that if a domestically registered bond is traded, the other bond to be traded is registered abroad, and netting cannot be used. The ISC has a 50% chance of representing a given buyer. The larger the market share of the domestic CSD becomes, the more likely it is that the ISCs would benefit from netting. If all the companies are registered in country 1 ($\Gamma_2 = 0$), all the payments can be netted.

Therefore, equation (1) can be rewritten as

$$v_i = \frac{\alpha\Gamma_j}{2} + b_i + y \tag{5}$$

3.2 Pricing decisions by the CSDs

The CSDs try to maximise the expected value of profits. Their decision variables are the price paid by issuers (denoted p_i) and the price per transaction paid by settlement counterparties (denoted b_i). Issuers try to minimise the sum of fees paid by themselves and the settlement costs to their bondholders. Investors' costs are relevant because they affect the securities prices in the primary market.

If 100·j% of the bondholders live in country 2, the cost of using CSD 1 is

$$p_1 + I\left(\frac{2}{M}\right)\cdot\{V_1 + j\cdot h\}$$

2/M being the probability that the issuer will be either of the two issuers whose securities are traded and V_1 the price charged by all the ISCs of the country 1.

The cost of using the CSD 2 is

$$p_2 + I\left(\frac{2}{M}\right)\cdot\{V_2 + (1-j)\cdot h\}$$

Because $V_1 = \alpha\Gamma_2/2 + b_1 + y$ and $V_2 = \alpha\Gamma_1/2 + b_2 + y$, the condition for using CSD 1 can be written

$$p_1 + \left(\frac{2I}{M}\right)\cdot\left\{\frac{\alpha\Gamma_1}{2} + b_2 + y + j\cdot h\right\} < p_2 + \left(\frac{2I}{M}\right)\cdot\left\{\frac{\alpha(1-\Gamma_1)}{2} + b_2 + y + (1-j)\cdot h\right\}$$

$$\Leftrightarrow j < \frac{\{2hI - \alpha I - 2Ib_1 + 2Ib_2 + 2\alpha\Gamma_1 I - Mp_1 + Mp_2\}}{\{4hI\}} \tag{6}$$

The condition implies a network externality. The market share of CSD 1 (Γ_1) has a direct impact on its competitiveness. The reason for this outcome is quite simple: If most companies are registered at CSD 1, it becomes more likely that ISCs operating in country 1 need not make gross payments in the settlement system. This, in turn, has a direct impact on the fee paid by investors (V_1).

In equilibrium, the relative share of issuers preferring CSD 1 must equal the market share Γ_1. Because issuers' bondholder structures are evenly distributed along the continuum from j = 0 to j = 100, it follows that (6) implies

$$\Gamma_1 = \tfrac{1}{2} + \frac{\left[2b_2 - 2b_1 + \left(\frac{M}{I}\right)\cdot(p_2 - p_1)\right]}{[4h - 2\cdot\alpha]} \tag{7}$$

The CSD has two decision variables, b and p. As determinants of market shares these two variables are perfect substitutes; any combination of p and b that satifies the condition $2Ib_1 + Mp_1 = D$ (D being any constant) leads to the same market share. The CSD can decide these prices in the following way. First, CSD 1 decides a suitable value of D. Then it decides which value of p_1 to use; this decision determines the value of b_1. When D is given, the market share Γ_1 is determined even if the CSD has not decided which combination of the two fees (b and p) to use to implement the chosen value of D. Using this notation, the expected profit of CSD 1 can be written as

$$\Pi_1 = \Gamma_1\left[M \cdot p_1 + \left\{\frac{4 \cdot I \cdot (D - Mp_1)}{(2I)}\right\} - z_1\right] = \Gamma_1\left[2D - M \cdot p_1 - z_1\right]$$

$$\Rightarrow \frac{\partial \Pi_1}{\partial p_1} = -\Gamma_1 M < 0$$

It follows that the optimal price paid by issuers is 0, and the whole fee burden is borne by ISCs and investors ($p_1 = p_2 = 0$, $b_1 = D/(2I)$). When choosing the CSD, issuers pay no attention to the fees paid by future bondholders. However, these fees are a valuable source of revenue for CSDs, which rely on such income as much as possible.

There are two issues of I bonds to be traded. For both of them the likelihood of being registered in the CSD 1 equals its market share (Γ_1), implying that the expected value of the number of processed securities equals $2I\Gamma_1$. Each traded issue registered in CSD 1 yields two service fees (b_1) per processed security, one for selling and another for buying. The cost per processed security equals $2 \cdot z_1$. Therefore, the expected profit of the CSD i is

$$\Pi_i = 2 \cdot I \cdot \left[b_i - z_i\right] \cdot \frac{\left[-\alpha + 2b_j - 2b_i + 2h\right]}{\left[2h - \alpha\right]} \tag{8}$$

The first order optimsation condition of a CSD is

$$\frac{\partial \Pi_i}{\partial b_i} = -2I\frac{\left[\alpha + 4b_i - 2 \cdot (b_j + h + z_i)\right]}{\left[2h - \alpha\right]} = 0 \tag{9}$$

This condition is satisfied for both CSDs iff (i = 1,2)

$$b_i = \frac{\left(-3 \cdot \alpha + 6h + 4z_i + 2z_j\right)}{6} \tag{10}$$

The second order condition is $\partial^2 \Pi_1 / \partial b_1^2 = -8I/(2h - \alpha)$. This is negative and the extreme values are maxima iff $\alpha < 2h$. If this condition is not satisfied there are no meaningful equilibria where both CSDs have a positive market share. Formula (7) would imply that $\partial \Gamma_i / \partial p_i > 0$ and $\partial \Gamma_i / \partial r_i > 0$, which is not a meaningful result.

The result 10 can be understood intuitively in the following way. First, being cost inefficient (having a high value of z) means means a high optimal price. A cost inefficient competitor improves the possibilities to charge high prices because price competition is not especially fierce. If the cost of making cross-border transactions (h) is high, the CSD's pricing decisions are made in a less competitive environment because the issuer's decisions are determined by bondholders' home countries rather than the CSD's prices.

The most interesting finding might be the impact of netting possibilities on price competition. If almost nothing can be gained by netting ($\alpha \approx 0$), price competition is moderate. If, instead, the potential cost savings are substantial ($\alpha >> 0$), price competition is fierce. By attracting an issuer with aggressive pricing the CSD can easily attract another issuer, because its bondholders value the possibility to benefit from netting, in case they will exchange bond issues with the bondholders of the issuer i. This outcome is analogous in some ways with that of Katz and Shapiro (1986): positive network externalities between customers of the same seller can intensify price competition because mere market share as such further improves competitiveness.

These pricing decisions imply the following market shares

$$\Gamma_i = \frac{\lfloor -3\alpha + 6h - 2z_i + 2z_j \rfloor}{[12h - 6\alpha]} \tag{11}$$

The profits of the country i CSD can be calculated by combining the results (10) and (11)

$$\Pi_i = I \frac{[-3\alpha + 6h - 2z_i + 2z_j]^2}{[9(2h - \alpha)]} \tag{12}$$

Because the cost of cross-border transactions is the CSD's only source of market power, it is not surprising that high costs increase the likelihood that both CSDs would make positive profits. The cost of making gross payments (α), has another kind of impact. A high cost of gross payments intensifies price competition and makes customers prefer the larger CSD, making it increasingly difficult, especially for the smaller CSD, to charge prices that exceed costs.

The empirical prediction of this model is that the issuers are loss-leaders, as defined by Rochet and Tirole (2001), whereas investors are the profit-making segment for CSDs.

4 Linking the two securities centres

4.1 Assumptions

Every ISC can participate in the securities settlement system of the neighbouring country through the domestic CSD. The domestic CSD has an omnibus account with the foreign CSD, on which customers' securities are held. The operating costs of a transaction are borne by the CSD of the investor's home country. From the point of view of registration country processes, there is only one large net transaction on one particular customer account, whereas the CSD based in the investors' home country must administer thousands of small transactions on a large number of accounts.

CSD i sets three different prices.

A price paid by each issuer (p_i, $p_i \geq 0$).

A basic unit fee paid by ISCs for settlement transactions involving any security (b_i, $b_i \geq 0$)

An additional fee paid by ISCs for settlement transactions with foreign securities (r_i, $r_i \geq 0$).

When trading in foreign securities, the investor can either use a domestic ISC connected to the domestic CSD and the link, or alternatively the investor can participate via a foreign ISC. If the investor uses a foreign ISC, there is an extra cost h, as in the basic version of the model.

Things happen in the following order

- CSDs set the prices for issuers (p's) and for ISCs (b's and r's, $b_i \geq 0$)
- ISCs set their prices
- Issuers choose CSDs
- Investors choose ISCs. Trades are agreed, cleared and settled.

Establishing the link is pointless unless the CSDs know that investors are going to use it. Because of full information, both CSDs are able to determine beforehand their own pricing, the rival's pricing and the optimal investor reactions to these decisions. Hence, the following analysis can be restricted to cases where the link is in use. However, investors' possibilities to use foreign ISCs are not completely irrelevant when CSDs set prices.

4.2 Competition between ISCs

If a cross-border transaction is processed via the link, every investor deals through one ISC. Because no investor has a gross payment to be made, the monetary payment between ISC and investor is always zero. Consequently even the monetary payments between ISC and CSD can always be netted. Interestingly, even the net payment between the two CSDs would always be zero because of complete netting at all the levels. If we assume that the CSDs offer no crossborder payment facilities, the ISCs in different countries may agree on bilateral netting or may use an existing international payment system in which payments can be netted. Hence, the cost component α vanishes. This reduced need for liquidity can be used as an argument in favour of consolidation and linking in the securities settlement industry.

Equation (2) implies that the prices paid by customers in country i are

$$\begin{aligned} V_{id} &= b_i + y \\ V_{if} &= b_i + r_i + y \end{aligned} \tag{13}$$

where V_{id} is the price paid by country i investors for domestic transactions and V_{if} the price paid for cross-border transactions.

4.3 Market shares

Issuer i, with 100·(i/M)% of its bondholders living in the country 2, prefers to use the CSD 1 iff

$$\begin{aligned} & p_1 + b_1 \cdot I\left(1 - \frac{i}{M}\right) + (b_2 + r_2) \cdot I \cdot \frac{i}{M} < p_2 + (b_1 + r_1)I\left(1 - \frac{i}{M}\right) + I \cdot \frac{i}{M} \cdot b_2 \\ & \Leftrightarrow i < M \frac{(Ir_1 - p_1 + p_2)}{(Ir_1 + Ir_2)} \end{aligned}$$

The market share of the CSD does not enter this expression. The network externality that prevailed in the previous version of the model no longer exists because all payments can be netted. The formulas for market shares can be derived easily from the above condition

$$\Gamma_i = \frac{(Ir_i - p_i + p_j)}{[I(r_i + r_j)]} \tag{14}$$

Interestingly, the basic transaction fee (b_i) is irrelevant for market share. Possibly even more surprising is that high extra fees charged for cross-border transactions increase the market share because CSD 1 can make the rival CSD 2 unattractive for country 1 customers.

$$\frac{\partial \Gamma_1}{\partial r_1} = \frac{[Ir_2 - p_2 + p_1]}{[I(r_1 + r_2)^2]} > 0$$

4.4 CSDs' profits

Now, the relative share of securities originally issued in a CSD has no direct impact on the number of secondary market transactions processed by it. Investors' home countries determine where the securities are settled irrespective of the original country of issuance.

CSD_1 can earn revenue in three different ways.

First, when securities are issued, the CSD collects fees related to securities registration and primary market transactions. This revenue is easily calculated by multiplying the fee revenue from each issue (p) by the number of issuers (M) by the market share of the CSD (Γ)

$$p_1 M \Gamma_1 \tag{15}$$

Secondly, it earns revenue by selling services to buyers. The number of securities to be bought equals (2·I). In expected value terms half of the buyers live in the home country of the CSD. A certain percentage of securities are registered abroad, implying that there is an extra fee revenue worth I $(1 - \Gamma_1)r_1$. Therefore the total net revenue from buyers equals

$$I(b_1 - z_1) + I(1 - \Gamma_1)r_1 \tag{16}$$

Calculating the fee revenue collected from investors selling securities is more complicated. The country of registration covariates with original bondholders' home countries. The expected value of net revenue earned by providing services to sellers of the domestically registered security i equals

$$\left(\frac{2}{M}\right) \cdot I(b_1 - z_1)\left(1 - \frac{i}{M}\right)$$

(2/M) being the likelihood that the issue is traded, I the number of securities per issue, $(b_1 - z_1)$ the net revenue per transaction and $(1 - i/M)$ the relative share of bondholders living in country 1 and consequently using the services of CSD 1.

As regards securities registered in the foreign country, the net revenue for selling is determined in a similar way, the difference being the extra fee r_1

$$\left(\frac{2}{M}\right) I \cdot (b_1 + r_1 - z_1)\left(1 - \frac{i}{M}\right)$$

The number of domestically registered bond issues is $M\Gamma_1$ and the total number of issuers is M. It follows that the net income from providing sellers with services is

$$\int_0^{M\Gamma_1} \left(\frac{2}{M}\right) \cdot I(b_1 - z_1)\left(1 - \frac{i}{M}\right) di + \int_{M\Gamma_1}^{M} \left(\frac{2}{M}\right) \cdot I \cdot (b_1 + r_1 - z_1) \cdot \left(1 - \frac{i}{M}\right) di \qquad (17)$$

The profit can be calculated as the sum of these three components (15, 16 and 17).

$$\Pi_i = 2b_i I + \Gamma_i M p_i + 2Ir_i - 3Ir_i\Gamma_i + \Gamma_i^2 Ir_i - 2Iz_i \qquad (18)$$

The additional fee (r) and the market share (Γ) have complicated interaction effects, whereas the impact of the basic fee (b) and the issuing fee (p) on profits are rather straightforward.

4.5 Prices and profits

When the expressions (14) are substituted for market shares, optimal prices in the primary market are determined by the following conditions

$$\frac{\partial \Pi_1}{\partial p_1} = 0 \qquad \frac{\partial \Pi_2}{\partial p_2} = 0$$

There is one combination of p's that satisfies both conditions, namely

$$p_i = I\frac{\left\{-8r_ir_j + M^2\left(r_j^2 + 3r_ir_j + 2r_i^2\right) + M\left(r_j^2 + 5r_ir_j + 2r_i^2\right)\right\}}{\left[M(3M-2)(r_i + r_j)\right]} \qquad (19)$$

The second order condition $(\partial^2\Pi_1 / \partial p_1^2 = -2\{(M-1)r_1 + Mr_2\}/\{I(r_1 + r_2)^2\} < 0)$ is satisfied. Because M>>0, both $p_1 > 0$ and $p_2 > 0$ whenever either $r_1 > 0$, $r_2 > 0$ or both.

Differentiation of formula 18 yields

$$\frac{\partial \Pi_1}{\partial b_1} = 2I > 0 \tag{20}$$

It would always be optimal to charge a higher fee, if pricing were not constrained by any conditions. Therefore, the upper limit for this fee is determined by the condition that the total fee paid by cross-border investors cannot be higher than the cost of using foreign ISCs. It follows that if a CSD wants to intermediate settlement orders through the link, the highest feasible price satisfies the condition

$$b_i + r_i = b_j + h \quad \Rightarrow \quad b_i = b_j + h - r_i \tag{21}$$

Hence, both the fee paid by issuers (p_i) and the basic fee paid by investors (b_i) can be expressed as functions of r_i, b_j and h.

By substituting expression (21) for b_1, substituting the optimal price presented in (19) for p_1 and substituting the expression (14) for market shares, taking into account the assumption that M>>0, differentiation of (18) yields

$$\operatorname*{Lim}_{M\to\infty}\left[\frac{\partial \Pi_1}{\partial r_1}\right] = \operatorname*{Lim}_{M\to\infty} M \frac{\{3p_2r_2 + 2Ir_1(r_1 + 2r_2)\}}{\left[9(r_1 + r_2)^2\right]} \tag{22}$$

Whenever $r_1 > 0$, $r_2 > 0$ or both, this equals $+\infty$. It follows that irrespective of rival prices, the additional fee for cross-border transactions (r_1) is the highest fee that still satisfies the condition (21), and the optimal combination of b_1 and r_1 is

$$r_1 = h + b_2 \quad ; \quad b_1 = 0 \tag{23}$$

Because the rival operates under similar circumstances, it is optimal for it to offer domestic services free of charge ($b_2 = 0$). It follows that, according to (23), the optimal additional fee for cross-border services equals the cost for investors to go accross the border themselves ($r_1 = r_2 = h$). This outcome is not likely to be highly dependent on the assumption of zero price elasticity of demand. The pricing decision of the CSD is constrained by the fact that domestic customers will use foreign ISCs whenever the additional fee (r) is higher than investors' cost of using foreign ISCs (h). If this condition is binding, it binds irrespective of whether there would be a higher but finite optimal monopoly price or not. In real life CSD's fees for cross-border transactions are higher than fees for domestic transactions (Lannoo and Levin (2001), p. 16).

Interestingly, the link does not promote integration of securities markets. In the absence of the link, the cost differential between domestic and cross-border transactions is an exogenous constant h, at least if both CSDs are equally cost efficient. Now, in the presence of the link, the difference still equals h, even though the cost consists of CSDs fees.

When $r_1 = r_2 = h$ and $b_1 = b_2 = 0$, the formula (19) implies that the fee paid by issuers equals

$$p_i = \frac{I(2+M)\cdot h}{M} \tag{24}$$

Applying the results 14, 18, 23 and 24 yields

$$\Pi_i = \frac{I[h(7+2M)-8z_i]}{4} \tag{25}$$

This model predicts that in the presence of the link CSDs would charge issuers rather than investors. In the basic version issuers could make CSDs compete, whereas investors could not. If there is a link between the two CSDs, issuers no longer determine where the secondary market investors have to operate, which makes it less essential to attract them.

This outcome is somewhat analogous to a result of Laffont, Rey and Tirole (1998). They concluded that if telecommunications operators can charge additional fees for calls between nets, there can be positive network externalities between customers of the same operator, which might intensify price competition, exactly as in this model on securities settlement systems. However, because telecommunications networks are not two-sided markets, the fee burden cannot be entirely shifted to another customer group.

4.6 Will the link be established?

Profit maximising CSDs establish the link if they can earn higher profits with than without it. The situation can be analysed by comparing the expressions for profits under the two alternative arrangements (12 and 25). CSD i would prefer to establish the link if the following condition is satisfied

$$\frac{I[-3\alpha+6h-2z_i+2z_j]^2}{[9\cdot(2\cdot h-\alpha)]} < \frac{I[h(7+2M)-8z_i]}{4} \tag{26}$$

If $z_1 = z_2 = z$, either both or neither of the CSDs prefer to establish the link. Thus condition (26) can be rewritten as

$$M > \tfrac{1}{2} + \frac{4z - 2\alpha}{h} \qquad (27)$$

If there are no operating costs ($z = 0$), the CSDs always prefer to establish the link. Non-linked CSDs can pass this cost burden to investors, whereas linked CSDs cannot. A large number of issuers (M) makes it more certain that the CSDs would want to establish the link because issuers become the profit making sector, and if there is a large number of them, opening the link is a lucrative strategy. High costs of gross payments (α) encourage CSDs to establish the link; these costs intensify price competition in the absence of the link.

From the point of view of social welfare the link is particularly useful if using foreign ISCs is expensive for investors ($h>>0$). Fortunately the two CSDs are especially interested in opening the link in such cases. By opening the link the two CSDs can transform investors' costs of making cross-border transactions into fee revenue.

5 Regulation of cross-border fees

5.1 Assumptions

The European Union enhances the integration of member countries' financial markets. As regards retail payment services, the union is gradually introducing a directive on price regulation. Fees for cross-border payments are not to differ from those for domestic transactions. This section presents an analysis of the possible impact of a comparable regulation on securities settlement systems. The CSDs are obliged to form a link. Moreover, there are not to be additional fees for cross-border transactions ($r = 0$).

Investors trading in foreign securities can use domestic ISCs and the link between the two CSDs, or they can use foreign ISCs. Exactly as in the previous sections, they incur a fixed cost (h) if they use foreign ISCs. If issuers are indifferent between the two CSDs, they randomise between them. There is no home country bias in issuance. If there is no Nash equilibrium in the Bertrand game between the CSDs, they end up in an undercut-proof equilibrium, as defined by Shy (2002).

5.2 The undercut-proof equilibrium

The situation presented in this section is highly analogous to the one presented by Shy (2002). Shy assumes two competing firms selling two different brands. Every consumer has an established relationship with either of the two companies. Buying from the competitor would cause extra switching costs. Each consumer buys one unit of good. It turns out that there is no Nash equilibrium between the two companies in pure strategies in Bertrand competition. The optimal price for each firm would be the price charged by the competitor plus the switching cost. It would obviously be impossible to find any equilibrium where both companies would charge more than the competitor. A firm could also decide to undercut by pricing low enough to get all the customers, including those who have the customer relationship with the competitor. This would lead to a no-Nash-equilibrium situation because the firm whose price is undercut would find it profitable to react by charging a somewhat higher fee that cannot be profitably undercut. Firms end up in a so-called undercut proof equilibrium. In an undercut-proof equilibrium both firms charge the highest price the rival cannot profitably undercut, if the alternative is to charge the price that prevails in the undercut-proof equilibrium. This undercut-proof equilibrium is not a Nash equilibrium.

When $r_1 = r_2 = r$, expression 19 reduces to $p_i = I \cdot (2 + M)r/M$;

When there are no additional fees for cross-border services ($r = 0$), this formula implies that the optimal fee to be paid by issuers equals zero. The CSDs end up in Bertrand competition with identical services and zero marginal costs, and the price (p) converges to zero. This, in turn, implies that issuers randomise between the two CSDs. According to the law of large numbers their market shares will be equal, and there will be no correlation between the country of registration of a security and the home country of the investors.

Because issuers pay no fees, and because there are no fees for cross-border transactions, both CSDs are completely dependent on the basic fees paid by domestic investors. The expression for profits reduces to

$$\Pi_i = 2I(b_i - z_i) \tag{28}$$

According to this expression it would always be profitable to increase the price ($d\Pi_i/db_i > 0$). However, investors have the option to use foreign ISCs. The highest price the CSD i could charge and still get the transactions of domestic customers equals

$$b_i = b_j + h - \varepsilon \tag{29}$$

where ε is an arbitrarily small positive constant.

It would be impossible to find examples where at least some customers would process certain transactions through domestic ISCs and other transactions through foreign ISCs. Because there are no such cases, all the payments can be netted, there are no costs related to gross payments, and the cost component α vanishes.

With the price (29) the profit would equal $2I(b_j + h - z_i)$

A CSD could also try to get all the transactions of all the customers by undercutting. The highest price the CSD could charge and get all of both the transactions by domestic customers and the cross-border transactions of foreign investors is

$$b_i = b_j - h - \varepsilon \qquad (30)$$

With this price CSD i would also get all the issuers because the undercutting CSD would be a cheaper alternative for all the investors. The expected value of its profit would equal

$$4I(b_j - h - \varepsilon - z_i) \qquad (31)$$

Undercutting, ie charging the price (30) instead of the price (29), is profitable for CSD i if

$$4I(b_j - h - \varepsilon - z_i) > 2I(b_j + h - z_i) \Leftrightarrow b_j > 3h + 2z_i + \varepsilon \qquad (32)$$

With sufficiently high rival prices (b_j) condition (32) is satisfied, implying that it becomes profitable to undercut. When firms decide the basic fees (b's), the situation is analogous to Shy's model, and there is no Nash equilibrium in pure strategies.

If a customer living in country 2 deals with foreign securities, the cost of a transaction through a domestic ISC and domestic CSD 2 equals $b_2 + y$. If the customer uses foreign ISCs, the cost equals $b_1 + y + h$. If CSD 1 wants to undercut, the price ($b_1^{'}$) it should charge would satisfy the condition

$$b_2 + y - \varepsilon = b_1^{'} + y + h \Rightarrow b_1^{'} = b_2 - h - \varepsilon$$

where $b_1^{'}$ is the price CSD 1 uses for undercutting if it decides to undercut.

The highest price that can be used for profitable undercutting ($b_1^{'}$) satisfies the condition

$$2I(b_1 - z_1) + \varepsilon = 4I(b_1^{'} - z_1) \text{ and analogously } 2I(b_2 - z_2) + \varepsilon = 4I(b_2^{'} - z_2)$$

Combining these conditions with (32) and rounding ε = 0 yields

$$b_1 = \frac{(6h + z_1 + 2z_2)}{3} \quad b_2 = \frac{(6h + z_2 + 2z_1)}{3}$$
$$b_1' = \frac{(3h + z_1 + 2z_2)}{3} \quad b_2' = \frac{(3h + z_2 + 2z_1)}{3}$$

If there is no link between the CSDs, the cost of cross-border transactions for investors living in country 2 is determined according to equations 5, 7 and 10 and the extra cost h.

$$h + V_1 = \frac{\alpha\Gamma_2}{2} + \frac{(-3\alpha + 6h + 4z_1 + 2z_2)}{6} + y + h = \frac{-(1-\Gamma_2)\alpha}{2} + \frac{\{6h + z_2 + 2z_1\}}{3}$$

This is less than the transaction fee charged by CSD 2 (b_2) in the undercut-proof equilibrium. Hence, in the undercut-proof equilibrium, the fee for transactions is higher than the total cost of cross-border transactions that prevails in the basic version without a link. Thus the regulation does not make it cheaper to trade in foreign securities. Instead, it becomes more expensive to process transactions with domestic bonds. This cannot be what the policy makers aim at.

In the basic version of the model, analysed in the section 3, the two CSDs had to compete for issuers by making themselves attractive locations for investors, simply because investors' costs affected the prices of securities in the primary market. In section 4 the CSDs competed for issuers even more directly. Now, because of the link and the ban on additional fees for cross-border services, the country of registration is no longer relevant to the costs for investors in the secondary market. All the transactions are settled through the home country CSD of the investor. Hence, it is no longer possible to attract issuers with low prices, and the main source of competitive pressure has been largely eliminated. It is not surprising that the average price for settlement services increases.

Somewhat similar results have been presented in the earlier literature. Banning price differentials between domestic and export prices as an antidumping measure may enhance tacit collusion between oligopolistic firms. (See Martin (2001), p. 203–204). If competing oligopolistic telecommunication operators are not allowed to charge different prices for calls between nets, they might simply increase the price for all the phone calls (Laffont, Rey and Tirole (1998)).

6 Conclusions

6.1 Summary of the main results

This paper has presented an oligopoly model on the securities settlement industry. The main focus has been on duopolistic competition between two national securities settlement centres, and the impact of a securities link between the two CSDs on this competition. The functioning of different net and gross settlement arrangements has been ignored. In this sense this paper differs from many articles written by industry practitioners.

It was assumed that the need for securities settlement services is exogenous. Each CSD runs both a book-entry register and a settlement system. Secondary market transactions in a given security must be settled in the system in which the security was issued. No investment service company can arrange services with securities registered in the foreign CSD. If investors conduct transactions with securities registered in the foreign country, they must use services offered by foreign investment service companies. It follows that CSDs compete fiercely for issuers in the primary market. Investors have no choice: they must settle their transactions in the CSD chosen by the issuer. Consequently, CSDs collect all the revenue from ISCs and investors, while issuers get services for nothing.

Section 4 analyses a situation where the two CSDs are linked. Investors can settle transactions with foreign securities via either domestic ISCs and the domestic CSD, or they can bypass the link and use services offered by foreign ISCs. Investors' transactions do not have to be settled in the CSD chosen by the issuer, and it is no longer essential for CSDs to attract as many issuers as possible. Consequently, issuers become the profit-making segment, whereas investors can get domestic services free of charge and cross-border services at reasonable prices.

With or without a link, the CSDs have some monopoly power. The monopoly power is in both cases largely determined by the additional costs (h) investors incur if they use foreign ISCs. Therefore this cost component must be kept reasonable even when the two CSDs are linked; this is essential even if investors hardly ever use foreign ISCs.

Section 5 analyses what might happen if the CSDs of the two countries were obliged by law to create an integrated environment. The two CSDs must establish the link, and it is forbidden to charge any fees beyond the basic fee for domestic transactions for executing cross-border transactions through it. It may be unclear how the CSDs would price secondary market settlement orders under this arrangement, but they might simply increase the price for all the transactions, including purely domestic ones, to a level that is higher than the costs of cross-border transactions in the absence of a link. Hence it may be a bad idea to enhance capital market integration with government price regulations.

6.2 Concluding remarks and suggestions for further research

The model could to some extent be interpreted as a description of two competing trading systems. However, the cost of making gross payments (α) is typical for settlement systems. Unlike previous models on network effects in trading, there is no liquidity-related price formation in this model. Moreover, although remote access to trading systems has become commonplace, there is no remote access in this model. And, last but not least, securities can be traded on multiple platforms but, despite the existence of tiered holding systems and links between CSDs, no security can be simultaneously issued in two book-entry systems.

Because this paper contains pioneering work, much of the required analysis remains to be done. Taking the price elasticity of demand into account would improve the possibilities to analyse consumer surplus and issuer profits. According to Rochet and Tirole (2001) these factors could be highly important determinants of platform industries' pricing. Taking the price elasticity of demand into account would be analytically problematic, but it might be possible, at least via numerical simulations. Fortunately, the intuition behind the results is not greatly affected by the absence of price elasticity, but the possibility of major changes in the outcomes cannot be ruled out.

In real life there are many kinds of ownership connections and cooperative agreements between securities market institutions. The analysis could be expanded by taking into account many alternative structures. The settlement system and the book-entry register are often operated by different institutions. Moreover, the market place could also be explicitly modelled. In many cases stock exchanges operate their own settlement systems. International securities settlement systems often do not provide depository services, or they offer depository services only on a very limited scale. Moreover, they have no 'natural' customer base consisting of domestic investors. In the analysis, such an institution could be modelled as a CSD with a zero market share in the primary market but with links with both national CSDs.

This model abstracts from the institutional problems foreign issuers might face in issuing securities in a foreign system. In the case of equities, there are unresolved legal problems. It seems very likely that dismantling these institutional barriers would enhance competition between CSDs. It might be an interesting extension to assume that each issuer has a given home country and that issuing securities in the neighbouring country would cause some additional costs.

In real life many securities market infrastructure institutions are joint-venture undertakings of investments service companies. If it were assumed that the two CSDs maximise the sum of their own profits and the profits of the shareholder ISCs, basically nothing would change. Because of Bertrand competition with identical services, ISCs' profits are always zero, irrespective of CSD pricing. Thus CSDs would still maximise nothing but their own profits. Park and Ahn (1999) presented a detailed analysis on the nature of jointly owned upstream suppliers as instruments of collusion.

And, last but not least, the analysis could be expanded by modelling the heterogeneity of investors. To concretise, the cost of using foreign investment service companies (h) probably differs between investor categories. The cost is, at least in relative terms, higher for households than for large pension insurance companies.

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