

# Competition and integration of securities settlement infrastructures in Europe. An approach in terms of composite goods.

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## Abstract

This article analyzes the competition and integration process in the European securities settlement industry. Banks, as custodians, combined to Central Securities Depositories (CSDs) or International Central Securities Depositories (ICSDs) as operators of Securities Settlement Systems (SSS), produce securities settlement services which can be regarded as composite goods. Securities settlement service combines banking services offered by custodian banks (intermediary custody) and central securities settlement services provided by CSDs (final custody). We use the Economides and Salop's model to analyze different market structures which may simplify and optimize cross-borders operations throughout the EU whose costs still remain higher than for domestic operations because of the still fragmented organization of European custody and settlement industry. We show the complexity of the current consolidation process of settlement infrastructures in Europe. Different market structures and their effects on investor's welfare are examined : horizontal integration of CSDs, vertical integration of custodians and

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CSDs (ICSD's model), horizontal integration between intermediary custodians. We determine under which competitive conditions the ICSD's model can be profitable for investors.

JEL classification: G21, G15, L11 Keywords : central securities depositaries, securities settlement systems, financial market infrastructures, composite goods, vertical and horizontal integration.

## 1 Introduction

Securities Settlement Systems (SSSs) operated by Central Securities Depositaries (CSDs) are at the final stage of the securities chain-value. After being traded on market facilities (stock-exchanges, OTC markets, Multi-Trade Facilities<sup>1</sup>) and often cleared in clearing houses, all transactions have to be settled in a SSS. SSSs are institutional arrangement necessary to finalize securities transactions.<sup>2</sup> Through the SSS it administrates, the CSD provides the settlement service infrastructure for banks which use their services for their customers<sup>3</sup> to achieve a securities settlement instruction, an investor needs a bank acting as a custodian and a CSD which operates the SSS (settlement function) and holds central securities accounts (central book-keeping function). This arrangement is quite simple for domestic operations : banks (custodians) are members of a national CSD which operates a national SSS to settle their trades. For cross-border operations, securities' settlement is more complex since there is not such an institutional and structured arrangement, even if one considers the operation of securities'settlement inside the euro area . These operations, which are however more common, due to the development of a European portfolio management, need complex forms of "post-market intermediation". Like for payments systems, a correspondent banking model is today still necessary to complete these operations because of the lack of an "ad hoc" pan-European infrastructure for delivery and settlement of securities. A custodian has indeed to build a link with a foreign local custodian connected to its SSS to settle trades.

The fragmentation of European securities' settlement infrastructures<sup>4</sup> is nowadays one of the barriers which prevent the integration of European fi-

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<sup>1</sup>Or alternative trading system.

<sup>2</sup> It also includes derivatives transactions.

<sup>3</sup>Or for themselves if one considers self-operations.

<sup>4</sup>There are currently about 33 SSSs in UE 25 (SCB, April 2004, Blue Book).

nancial markets. The two Giovannini reports<sup>5</sup> on the problems raised by cross-border clearing and settlement throughout Europe have pointed out 15 fiscal, legal and technical barriers on securities cross-border settlement which should be removed. The lack of integration between SSSs throughout Europe is one of technical barriers which prevent the financial integration of capital markets aimed by the Financial Services Action Plan (FSAP). With new ISD and the project of a directive on securities' settlement<sup>6</sup>, the improvement of cross-border operations on a more integrated market is necessary to facilitate securities circulation, especially in the euro area. Free choice for localization of securities' settlement and custody should be possible. Competition and consolidation on the custody market are on the way to rationalize securities' settlement procedures. Like for payment systems, the questions of inter-operability between SSSs or the implementation of a pan-European CSD must be considered.

Time is then to simplification of cross-border settlements in Europe. But time is also to a very complex process of securities' settlement market re-constitution which affects CSDs as well as custodian banks. A consolidation process is currently on its way between national SSSs, especially for stock-exchanges which have merged<sup>7</sup>. Besides, International Central Securities Depositories (ICSDs), Euroclear and Clearstream, intend to deliver cross-border settlement services in Europe<sup>8</sup>. They directly compete with global custodians which provide securities' settlement services through their sub-custodians networks. The complexity of consolidation process in the securities' settlement industry is linked to the characteristic of this market. Custody and securities' settlement market is indeed composed of two kinds of complementary infrastructures: CSDs provide central infrastructures through the SSS which allows circulation of securities between custodian banks (primary SSS); custodian banks provide securities' transfers and securities' book-keeping for their clients (secondary SSS or securities' settlement facilities). CSDs manage central market infrastructures and custodians manage customer oriented facilities (custody and securities transfer for investors). This separation is nebulous in Europe: ICSDs play indeed these two roles. They operate SSSs and they also have banking functions. In an open market, we can wonder if

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<sup>5</sup>Giovannini, and al. (2001, 2003), Cross-border clearing and settlement arrangements in the European Union, Brussels, November.

<sup>6</sup>See also Commission of the European Communities, 2004, Clearing and settlement in the European Union - The way forward, Communication from the Commission to the Council and the European Parliament, April, COM (2004) , Brussels.

<sup>7</sup>For instance, ESES RGV project in Euronext Group. ESES RGV is supposed to become the single settlement facility on all Euronext's markets by 2007.

<sup>8</sup>SAP (Single Access Plate-form) project led by Euroclear Group.

ICSDs can pluralize these functions without being a threat to a fair competition. Is it necessary to adopt a regulation which separates central infrastructures' activities (core functions) and banking activities ? Are the CSDs' services a "utility" or a common service ? Can a single settlement platform be operated by a private-owned commercial bank or should it be assumed by a sort of "central bank" for securities on behalf of a financial community<sup>9</sup> in a field sensible to systemic risk<sup>10</sup>? These are some of the questions which are today at the very heart of European financial post-market integration.

Although most of the literature on financial integration still focuses on competition between stock exchanges on a oligopoly market (Di Noia, 1999; Shy and Tarkka, 2001 for instance), post-market infrastructures, e.g. clearing houses and CSDs are today much more taken into account (Giddy et al., 1996, Goldberg and al., 2002, Chanel-Reynaud and Chabert, 2004, Russo, 2004) but they just begin to be considered from a strictly theoretical point of view (Kaukko, 2004, Knieps, 2004, Tapking and Yang, 2004, Van Cayseele, 2004).

This paper aims precisely at examining, on a pure theoretical stand, how the still fragmented European securities settlement systems market is supposed to evolve to favour financial post-market integration. We do not only analyze integration between market infrastructures (SSSs), but we also aim at analyzing the custody market in its whole. We then consider primary infrastructures ((I)CSDs as providers of central SSSs) but also secondary facilities (custodians and ICSD as securities' settlement service providers for investors). By this way, we can examine how (I)CSDs are competing between themselves but also with (global) custodians.

We consider instructions of delivery and settlement on securities as composite goods . A domestic security settlement service requires two complementary firms, respectively, an intermediary custodian (IC e.g. a bank in charge of settlement and custody services for investors) and central securities "notary" of domestic securities, ultimate custodian (UC e.g. a CSD which administrates the central SSS). IC holds the securities account of a customer (investor) and has central securities account in the books of the CSD (UC) which operates the SSS for securities transfer between custodians. CSD is a monopolistic producer of the component settlement (it operates a single national SSS). There are several banks which provide the intermediary custody

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<sup>9</sup> It is the position defended by the French Banking Association. See, FBF, august 2004, remarks and observations of FBF about a document "Communication from the Commission to the Council and the European Parliament. Clearing and Settlement in the European Union: the way forward", 42 p.

<sup>10</sup>See Iori, 2004.

activity. For cross-border operations, the organisation is more complex<sup>11</sup>. Custodians have to manage this organizational complexity because of the absence or inadequacy of direct links between CSD or remote access. Currently, domestic securities never leaves their issuing country: they have to be centrally held in the books of the national CSD . SSSs cannot be substituted as long as some restrictions remain: location of settlement (barrier 2 in Giovannini report), barriers on remote access (barrier 5), restrictions on localization of securities (barrier 9). These barriers have to be removed to improve cross-border operations,as mentioned in the new ISD (article 34)<sup>12</sup> which makes the choice of SSSs possible. Under these conditions,SSSs are regarded as substitutes for another; intermediary custody activity is also regarded as a substitute good.

This paper analyzes the different market structures that can be observed when CSDs are in a monopolistic position and the consequences a relax of present barriers could have on the European settlement industry. We analyze different market structures when CSDs have a monopolistic position and when they lose this position to illustrate the possible implications of integration between CSDs, between CSDs and intermediary custodians and between intermediary custodians themselves. Various levels of profit and price characterizing these different market structures can be observed. This approach also allows us to analyze if market infrastructures should be separated from

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<sup>11</sup>Considering BIS's typology, a non-resident bank can settle its trade through five channels:

- through direct access to the CSD in the issuing country (channel 1);
- through a local bank which is member of the CSD in the issuing country (channel 2);
- through a global custodian that employs a local agent as sub-custodian (channel 3);
- through an ICSD that has established a direct or indirect link, through a local agent, to the CSD in the issuing country (channel 4);
- through a CSD in the non-resident's own country that has established a link (usually direct) to the CSD in the issuing country (channel 5).

<sup>12</sup>Article 34 of new ISD : "Member States shall require that investment firms from other Member States have the right of access to central counterpart, clearing and settlement systems in their territory for the purposes of finalizing or arranging the finalization of transactions in financial instruments. Member States shall require that access of those investment firms to such facilities be subject to the same non-discriminatory, transparent and objective criteria as apply to local participants.Member States shall not restrict the use of those facilities to the clearing and settlement of transactions in financial instruments undertaken on a regulated market or MTF in their territory".

banking intermediation.

In this article we start in section 2 by describing the theoretical framework and the notations used in the subsequent sections. Securities' settlement systems are regarded as composite goods . We consider two financial areas (two countries in which two banks act as custodians and, therefore, are members of their national CSD). In the following Section we analyze the market structure when CSDs are in a monopolistic position and it's impact on prices . Section 4 analyzes different market structures when the border is relaxed. Section 5 presents our concluding remarks.

## 2 The model.

Our article is based on Economides and Salop's model on composite goods (1992) and on Kim and Shin's model (2002). We consider two countries 1 and 2. Each country has an ultimate custodian  $UC_i$  and two intermediary custodians in competition, noted  $IC_i$  and  $IC'_i$ : Index  $i$  of the custodians corresponds to the country in which they are located. The model is based on two ultimate custodians and four intermediary custodians:  $C = \{UC_1, UC_2, IC_1, IC_2, IC'_1, IC'_2\}$ . We make assumption that the marginal cost of production of each service of custody is equal to zero.

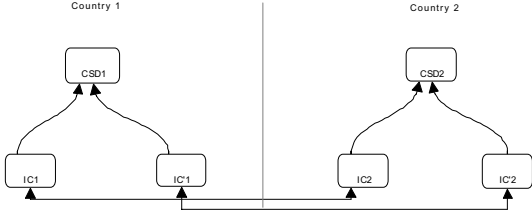


Figure 1: Composite Goods in situation of monopoly.

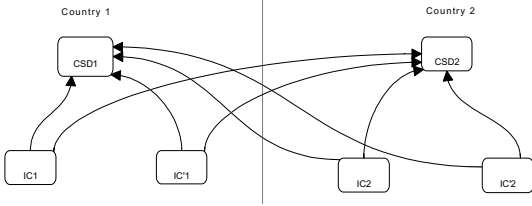


Figure 2: Composite Goods in the case of competition between ultimate custodians.

It could be considered in a first time that each ultimate custodian is in a monopoly position (Fig. 1): the access to an ultimate custodian of a given country is reserved only to the intermediary custodians locally established . Custodian banks of country  $i$  ( $IC_i$  and  $IC'_i$  ) have an access to the primary SSS of CSDi ( $UC_i$ ). We consider that there is complementarity only between  $IC_1$  and  $IC_2$  on the one hand, and between  $IC'_1$  and  $IC'_2$  on the other hand. The components  $IC_1$  and  $IC'_2$  are incompatible just as  $IC'_1$  and  $IC_2$ . Thus an investor located in country 2 (resp.country 1) who wants to buy domestic securities of country 1 (resp.country 2) needs to address to the one of the two intermediary custodians of his choice located in his town country. This one must then pass by means of the intermediary custodians of the country 1 (of country 2) with which he has a bond of complementarity to reach  $UC_1$  ( $UC_2$ ). As a consequence, the investor of country 2 needs either the composite good  $S_1: IC_2- IC_1- UC_1$  or the composite good  $S'_1 : IC'_2- IC'_1-UC_1$ . The investor of country 1 needs either the composite good  $S_2 : IC_1- IC_2-UC_2$  or the composite good  $S'_2 : IC'_1- IC'_2-UC_2$ . Each of the two investors thus has the choice between two channels of settlement service delivery :  $S_1,S'_1$  for the investor of country 2 and  $S_2,S'_2$  for the investor of country 1. The cross border settlement services are services mobilizing a centralized infrastructure (primary SSS managed by the CSD) and a " decentralized " infrastructure (secondary SSS of the banks).

In a second time, we introduce competition on the ultimate custody market (Fig. 2): the  $UC_i$  becomes substitutable or compatible so that one  $IC$  of a given country can reach directly one foreign  $UC$  without the intermediary of one  $IC$  locally established.

The number of composite goods passes in this case for each investor from two to eight :  $S_{11} = UC_1IC_1$ ,  $S'_{11} = UC_1IC'_1$ ,  $S_{12} = UC_1IC_2$ ,  $S'_{12} =UC_1IC'_2$ ,  $S_{21} =UC_2IC_1$ ,  $S'_{21} =UC_2IC'_1$ ,  $S_{22} =UC_2IC_2$ ,  $S'_{22} =UC_2IC'_2$ . Competing intensity on the offer of service of delivery and settlement increases, and each investor has the choice between eight channels of delivery and settlement service.

### 3 Monopoly of the central securities depositories

In this section, we suppose the condition of monopoly of central securities depositories. The CSD manages the SSS to which the local custodians have directly access for the cross-border transactions . A foreign custodian must thus pass through a local correspondent having access to the SSS where the

operation will take place. We will seek to determine the market structures for which the prices of the composite goods are the lowest.

We suppose that for the investor of country 2 (respectively of country 1), composite goods  $S_1$  et  $S'_1$  ( $S_2$  et  $S'_2$ ) can perfectly be substituted. In order to study the equilibrium prices of the various composite goods ( $S_1, S'_1, S_2, S'_2$ ), we consider a linear demand function defined as follows:

$$\begin{pmatrix} D_{S_1} \\ D_{S'_1} \\ D_{S_2} \\ D_{S'_2} \end{pmatrix} = \begin{pmatrix} a \\ a \\ a \\ a \end{pmatrix} - b \begin{pmatrix} p_{S_1} \\ p_{S'_1} \\ p_{S_2} \\ p_{S'_2} \end{pmatrix} + c \begin{pmatrix} p_{S'_1} \\ p_{S_1} \\ p_{S'_2} \\ p_{S_2} \end{pmatrix} \quad (1)$$

where  $a, b, c > 0$ , and  $b > c$  (condition of substitution between goods) . The price of each composite good is equal to the sum of the three component equilibrium prices:

$$\begin{pmatrix} p_{S_1} \\ p_{S'_1} \\ p_{S_2} \\ p_{S'_2} \end{pmatrix} = \begin{pmatrix} p^{UC_1} + p^{IC_1} + p^{IC_2} \\ p^{UC_1} + p^{IC'_1} + p^{IC'_2} \\ p^{UC_2} + p^{IC_2} + p^{IC_1} \\ p^{UC_2} + p^{IC'_2} + p^{IC'_1} \end{pmatrix} \quad (2)$$

The equilibrium prices of the various composite goods will be given while resting not only on the four market structures defined by Economides and Salop (1992) but also on a broad range of market structures describing the possible coalitions between the six custodians. Let  $S_M^m = (\{k_1\}, \dots, \{k_j\}, \dots, \{k_n\})$ ,  $n$  be the number of custodians in the coalitions  $k$  composing the structure  $S_M^m$  and  $m$  be the reference number of the structure (see table 1 and table 2 in appendix); for example the market structure of the type  $(\{3\}, \{2\}, \{1\})$  :  $(\{UC_2, IC_2, IC'_2\} \{IC_1, IC'_1\} \{UC_1\})$ , is characterized by the presence of two types of coalitions :  $k_3 = UC_2 - IC_2 - IC'_2$ ,  $k_2 = IC_1 - IC'_1$  and an independent element  $k_1 = UC_1$ . Equilibrium prices of each market structure  $S_M^m$  are given by solving the conditions of first order :

$$\frac{\partial \pi^{k_j}}{\partial p_X} = 0 \quad \text{where } X \in k_j, k_j \in S_M^m \quad (3)$$

Where  $\pi^{k_j}$  is the total profit of the coalition.  $\pi^{k_j}$  is the sum of individual

profits of custodians which belong to the coalition.

$$\begin{pmatrix} \pi_{UC_1} \\ \pi_{UC_2} \\ \pi_{IC_1} \\ \pi_{IC'_1} \\ \pi_{IC_2} \\ \pi_{IC'_2} \end{pmatrix} = \begin{pmatrix} p_{UC_1} D_{UC_1} \\ p_{UC_2} D_{UC_2} \\ p_{IC_1} D_{IC_1} \\ p_{IC'_1} D_{IC'_1} \\ p_{IC_2} D_{IC_2} \\ p_{IC'_2} D_{IC'_2} \end{pmatrix} = \begin{pmatrix} p_{UC_1} (D_{S_1} + D_{S'_1}) \\ p_{UC_2} (D_{S_2} + D_{S'_2}) \\ p_{IC_1} (D_{S_1} + D_{S_2}) \\ p_{IC'_1} (D_{S'_1} + D_{S'_2}) \\ p_{IC_2} (D_{S_1} + D_{S_2}) \\ p_{IC'_2} (D_{S'_1} + D_{S'_2}) \end{pmatrix} \quad (4)$$

The total number of possible market structures is equal to 203. However, the studied configuration (monopoly of the national CSD ) imposes criteria of selection which restrict the field of study to 97 cases :

- Two ultimate custodians cannot be in the same coalition to respect the assumption of national monopoly of ultimate custodian and the legal barriers that inhibit competition between CSDs.
- A coalition containing an ultimate custodian and intermediary custodians must imperatively contain at least a local intermediary custodian in order to respect the assumption of absence of direct access to a foreign ultimate custodian.

We will limit our analysis to the case of an investor of country 2 wishing to buy securities of country 1. The composite goods studied will be thus  $S_1$  and  $S'_1$  . The chart of the equilibrium prices (Fig. 3) of the composite goods re-

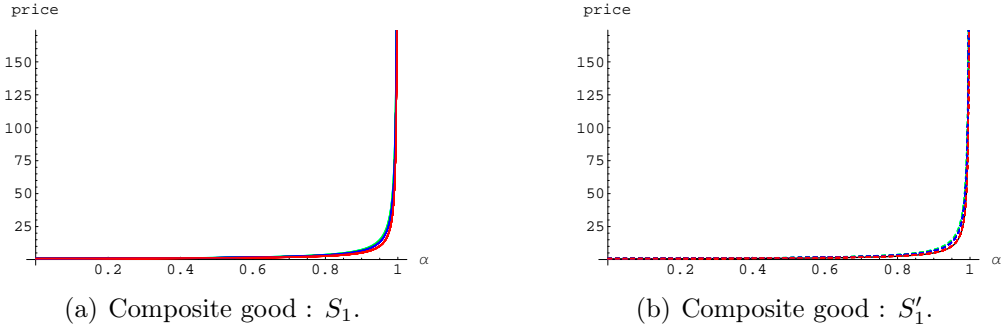


Figure 3: Price of the composite goods in monopoly situation.

lating to the various market structures does not allow a comparison between price levels in the different market structures.

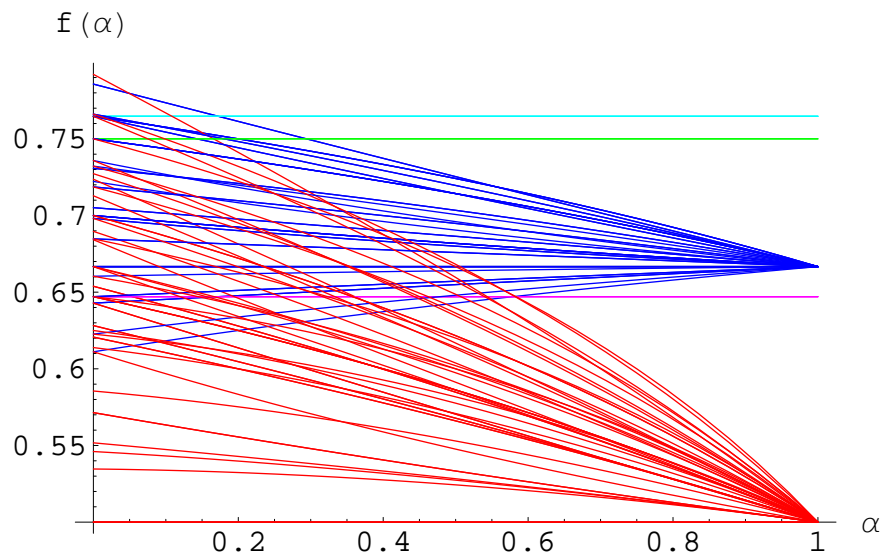
However, whatever the structure of coalition, the price of a composite good  $p_{S_i}$  under a market structure  $S_M^i$  can be written in the following form:

$$p_{S_i}^{S_M} = \frac{a}{b} \frac{1}{1-\alpha} f^{S_M}(\alpha) \quad (5)$$

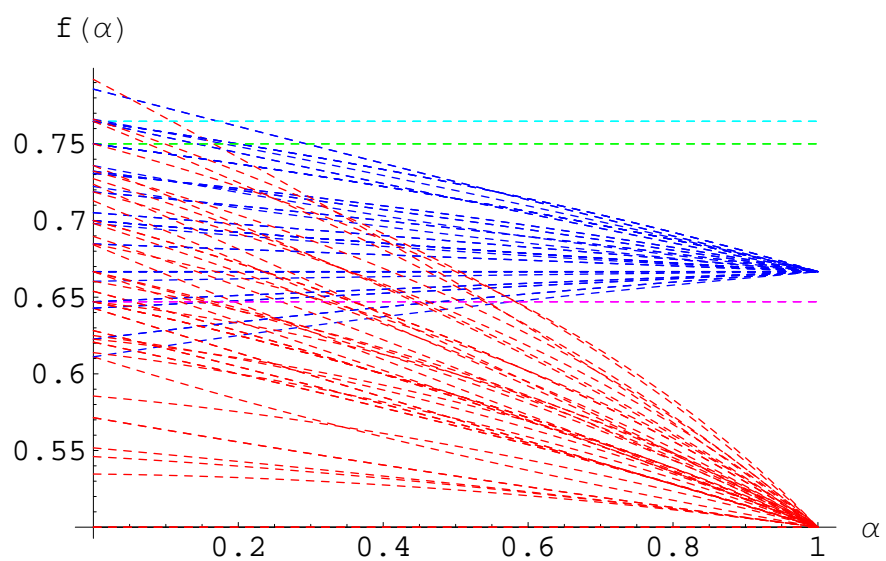
$f$ , defined on  $[0, 1]$  is related only to the degree of substitution  $\alpha = \frac{c}{b}$ . Thus, it is the term in  $\frac{1}{1-\alpha}$  which makes that  $\lim_{\alpha \rightarrow 1} p_{S_i}^{S_M} = +\infty$ . However, comparing the prices for two structures  $S_M^m$  and  $S_M^n$  comes down to compare the functions  $f$ :  $\frac{p_{S_i}^{S_M^m}}{p_{S_i}^{S_M^n}} = \frac{f^{S_M^m}(\alpha)}{f^{S_M^n}(\alpha)}$ . The functions  $f$  being limited, their chart allows a better visualization of the results for the values of  $\alpha$  close to 1<sup>13</sup>(Fig. 4).

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<sup>13</sup>A perfect substitution between delivery and settlement services ( $\alpha = 1$ ) corresponds to an absence of inertial factors (habits related to the practices of delivery and settlement ), absence of difference related to technical requirement, market practices ...



(a) Composite good :  $S_1$ .



(b) Composite good :  $S'_1$ .

Figure 4: Comparison between function  $f$  in monopoly situation.

We notice that the charts are symmetric and that the curves relating to the different market structures converge towards five levels , defining thus five families :

family	1	2	3	4	5
$f(1) =$	$\frac{13}{17}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{11}{17}$	$\frac{1}{2}$

Table 1: Values of  $f$  for  $\alpha = 1$ .

The comparison between the functions  $f$  relating to these five families for  $\alpha$  equal to 1 is interesting. Thus we can conclude for example that the price of family 1 is 53 % higher than that of family 5.

While considering the nature of market structures per family (Tab1 appendix 1), we observe that the two forms of integration, vertical and horizontal, coexist in each one of these market structures , except those of family 2, where we only notice a form of horizontal integration. The vertical or horizontal integration between the various actors of the custody market involves multiform under-coalitions (in term of their members' nature and number) ), differentiating thus the market structures in its whole.

It should be stressed that a vertical integration can concern components or actors of same nature, like the two complementary custodians  $IC_1 IC_2$  or  $IC'_1 IC'_2$ , or actors of different nature but complementary like the combination of infrastructure managed by CSDs (primary SSSs) and of banking activities offered by custodians (secondary SSSs).

In the custody industry , the question is to know if the activities of intermediary custodians should be separated from those of CSDs and ICSDs. Indeed, the ICSD and CSD which play at the same time the role of infrastructure and the role of banking intermediary (bookkeeper - custodian) can be tempted to exert an unfair competition towards the banks present in the activities of bookkeeping. Would it be necessary to adopt a model which separates the infrastructure activities from banking activities? On the contrary, would it be relevant to adopt models integrating the intermediary custodians and the central securities depositaries ?

The effects of vertical integrations (between components or actors of same nature or of different nature) are ambiguous. On the one hand they depend on degree and nature on consolidation in the whole market, and on the other hand on degree of substitution between composite goods . The effects of a vertical integration between some custodians can be impacted by the nature of consolidations intra and/or inter-layers in the custody market as it is shown in the example below. It is necessary to carry out an arbitration between the effects of vertical integrations and the effects of horizontal integrations on the market in its whole.

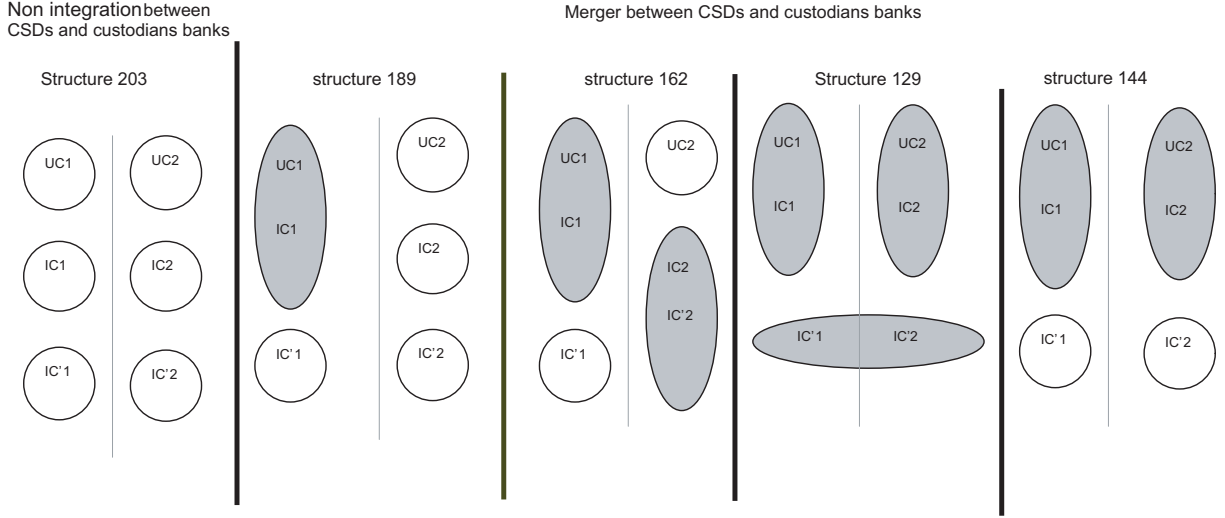


Figure 5: Vertical integration between  $UC_1$  et  $IC_1$ .

We propose to analyze the effect of a vertical integration between  $UC_1$  and  $IC_1$  on composite goods prices  $p_{S_1}$ ,  $p_{S'_1}$  and on custodians' profits in the following cases (Fig. 5):

- When this integration takes place in country 1 of issued securities, whereas in the buyer country the various custodians remain independent (structure 189).
- When vertical integration between infrastructure and custodians takes place at the same time in country 1 and country 2 and  $IC'_1$  et  $IC'_2$  are integrated vertically (structure 129).
- When vertical integration between CSD and custodians takes place in country 1; at the same time in the buyer country,  $IC_2$  and  $IC'_2$  are integrated horizontally (structure 162).
- At last, when vertical integration between infrastructure and custodians takes place at the same time in country 1 and country 2 and  $IC'_1$  and  $IC'_2$  remain independent (structure 144).

We take as reference for prices and profits those of the market structure number 203 corresponding to the independent production. If we compare the prices of the various structures, we obtain :

$$\begin{cases} p_{S_1}^{129} < p_{S_1}^{189} < p_{S_1}^{162} < p_{S_1}^{203} & \text{for } \alpha < 0,45 \\ p_{S_1}^{129} < p_{S_1}^{189} < p_{S_1}^{203} < p_{S_1}^{162} & \text{for } \alpha > 0,45 \end{cases} \quad (6)$$

$$\begin{cases} p_{S'_1}^{129} < p_{S'_1}^{189} < p_{S'_1}^{162} < p_{S'_1}^{203} & \text{for } \alpha < 0, 31 \\ p_{S'_1}^{129} < p_{S'_1}^{189} < p_{S'_1}^{203} < p_{S'_1}^{162} & \text{for } \alpha > 0, 31 \end{cases} \quad (7)$$

The composite goods' prices resulting from structure 129 are always lower and this whatever the level of  $\alpha$ . Prices resulting from the independent production 203 and from structure 162 vary according to  $\alpha$ .

We seek now to determine under which market conditions an integration between an infrastructure function and an intermediary custody function is advantageous to the custodians. For that, we compare the profit of entity merged with the sum of the custodian's profit, members of this coalition before concentration:

$$\left. \begin{cases} \pi_{UC_1IC_1}^{189} < \pi_{UC_1IC_1}^{203} \\ \pi_{UC_2}^{189} < \pi_{UC_2}^{203} \\ \pi_{IC_2}^{189} < \pi_{IC_2}^{203} \end{cases} \right\} \forall \alpha$$

$$\left. \begin{cases} \pi_{IC'_1}^{189} < \pi_{IC'_1}^{203} \\ \pi_{IC'_2}^{189} < \pi_{IC'_2}^{203} \end{cases} \right\} \text{for } \alpha < 0, 32 \quad (8)$$

$$\left. \begin{cases} \pi_{IC'_1}^{189} > \pi_{IC'_1}^{203} \\ \pi_{IC'_2}^{189} > \pi_{IC'_2}^{203} \end{cases} \right\} \text{for } \alpha > 0, 32$$

$$\left. \begin{cases} \pi_{UC_1IC_1}^{162} < \pi_{UC_1IC_1}^{189} \\ \pi_{IC_2IC'_2}^{162} < \pi_{IC_2IC'_2}^{189} \\ \pi_{IC'_1}^{162} < \pi_{IC'_1}^{189} \\ \pi_{UC_2}^{162} < \pi_{UC_2}^{189} \end{cases} \right\} \quad (9)$$

$$\left. \begin{cases} \pi_{UC_1IC_1}^{203} < \pi_{UC_1IC_1}^{129} \\ \pi_{UC_2IC_2}^{203} < \pi_{UC_2IC_2}^{129} \end{cases} \right\} \forall \alpha$$

$$\left. \begin{cases} \pi_{IC'_1IC'_2}^{203} < \pi_{IC'_1IC'_2}^{129} \\ \pi_{IC'_1IC'_2}^{203} > \pi_{IC'_1IC'_2}^{129} \end{cases} \right\} \begin{array}{l} \text{for } \alpha < 0, 23 \\ \text{for } \alpha > 0, 23 \end{array} \quad (10)$$

$$\left. \begin{cases} \pi_{UC_1IC_1}^{189} < \pi_{UC_1IC_1}^{129} \\ \pi_{UC_2IC_2}^{189} < \pi_{UC_2IC_2}^{129} \end{cases} \right\} \forall \alpha$$

$$\left. \begin{cases} \pi_{IC'_1IC'_2}^{189} < \pi_{IC'_1IC'_2}^{129} \\ \pi_{IC'_1IC'_2}^{189} > \pi_{IC'_1IC'_2}^{129} \end{cases} \right\} \begin{array}{l} \text{for } \alpha < 0, 18 \\ \text{for } \alpha > 0, 18 \end{array} \quad (11)$$

$$\left. \begin{array}{l}
\left. \begin{array}{l}
\pi_{UC_1 IC_1}^{203} < \pi_{UC_1 IC_1}^{144} \\
\pi_{UC_2 IC_2}^{203} < \pi_{UC_2 IC_2}^{144}
\end{array} \right\} \forall \alpha \\
\left. \begin{array}{l}
\pi_{IC'_1}^{203} < \pi_{IC'_1}^{144} \\
\pi_{IC'_2}^{203} < \pi_{IC'_2}^{144}
\end{array} \right\} \text{for } \alpha < 0, 44 \\
\left. \begin{array}{l}
\pi_{IC_1}^{203} > \pi_{IC_1}^{144} \\
\pi_{IC'_2}^{203} > \pi_{IC'_2}^{144}
\end{array} \right\} \text{for } \alpha > 0, 44
\end{array} \right\} \quad (12)$$

According to (8), custodians  $UC_1$  and  $IC_1$  will not be incited to merge if the other actors of the market remain independent since  $\pi_{UC_1 IC_1}^{189} < \pi_{UC_1 IC_1}^{203}$  whatever  $\alpha$ . It is interesting to notice that such integration is on the other hand preferable for  $IC_2$ ,  $IC'_1$  and  $IC'_2$  which see their profit increasing compared to the initial structure 203. According to (8) and (9), custodians  $UC_1$  and  $IC_1$  will not be incited to merge if  $IC_2$  and  $IC'_2$  have merged. Structure 203 is preferable to structure 162 since  $\pi_{UC_1 IC_1}^{162} < \pi_{UC_1 IC_1}^{203}$ . The passage of an independent production structure to another structure type 189 or 162 will not incite custodians  $UC_1$  and  $IC_1$  to merge since the profit of their entity merged is lower than the sum of their profits before consolidation. If we consider cases (10) and (12),  $UC_1$  and  $IC_1$  will be incited to merge if and only if  $UC_2$  merge with  $IC_2$ . Structure 129 is preferable to structure 203 for all custodians when  $\alpha < 0,23$ . When  $\alpha > 0,23$ , there is a divergence of interest since  $IC'_1$  and  $IC'_2$  see their profits dropping compared to the structure of independent production. In the same way, structure 144 is preferable to the structure 203 for all custodians if and only if  $\alpha < 0,44$ . When  $\alpha > 0,44$ , the profits of  $IC'_1$  and  $IC'_2$  drop compared to the structure 203.

Contrary to Economides's model [ 1994 ] on the incentive of firms to vertically integrate complementary components , according to the degree of substitution of composite goods, competition in the custody activity is only possible on the segment of the intermediary custody (the CSDs are in a monopoly position). However, we obtain results close to those of Economides. When composite goods are perfect substitutes, independent production is Pareto equilibrium. In that case, vertical integration between CSDs and intermediary custodians reduces profit for some custodians. For a low or an intermediate level of substitution, the two forms of organization: vertical integration and the independent production are equilibrium structures.

The movements in the composition of the under-coalitions (Fig. 5) deeply modify the market conditions. The effects of an integration between CSDs and intermediary custodians depend on  $\alpha$  and on the integration form in the rest of the custody market. A separation or integration between CSDs and

intermediary custodians is not always the best structure for actors of the market (investors, central securities depository, custodians). Several structures combining vertical and horizontal integration emerge. The difference of price and profit of a structure compared with another depends on the degree of substitution between the two composite goods  $S_1$  and  $S'_1$  and on nature and degree of concentration in the remainder of the market.

**Proposition 1** *The impact of a vertical integration between actors of the custody market (CSDs and intermediary custodians) on the prices of cross-border delivery and settlement depends:*

- *On the degree of substitution between the various channels of delivery and settlement regarded as composite goods combining a monopolistic infrastructure (primary SSS) and services of custody in competition (secondary SSS);*
- *On the nature of the concentrations in the whole of the market considering the systemic nature of this market.*

Some market structures highlighted by Economides cannot be transposed to the custody market: it is the example of parallel vertical production. The joint ownership can be compared with the integration of all the intermediary custodians and of the ultimate custodian taking part in the production of the composite goods  $S_1$  and  $S'_1$  e.g.  $UC_1, IC_1, IC'_1, IC_2, IC'_2$ . In this case, the two composite goods competitors are produced by only one entity. If we compare profits and prices of the joint ownership and of the independent production, we obtain:

$$\begin{cases} \pi_{UC_1 IC_1 IC'_1 IC_2 IC'_2}^{203} < \pi_{UC_1 IC_1 IC'_1 IC_2 IC'_2}^1 & \forall \alpha \\ \pi_{UC_2}^{203} < \pi_{UC_2}^1 & \text{for } \alpha > 0,5 \\ \pi_{UC_2}^{203} > \pi_{UC_2}^1 & \text{for } \alpha < 0,5 \end{cases} \quad (13)$$

According to (13) whatever the level of  $\alpha$ , the ultimate custodian  $UC_1$  and the intermediary custodian  $IC_1, IC_2, IC'_1, IC'_2$  will be encouraged to merge, profits are indeed higher compared to the independent production. However, when  $\alpha < 0,5$  there is a divergence of interest between  $UC_2$  and the entity made up of  $(UC_1 IC_1 IC'_1 IC_2 IC'_2)$ . Whereas the latter sees its profit increase compared to the initial structure 203,  $UC_2$  on the contrary sees its profit drop.

$$\begin{cases} p_{S_1}^{203} > p_{S_1}^1 & \text{for } \alpha < 1 \\ p_{S_1}^{203} = p_{S_1}^1 & \text{for } \alpha = 1 \end{cases} \quad (14)$$

It should be noted that in each one of these two structures we find an equality of prices for the two composite goods  $S_1$  and  $S'_1$ . According to (18), when  $\alpha < 1$ ,  $S_1$  and  $S'_1$  prices resulting from an independent production are always higher than those resulting from the joint ownership. When  $\alpha = 1$  we have an equality of prices. According to (13) and (18), we can conclude that for an average or high level of substitution, the joint ownership is preferable as well as for custodian members of the coalition as for investors of country 2 wishing to buy securities of country 1.

**Proposition 2** *For intermediate or high level of substitution, full integration of channels of delivery and settlement competitors in the form of a macro ICSD favors the reduction of the prices of cross-border settlement and maximize profit compared to independent production. For a low level of substitution, a market structure around a ICSD disadvantages the CSDs set apart from the consolidation. The latter are protected by legal barriers and monopoly on the ultimate custody market.*

Let us consider the prices of structure 69 (family 4) and those of structure 102 (family 1). In each one of these two structures, we notice a double horizontal integration and a double vertical integration. However the nature of the vertically integrated custodians differs. We see that for an investor

$$\begin{array}{ccc}
 \begin{array}{c}
 \text{UC}_2 \\
 \text{IC}_2 \text{ --- } \text{IC}'_2 \\
 \text{(a) Structure 102.}
 \end{array}
 &
 \text{IC}_1 - \text{IC}'_1 \quad \text{UC}_1 &
 \begin{array}{c}
 \text{UC}_1 \\
 \text{IC}_1 \text{ --- } \text{IC}'_1 \\
 \text{(b) Structure 69.}
 \end{array}
 \end{array}$$

located in country 2 and wishing to buy securities of Country 1, structure 69 is advantageous compared to structure 102.

On the contrary structure 102 is more favorable than structure 69 for an investor wishing to buy securities of country 2.  $IC_2$  and  $IC'_2$  prices move in the same way as those of  $IC_1$  and  $IC'_1$  in structure 102. But  $UC_1$  price in structure 69 is null whereas in the structure 102 it is high. In the same way, the price of  $UC_2$  is null in structure 102 and increases in structure 69. This situation implies a divergence of interest between investors of the two countries: whereas the investor wishing to buy securities of country 1 takes advantage from a strong concentration between  $UC$  and  $IC$  in country 1 and from a weak concentration in its country, the investor wishing to buy securities of country 2 is advantaged by the opposite situation.

The evolution of the market structure in country 2 can influence the prices of country 1 and conversely.

**Proposition 3** *Vertical integration between CSDs and intermediary custodians has paradoxical effects on the prices of cross border delivery and settlement, depending on whether it is operated in the country of origin or the country of investment. The foreign investors take advantage with an integration between CSD and intermediary custodians in the country of investment and with a separation of the activities of infrastructure from banking activities in their countries of origin. In this sense, the effects of a vertical integration between CSD and custodians banks are asymmetric. The only structure which offers the same tariffing conditions for the foreign investors, whatever their country of origin, is the independent production.*

By combining proposal 1 and 3, we can deduce that in the presence of a monopolistic structure where the CSDs manage a national SSSs whose access is reserved only for intermediary custodians established locally, a separation or integration between primary SSS and secondary SSS is not always the best structure. Several structures combining vertical and horizontal integration emerge and the difference in price depends of the degree of substitution between the various channels of delivery and settlement and on the nature of concentration in the market (proposition 1). However, the independent production is socially preferable when the degree of substitution between the various channels of delivery and settlement is very significant: the prices of the composite goods  $S_1, S'_1, S_2, S'_2$  are equal and consequently the prices are identical for the whole of the investors. This tends to show the interest to separate the offer issued from the ultimate custodian (infrastructure service) of that issued from the intermediary custodians when  $\alpha$  is very significant in order to ensure the same level of price for all foreign investors.

**Proposition 4** *In the case of a national monopoly of the CSD, several structures of market socially advantageous emerge. Only the independent production represents an equilibrium of Pareto in the case of a perfect substitution between the various channels delivery and settlement.*

Vertical integration between CSD and custodians banks can be a solution if we don't take into account an alignment of the conditions of treatment of the cross-border operations at the European level. By taking into account such a requirement favorable for a circulation of saving at European level, a separation between CSD and custodian banks is essential in the current case of monopoly of central depositaries.

## 4 Direct access to the foreign central depository.

We assume here that the two central depositories become perfectly substitutable <sup>14</sup>. Thus, adhesion to each of the two ultimate custodians is not reserved any more for the national intermediary custodians only but it is also allowed to the other foreign intermediary custodians. The access is now open to the primary SSS . Thus, an investor of country 2 has not the obligation to pass through an intermediary custodian of his country for settle/deliver of securities of country 1. From now on, he can be addressed to any of the four intermediary custodians. He has the choice between eight composite goods (Fig. 2). We suppose then that there is not a bond of complementarity between intermediary custodians, the latter are all in competition.

In this section we retain all 203 coalitions. The equilibrium prices of composite goods are treated as in the first part (equation 3). Linear demand functions (equation 1) become:

$$\begin{pmatrix} D_{S_{11}} \\ DS'^{11} \\ DS^{12} \\ DS'^{12} \\ DS^{21} \\ DS'^{21} \\ DS^{22} \\ DS'^{22} \end{pmatrix} = \begin{pmatrix} a \\ a \\ a \\ a \\ a \\ a \\ a \\ a \end{pmatrix} - b \begin{pmatrix} p_{11} \\ p'_{11} \\ p_{12} \\ p'_{12} \\ p_{21} \\ p'_{21} \\ p_{22} \\ p'_{22} \end{pmatrix} + c \begin{pmatrix} p'_{11} + p_{12} + p'_{12} + p_{21} + p'_{21} + p_{22} + p'_{22} \\ p_{11} + p_{12} + p'_{12} + p_{21} + p'_{21} + p_{22} + p'_{22} \\ p_{11} + p'_{11} + p'_{12} + p_{21} + p'_{21} + p_{22} + p'_{22} \\ p_{11} + p'_{11} + p_{12} + p_{21} + p'_{21} + p_{22} + p'_{22} \\ p_{11} + p'_{11} + p_{12} + p'_{12} + p'_{21} + p_{22} + p'_{22} \\ p_{11} + p'_{11} + p_{12} + p'_{12} + p_{21} + p_{22} + p'_{22} \\ p_{11} + p'_{11} + p_{12} + p'_{12} + p_{21} + p'_{21} + p'_{22} \\ p_{11} + p'_{11} + p_{12} + p'_{12} + p_{21} + p'_{21} + p_{22} \end{pmatrix} \quad (15)$$

With  $a, b, c$  strictly positive constants,  $b > 7c$  <sup>15</sup> and  $p_{11}, p'_{11}, p_{12}, p'_{12}, p_{21}, p'_{21}, p_{22}, p'_{22}$ , respective prices of composite goods  $S_{11}, S'_{11}, S_{12}, S'_{12}, S_{21}, S'_{21}, S_{22}, S'_{22}$ .

The price functions of composite goods change compared to the first case

<sup>14</sup>This assumption is in conformity with the evolutions regulations in progress (ISD 2 and European draft Directive on the delivery and settlement)

<sup>15</sup>When  $\alpha = \frac{1}{7}$  the composite goods can perfectly be substituted . The differentiation between composite goods (channels of delivery and settlement results from various factors:

- differences in settlement deadlines;
- System in DVP or not;
- differences related to taxation...

(equation 2) and become:

$$\begin{pmatrix} p_{11} \\ p'_{11} \\ p_{12} \\ p'_{12} \\ p_{21} \\ p'_{21} \\ p_{22} \\ p'_{22} \end{pmatrix} = \begin{pmatrix} p^{IC_1} + p^{UC_1} \\ p^{IC'_1} + p^{UC_1} \\ p^{IC_2} + p^{UC_1} \\ p^{IC'_2} + p^{UC_1} \\ p^{IC_1} + p^{UC_2} \\ p^{IC'_1} + p^{UC_2} \\ p^{IC_2} + p^{UC_2} \\ p^{IC'_2} + p^{UC_2} \end{pmatrix} \quad (16)$$

Individual profits (equation 4) become:

$$\begin{pmatrix} \pi_{UC_1} \\ \pi_{UC_2} \\ \pi_{IC_1} \\ \pi_{IC'_1} \\ \pi_{IC_2} \\ \pi_{IC'_2} \end{pmatrix} = \begin{pmatrix} p_{UC_1} D^{UC_1} \\ p_{UC_2} D^{UC_2} \\ p_{IC_1} D^{IC_1} \\ p_{IC'_1} D^{IC'_1} \\ p_{IC_2} D^{IC_2} \\ p_{IC'_2} D^{IC'_2} \end{pmatrix} = \begin{pmatrix} p_{UC_1} (DS^{11} + DS'^{11} + DS^{12} + DS'^{12}) \\ p_{UC_2} (DS^{21} + DS'^{21} + DS^{22} + DS'^{22}) \\ p_{IC_1} (DS^{11} + DS'^{11}) \\ p_{IC'_1} (DS'^{11} + DS'^{21}) \\ p_{IC_2} (DS^{12} + DS'^{22}) \\ p_{IC'_2} (DS'^{12} + DS'^{22}) \end{pmatrix} \quad (17)$$

Symmetry being given between the whole of composite goods and the fact we study the 203 potential market structures, we will only examine the equilibrium prices for only one composite goods (Fig. 6).

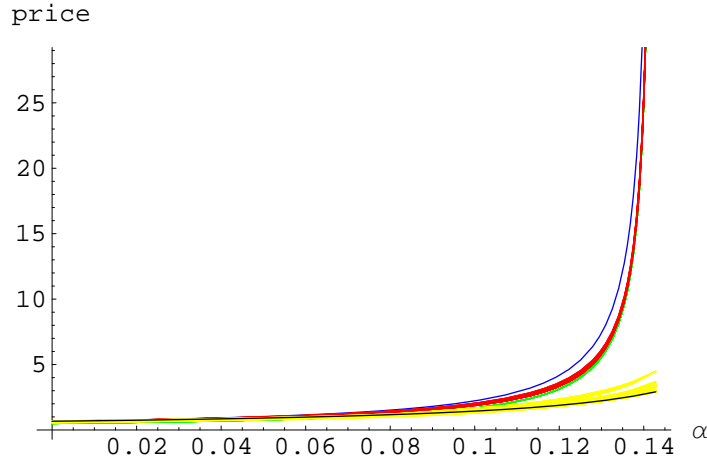


Figure 6: Price curves for  $S_{11}$ .

As in section 2, we can obtain more information on the difference in prices of composite goods by comparing functions  $f$ .

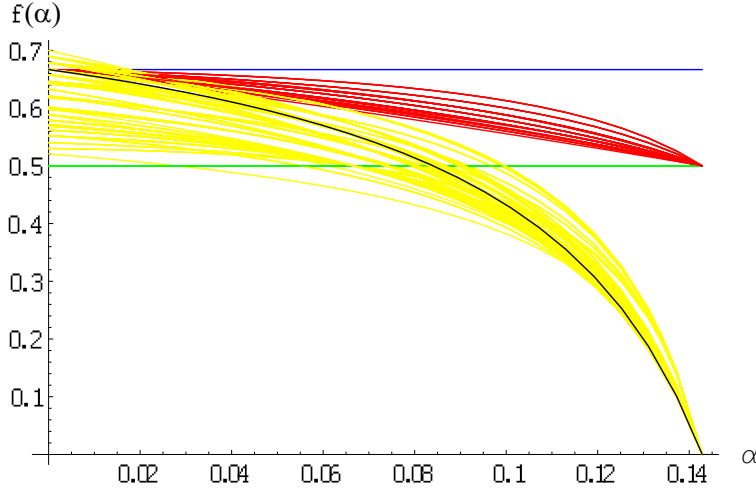


Figure 7: functions  $f$  in condition of competition.

We notice that the reorganization of market structures following a relax of the legal borders reveals 4 families (Fig. 7) defined by the value of  $\alpha = \frac{1}{7}$  and by the nature of  $f$  (constant or not):<sup>16</sup>

family	1	2	3	4
$f(\frac{1}{7}) =$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{2}$	0
$f$ constant	yes	no	yes	no

Table 2: Values of  $f$  for  $\alpha = \frac{1}{7}$ .

Family 1 corresponds to a horizontal integration between the intermediary custodians on one hand and a horizontal integration between  $UC_1$  and  $UC_2$  on the other. The other families are characterized by the coexistence of both forms of vertical and horizontal integration.

In family 2, we note in all the structures an horizontal integration between  $UC_1$  and  $UC_2$ , while  $IC_1$  is never in coalition with  $UC_1$ ,  $UC_2$ . In family 3, in all market structures,  $UC_1$ ,  $UC_2$  and  $IC_1$  unite together, the composite goods  $UC_1 IC_1$  are produced by only one vertically integrated entity. In family 4, we do not observe any horizontal integration between  $UC_1$  and  $UC_2$ . On the other hand, one can observe a vertical integration between  $UC_1$  and  $IC_1$  in all the structures of this family (the composite good studied here is  $S_{11}$  corresponding to  $UC_1 IC_1$ ).

Contrary to the preceding case, there is a family of market structures for which the prices of the composite goods have a finite limit for a perfect substitution:  $\lim_{\alpha \rightarrow \frac{1}{7}} p_{S_i} \neq +\infty$

<sup>16</sup>this criterion distinguishes families 2 and 3

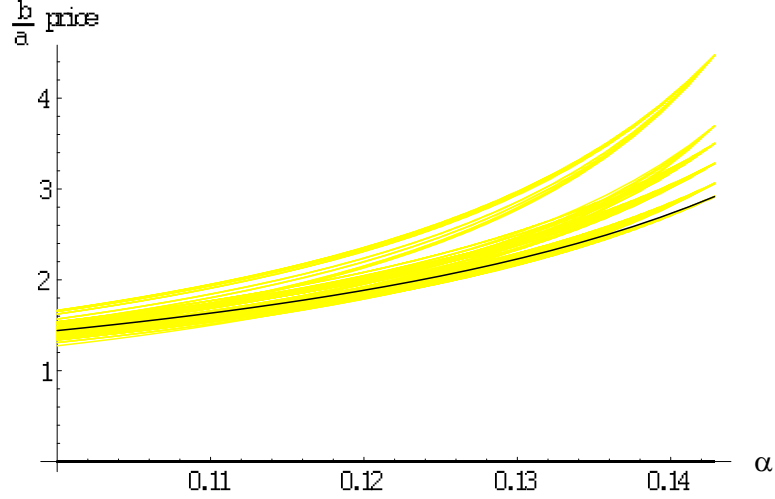


Figure 8: price curves for family 4.  
 Prices in family 4 are limited. We can represent them separately (Fig. ??):  
 this family can be divided into 6 subfamilies defined by the value of the price  
 for  $\alpha = \frac{1}{7}$

sub-family	1	2	3	4	5	6
price* $\frac{b}{a}$	$\frac{161}{36}$	$\frac{133}{36}$	$\frac{7}{2}$	$\frac{105}{32}$	$\frac{49}{16}$	$\frac{35}{12}$

Table 3: Composite goods price difference within family 4 .

Figure 7 reveals that the arbitration between the effects of the vertical integration and the effects of the horizontal integrations depends on the degree of substitution between the various channels of delivery/settlement and of the nature of concentration on the market.

**Proposition 5** *Impact of a vertical integration between actors of custody market(CSD and custodians) on the prices of the cross border delivery and settlement depends :*

- *On the degree of substitution between the various channels of the delivery and settlement services.*
- *On the nature of concentration in the whole market.*

The comparison of the prices and the profits of the market structures 1 and 203 shows that: :

$$\begin{cases} p_{S_1}^1 > p_{S_1}^{203} & \text{for } \alpha > 0,08 \\ p_{S_1}^1 < p_{S_1}^{203} & \text{for } \alpha < 0,08 \\ p_{S_1}^1 = p_{S_1}^{203} & \text{for } \alpha = 0,08 \end{cases} \quad (18)$$

$$\begin{cases} \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^1 > \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^{203} & \text{for } \alpha > 0,08 \\ \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^1 < \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^{203} & \text{for } \alpha < 0,08 \\ \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^1 = \pi_{UC_1UC_2IC_1IC'_1IC_2IC'_2}^{203} & \text{for } \alpha = 0,08 \end{cases} \quad (19)$$

The price of delivery and settlement service in the joint ownership (between the six custodians) is higher than independent production if and only if  $\alpha$  is higher than 0,08. For a very high level of  $\alpha$ , there is a divergence of interests between investors and custodians. For low or intermediate level of substitution between composite goods, joint ownership is advantageous for custodians as well as for investors. The persistence of a differentiation in the offer of delivery and settlement services for the investors justifies a joint ownership. On the contrary, a great substitution between the various channels of delivery and settlement involves a divergence of interest between investors and custodians. The non-integration between the different actors of custody market dominates according to Pareto when a perfect substitution between the channels of delivery and settlement occurs.

**Proposition 6** *The more substitutable the channels of delivery and settlement become, the more the investors take advantage at the persistence of several national CSD and several custodian banks. On the contrary, the persistence of the differences in the offer of delivery and settlement services favors a concentration.*

When analyzing the nature of market structures pertaining to families 1, 2 and 3, we can see that they all contain a horizontal integration between  $UC_1$  and  $UC_2$ . The prices of composite good  $S_{11}$  combining  $UC_1$  and  $IC_1$ , in family 2 are included in an interval [ P1, P18 ]. P1 is the price of the structure corresponding to a monopoly both on ultimate custody market and to intermediary custody market. P18 is the price resulting from the joint ownership<sup>17</sup>. Emergence in Europe of a " macro CSD " is likely to

<sup>17</sup>This result can be generalized with the remainder of the composite goods  $S'_{11}$ ,  $S_{12}$ ,  $S'_{12}$ ,  $S_{21}$ ,  $S'_{21}$ ,  $S_{22}$ ,  $S'_{22}$ . Their respective graphs can be similarly interpreted.

lead to a dominant position on the infrastructure market and thus exerts a pressure on the rise of delivery and settlement prices.

**Proposition 7** *In the presence of only one " primary SSS " managed by a European CSD, whatever the number and the degree of competition of the custodian banks , prices are maintained in a high price range penalizing the investors.*

When  $\alpha > 0,06$ , prices in family 4 are lower than P18. It is useful to remember that non horizontal integration between  $UC_1$  and  $UC_2$  is observed in the market structures pertaining to this family. The weakest prices  $S_{11}$  of the composite good are obtained in the cases of structure with vertical integration between  $UC_1$  and  $IC_1$  while maintaining competition on the market of the ultimate custody (family 4).

**Proposition 8** *A vertical integration between CSDs and intermediary custodians exerts a downward pressure on prices of delivery and settlement services under the condition of the persistence of several primary SSS in order to avoid an abuse of dominant position .*

We considered that it was essential to represent separately the structures of family 4 (Fig. 8). We can observe a convergence of prices within this family towards six different levels when  $\alpha = \frac{1}{7}$ . Family 4 can then be subdivided into 6 subfamilies. The structure of the independent production belongs to the sub-family number 6 whose price is lowest. In this subfamily, any form of horizontal integration is observed. Since there is a strong substitution between the ultimate custodians  $UC_1$  and  $UC_2$  on one hand and between the intermediary custodians  $IC_1, IC'_1, IC_2, IC'_2$  on the other hand, each investor has the choice between eight channels of composite goods resulting of the combination of an ultimate custodian and an intermediary custodian. Thus, in the sub-family 6, vertical integration causes a fall in the prices of composite goods following the elimination of the double margin. This reduction is reinforced by the perfect substitution or compatibility between the components of composite goods. The effect of compatibility and the effect of vertical integration are identical in term of reduction of the prices.

In the other sub-families, when the degree of substitution  $\alpha$  is high, the effect of horizontal integration prevails on the sum of the effects of vertical integration and the effects of compatibility. When competition on the ultimate and intermediary custody market is significant, horizontal integration between secondary SSS involves a big rise of prices, in this case the effects of the vertical integration and of compatibility on the fall of the prices are weak. On the contrary when the degree of substitution of  $\alpha$  is low we notice that the curves of price of the various market structures belonging to family 4 are contiguous.

**Proposition 9** *In term of consumer's surplus, having the production independent of the component of the delivery and settlement services seems preferable to all of the other market structures, if and only if, a perfect substitution between the various channels of delivery and settlement is observed.*

The effects of the various forms of integration on the prices of the delivery and settlements services having been analyzed in comparison with the criterion of substitution primarily, it is advisable to compare price differences in the two basic configurations knowing the monopoly of the CSDs and the opening to the competition of the latter. We will limit ourselves to the comparison of the prices resulting from the independent production which be regarded as a starting structure. The opening of the infrastructure managed by the CSDs to competition allows a fall of the prices in accordance with the new investment service directive. This difference is all the more significant since  $\alpha$  tends towards 1 (Fig. 9).

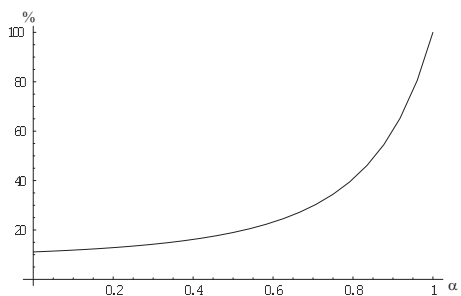


Figure 9: Difference in price of  $S_1$  and  $S_{11}$  in the two configurations.

**Proposition 10** *Direct access to the CSDs allows a reduction of the prices of cross border settlement operations.*

## 5 Conclusion

In this article, we first examined the effects of a vertical integration between CSD and custodian banks (combined with other forms of vertical and/or horizontal integration between intermediary custodians) in a monopolistic ultimate custody market, and second in an oligopolistic market, by regarding the production of the delivery and settlement service as a composite good. The principal results of this examination revealed the following elements: In the case of a monopoly of the CSDs, a vertical integration between CSD and custodian banks can have positive effects on the social welfare. It can indeed exert a downward pressure on prices and increase the profits of the custodians. However, when this vertical integration is combined with other forms of concentration, in particular the horizontal integration, the impact is more diffuse. The effect of a vertical integration is related then to several factors (especially degree and nature of concentration in the market, degree of substitution). Several socially advantageous market structures emerge. Only a case study taking into account the degree of substitution between the various channels of delivery and settlement and the strategic reaction of the competitor custodians would allow to make of choice .

In the case of a suppression of the exclusive rights of access to foreign central depository , a vertical integration between CSD and intermediary custodians reduces the prices if the two following conditions are fulfilled:

- Intermediate or high level of substitution between the various channels of delivery and settlement.
- Competition on the infrastructure market. A concentration between CSDs exerts upward pressure on prices of delivery and settlement.

These results are not in conformity with the Andria report preaching a strict separation between services of collective interest and commercial services in order to avoid a dominant and unfair position of actors cumulating infrastructure functions and banking functions. The results of our model are however in conformity with the Commission Report which does not seem to question the concentrations between central depository and custodians.

A vertical integration between CSD and custodians is not always harmful in terms of social welfare. For the Commission, the market will be self regulated by the play of competition and mergers. Results obtained suggest that

the regulation of concentrations in the custody market must pay a particular attention to the movements of horizontal integration between CSDs.

Overcost of cross-border operations coming primarily from the double layer of intermediation (proposal 10) appear to favour the model with direct access of the intermediary custodians to CSD in competition or favour to a model with several ICSD (proposal 7 and 8). Only one platform of European delivery and settlement is not socially optimal, nor economically desirable. The position of a European ICSD would be threatening for the unit of the financial community . A macro European central securities depository would be likely to misuse his dominant position.

The results obtained must be obviously interpreted within the framework of the assumptions of the model. The ICSD made up of a vertical integration between CSD and custodians do not have the possibility to offer preferential rates or using cross subsidies. Taking into account a tariff discrimination has an effect on the degree of substitution which plays a determining role in the incentive of the merging custodians .

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# Appendix.

Table 1: Regrouping of the market structures per family in the case of the monopoly of CSDs.

Family 1	
75	$\{UC_2, IC_2, IC'_1\} \{IC_1, IC'_2\} \{UC_1\}$
94	$\{UC_2, IC_1, IC'_2\} \{IC_2, IC'_1\} \{UC_1\}$
102	$\{UC_2, IC_2, IC'_2\} \{IC_1, IC'_1\} \{UC_1\}$
Family 2	
184	$\{IC_1, IC'_1\} \{IC_2, IC'_2\} \{UC_1\} \{UC_2\}$
187	$\{IC_1, IC'_2\} \{IC_2, IC'_1\} \{UC_1\} \{UC_2\}$
Family 3	
7	$\{UC_2, IC_1, IC_2, IC'_1, IC'_2\} \{UC_1\}$
16	$\{UC_2, IC_1, IC_2, IC'_2\} \{UC_1, IC'_1\}$
20	$\{UC_2, IC_2, IC'_1, IC'_2\} \{UC_1, IC_1\}$
27	$\{UC_2, IC_1, IC_2, IC'_1\} \{UC_1\} \{IC'_2\}$
31	$\{UC_2, IC_1, IC_2, IC'_2\} \{UC_1\} \{IC_1\}$
34	$\{UC_2, IC_1, IC'_1, IC'_2\} \{UC_1\} \{IC_2\}$
36	$\{UC_2, IC_2, IC'_1, IC'_2\} \{UC_1\} \{IC_1\}$
37	$\{IC_1, IC_2, IC'_1, IC'_2\} \{UC_1\} \{UC_2\}$
44	$\{UC_1, IC_1, IC'_1\} \{UC_2, IC_2, IC'_2\}$
45	$\{UC_1, IC_1, IC'_2\} \{UC_2, IC_2, IC'_1\}$
46	$\{UC_1, IC_2, IC'_1\} \{UC_2, IC_1, IC'_2\}$
47	$\{UC_1, IC_2, IC'_2\} \{UC_2, IC_1, IC'_1\}$
55	$\{UC_2, IC_2, IC'_1\} \{UC_1, IC_1\} \{IC'_2\}$
77	$\{IC_1, IC_2, IC'_1\} \{UC_2, IC'_2\} \{UC_1\}$
81	$\{UC_2, IC_2, IC'_2\} \{UC_1, IC_1\} \{IC'_1\}$
91	$\{IC_2, IC'_1, IC'_2\} \{UC_1, IC_1\} \{UC_2\}$
93	$\{UC_2, IC_1, IC'_2\} \{UC_1, IC_1\} \{IC_2\}$
99	$\{IC_1, IC'_1, IC'_2\} \{UC_1, IC_2\} \{UC_2\}$
101	$\{UC_2, IC_2, IC'_2\} \{UC_1, IC'_1\} \{IC_1\}$
103	$\{IC_1, IC'_1, IC'_2\} \{UC_2, IC_2\} \{UC_1\}$
105	$\{IC_1, IC_2, IC'_2\} \{UC_1, IC'_1\} \{UC_2\}$
116	$\{UC_2, IC_2, IC'_1\} \{UC_1\} \{IC_1\} \{IC'_2\}$
117	$\{IC_1, IC_2, IC'_1\} \{UC_1\} \{UC_2\} \{IC'_2\}$
120	$\{UC_2, IC_1, IC'_2\} \{UC_1\} \{IC_2\} \{IC'_1\}$
122	$\{UC_2, IC_2, IC'_2\} \{UC_1\} \{IC_1\} \{IC'_1\}$
123	$\{IC_1, IC_2, IC'_2\} \{UC_1\} \{UC_2\} \{IC'_1\}$
126	$\{IC_1, IC'_1, IC'_2\} \{UC_1\} \{UC_2\} \{IC_2\}$
127	$\{IC_2, IC'_1, IC'_2\} \{UC_1\} \{UC_2\} \{IC_1\}$
134	$\{UC_1, IC_1\} \{UC_2, IC'_2\} \{IC_2, IC'_1\}$
138	$\{UC_1, IC_2\} \{UC_2, IC'_2\} \{IC_1, IC'_1\}$
139	$\{UC_1, IC'_1\} \{UC_2, IC_2\} \{IC_1, IC'_2\}$
140	$\{UC_1, IC'_2\} \{UC_2, IC_2\} \{IC_1, IC'_1\}$
149	$\{UC_1, IC_1\} \{IC_2, IC'_1\} \{UC_2\} \{IC'_2\}$
155	$\{UC_2, IC_2\} \{IC_1, IC'_1\} \{UC_1\} \{IC'_2\}$
162	$\{UC_1, IC_1\} \{IC_2, IC'_2\} \{UC_2\} \{IC'_1\}$
177	$\{UC_1, IC'_1\} \{IC_1, IC'_2\} \{UC_2\} \{IC_2\}$
178	$\{UC_1, IC'_1\} \{IC_2, IC'_2\} \{UC_2\} \{IC_1\}$
183	$\{UC_2, IC'_2\} \{IC_1, IC'_1\} \{UC_1\} \{IC_2\}$
186	$\{UC_2, IC'_2\} \{IC_2, IC'_1\} \{UC_1\} \{IC_1\}$
196	$\{IC_1, IC'_1\} \{UC_1\} \{UC_2\} \{IC_2\} \{IC'_2\}$
197	$\{IC_2, IC'_1\} \{UC_1\} \{UC_2\} \{IC_1\} \{IC'_2\}$
200	$\{IC_1, IC'_2\} \{UC_1\} \{UC_2\} \{IC_2\} \{IC'_1\}$
201	$\{IC_2, IC'_2\} \{UC_1\} \{UC_2\} \{IC_1\} \{IC'_1\}$
Family 4	

Table 1: ...

69	$\{UC_1, IC_1, IC'_1\}\{IC_2, IC'_2\}\{UC_2\}$
73	$\{UC_1, IC_2, IC'_1\}\{IC_1, IC'_2\}\{UC_2\}$
90	$\{UC_1, IC_1, IC'_2\}\{IC_2, IC'_1\}\{UC_2\}$
Family 5	
6	$\{UC_1, IC_1, IC_2, IC'_1, IC'_2\}\{UC_2\}$
11	$\{UC_1, IC_1, IC_2, IC'_1\}\{UC_2, IC'_2\}$
19	$\{UC_1, IC_1, IC'_1, IC'_2\}\{UC_2, IC_2\}$
26	$\{UC_1, IC_1, IC_2, IC'_1\}\{UC_2\}\{IC'_2\}$
30	$\{UC_1, IC_1, IC_2, IC'_2\}\{UC_2\}\{IC'_1\}$
33	$\{UC_1, IC_1, IC'_1, IC'_2\}\{UC_2\}\{IC_2\}$
35	$\{UC_1, IC_2, IC'_1, IC'_2\}\{UC_2\}\{IC_1\}$
40	$\{UC_1, IC_1, IC_2\}\{UC_2, IC'_1, IC'_2\}$
41	$\{UC_1, IC'_1, IC'_2\}\{UC_2, IC_1, IC_2\}$
51	$\{UC_2, IC_1, IC_2\}\{UC_1, IC'_1\}\{IC'_2\}$
54	$\{UC_1, IC_1, IC'_1\}\{UC_2, IC_2\}\{IC'_2\}$
62	$\{UC_1, IC_1, IC_2\}\{UC_2, IC'_2\}\{IC'_1\}$
63	$\{UC_1, IC_1, IC_2\}\{IC'_1, IC'_2\}\{UC_2\}$
65	$\{UC_2, IC_1, IC_2\}\{IC'_1, IC'_2\}\{UC_1\}$
68	$\{UC_1, IC_1, IC'_1\}\{UC_2, IC'_2\}\{IC_2\}$
72	$\{UC_1, IC_2, IC'_1\}\{UC_2, IC'_2\}\{IC_1\}$
80	$\{UC_1, IC_1, IC'_2\}\{UC_2, IC_2\}\{IC'_1\}$
89	$\{UC_2, IC'_1, IC'_2\}\{UC_1, IC_1\}\{IC_2\}$
100	$\{UC_1, IC'_1, IC'_2\}\{UC_2, IC_2\}\{IC_1\}$
104	$\{UC_1, IC'_1, IC'_2\}\{IC_1, IC_2\}\{UC_2\}$
106	$\{UC_2, IC'_1, IC'_2\}\{IC_1, IC_2\}\{UC_1\}$
110	$\{UC_1, IC_1, IC_2\}\{UC_2\}\{IC'_1\}\{IC'_2\}$
111	$\{UC_2, IC_1, IC_2\}\{UC_1\}\{IC'_1\}\{IC'_2\}$
113	$\{UC_1, IC_1, IC'_1\}\{UC_2\}\{IC_2\}\{IC'_2\}$
115	$\{UC_1, IC_2, IC'_1\}\{UC_2\}\{IC_1\}\{IC'_2\}$
119	$\{UC_1, IC_1, IC'_2\}\{UC_2\}\{IC_2\}\{IC'_1\}$
124	$\{UC_1, IC'_1, IC'_2\}\{UC_2\}\{IC_1\}\{IC_2\}$
125	$\{UC_2, IC'_1, IC'_2\}\{UC_1\}\{IC_1\}\{IC_2\}$
129	$\{UC_1, IC_1\}\{UC_2, IC_2\}\{IC'_1, IC'_2\}$
141	$\{UC_1, IC'_1\}\{UC_2, IC'_2\}\{IC_1, IC_2\}$
144	$\{UC_1, IC_1\}\{UC_2, IC_2\}\{IC'_1\}\{IC'_2\}$
154	$\{UC_1, IC'_1\}\{UC_2, IC_2\}\{IC_1\}\{IC'_2\}$
156	$\{UC_1, IC'_1\}\{IC_1, IC_2\}\{UC_2\}\{IC'_2\}$
161	$\{UC_1, IC_1\}\{UC_2, IC'_2\}\{IC_2\}\{IC'_1\}$
163	$\{UC_1, IC_1\}\{IC'_1, IC'_2\}\{UC_2\}\{IC_2\}$
172	$\{UC_2, IC_2\}\{IC'_1, IC'_2\}\{UC_1\}\{IC_1\}$
174	$\{UC_2, IC'_2\}\{IC_1, IC_2\}\{UC_1\}\{IC'_1\}$
175	$\{IC_1, IC_2\}\{IC'_1, IC'_2\}\{UC_1\}\{UC_2\}$
176	$\{UC_1, IC'_1\}\{UC_2, IC'_2\}\{IC_1\}\{IC_2\}$
189	$\{UC_1, IC_1\}\{UC_2\}\{IC_2\}\{IC'_1\}\{IC'_2\}$
192	$\{UC_2, IC_2\}\{UC_1\}\{IC_1\}\{IC'_1\}\{IC'_2\}$
193	$\{IC_1, IC_2\}\{UC_1\}\{UC_2\}\{IC'_1\}\{IC'_2\}$
194	$\{UC_1, IC'_1\}\{UC_2\}\{IC_1\}\{IC_2\}\{IC'_2\}$
199	$\{UC_2, IC'_2\}\{UC_1\}\{IC_1\}\{IC_2\}\{IC'_1\}$
202	$\{IC'_1, IC'_2\}\{UC_1\}\{UC_2\}\{IC_1\}\{IC_2\}$
203	$\{UC_1\}\{UC_2\}\{IC_1\}\{IC_2\}\{IC'_1\}\{IC'_2\}$

Table 2: Regrouping of the market structures per family in the case of direct access to CSDs

Family 1	
18	$\{IC_1, IC_2, IC'_1, IC'_2\} \{UC_1, UC_2\}$
Family 2	
5	$\{UC_1, UC_2, IC_2, IC'_1, IC'_2\} \{IC_1\}$
7	$\{UC_2, IC_1, IC_2, IC'_1, IC'_2\} \{UC_1\}$
10	$\{UC_1, UC_2, IC_2, IC'_1\} \{IC_1, IC'_2\}$
14	$\{UC_1, UC_2, IC_2, IC'_2\} \{IC_1, IC'_1\}$
17	$\{UC_1, UC_2, IC'_1, IC'_2\} \{IC_1, IC_2\}$
25	$\{UC_1, UC_2, IC_2, IC'_1\} \{IC_1\} \{IC'_2\}$
29	$\{UC_1, UC_2, IC_2, IC'_2\} \{IC_1\} \{IC'_1\}$
32	$\{UC_1, UC_2, IC'_1, IC'_2\} \{IC_1\} \{IC_2\}$
37	$\{IC_1, IC_2, IC'_1, IC'_2\} \{UC_1\} \{UC_2\}$
39	$\{UC_1, UC_2, IC_2\} \{IC_1, IC'_1, IC'_2\}$
42	$\{UC_1, UC_2, IC'_1\} \{IC_1, IC_2, IC'_2\}$
43	$\{UC_1, UC_2, IC'_2\} \{IC_1, IC_2, IC'_1\}$
49	$\{UC_1, UC_2, IC_2\} \{IC_1, IC'_1\} \{IC'_2\}$
52	$\{UC_1, UC_2, IC'_1\} \{IC_1, IC_2\} \{IC'_2\}$
53	$\{IC_1, IC_2, IC'_1\} \{UC_1, UC_2\} \{IC'_2\}$
60	$\{UC_1, UC_2, IC_2\} \{IC_1, IC'_2\} \{IC'_1\}$
61	$\{UC_1, UC_2, IC_2\} \{IC_1, IC'_2\} \{IC_1\}$
66	$\{UC_1, UC_2, IC'_1\} \{IC_1, IC'_2\} \{IC_2\}$
67	$\{UC_1, UC_2, IC'_1\} \{IC_2, IC'_2\} \{IC_1\}$
78	$\{UC_1, UC_2, IC'_2\} \{IC_1, IC_2\} \{IC'_1\}$
79	$\{IC_1, IC_2, IC'_2\} \{UC_1, UC_2\} \{IC'_1\}$
84	$\{UC_1, UC_2, IC'_2\} \{IC_1, IC'_1\} \{IC_2\}$
85	$\{IC_1, IC'_1, IC'_2\} \{UC_1, UC_2\} \{IC_2\}$
86	$\{UC_1, UC_2, IC'_2\} \{IC_2, IC'_1\} \{IC_1\}$
87	$\{IC_2, IC'_1, IC'_2\} \{UC_1, UC_2\} \{IC_1\}$
109	$\{UC_1, UC_2, IC_2\} \{IC_1\} \{IC'_1\} \{IC'_2\}$
112	$\{UC_1, UC_2, IC'_1\} \{IC_1\} \{IC_2\} \{IC'_2\}$
118	$\{UC_1, UC_2, IC'_2\} \{IC_1\} \{IC_2\} \{IC'_1\}$
128	$\{UC_1, UC_2\} \{IC_1, IC_2\} \{IC'_1, IC'_2\}$
131	$\{UC_1, UC_2\} \{IC_1, IC'_1\} \{IC_2, IC'_2\}$
132	$\{UC_1, UC_2\} \{IC_1, IC'_2\} \{IC_2, IC'_1\}$
143	$\{UC_1, UC_2\} \{IC_1, IC_2\} \{IC'_1\} \{IC'_2\}$
146	$\{UC_1, UC_2\} \{IC_1, IC'_1\} \{IC_2\} \{IC'_2\}$
147	$\{UC_1, UC_2\} \{IC_2, IC'_1\} \{IC_1\} \{IC'_2\}$
158	$\{UC_1, UC_2\} \{IC_1, IC'_2\} \{IC_2\} \{IC'_1\}$
159	$\{UC_1, UC_2\} \{IC_2, IC'_2\} \{IC_1\} \{IC'_1\}$
160	$\{UC_1, UC_2\} \{IC'_1, IC'_2\} \{IC_1\} \{IC_2\}$
188	$\{UC_1, UC_2\} \{IC_1\} \{IC_2\} \{IC'_1\} \{IC'_2\}$
Family 3	
1	$\{UC_1, UC_2, IC_1, IC_2, IC'_1, IC'_2\}$
2	$\{UC_1, UC_2, IC_1, IC_2, IC'_1\} \{IC'_2\}$
3	$\{UC_1, UC_2, IC_1, IC_2, IC'_2\} \{IC'_1\}$
4	$\{UC_1, UC_2, IC_1, IC'_1, IC'_2\} \{IC_2\}$
6	$\{UC_1, IC_1, IC_2, IC'_1, IC'_2\} \{UC_2\}$
8	$\{UC_1, UC_2, IC_1, IC_2\} \{IC'_1, IC'_2\}$
9	$\{UC_1, UC_2, IC_1, IC'_1\} \{IC_2, IC'_2\}$
13	$\{UC_1, UC_2, IC_1, IC'_2\} \{IC_2, IC'_1\}$
23	$\{UC_1, UC_2, IC_1, IC_2\} \{IC'_1\} \{IC'_2\}$
24	$\{UC_1, UC_2, IC_1, IC'_1\} \{IC_2\} \{IC'_2\}$
28	$\{UC_1, UC_2, IC_1, IC'_2\} \{IC_2\} \{IC'_1\}$
38	$\{UC_1, UC_2, IC_1\} \{IC_2, IC'_1, IC'_2\}$
48	$\{UC_1, UC_2, IC_1\} \{IC_2, IC'_1\} \{IC'_2\}$
58	$\{UC_1, UC_2, IC_1\} \{IC_2, IC'_2\} \{IC'_1\}$
59	$\{UC_1, UC_2, IC_1\} \{IC'_1, IC'_2\} \{IC_2\}$
108	$\{UC_1, UC_2, IC_1\} \{IC_2\} \{IC'_1\} \{IC'_2\}$
Family 4	

Table 2: ...

11	$\{UC_1, IC_1, IC_2, IC'_1\} \{UC_2, IC'_2\}$
12	$\{UC_2, IC_1, IC_2, IC'_1\} \{UC_1, IC'_2\}$
15	$\{UC_1, IC_1, IC_2, IC'_2\} \{UC_2, IC'_1\}$
16	$\{UC_2, IC_1, IC_2, IC'_2\} \{UC_1, IC_1\}$
19	$\{UC_1, IC_1, IC'_1, IC'_2\} \{UC_2, IC_2\}$
20	$\{UC_2, IC_2, IC'_1, IC'_2\} \{UC_1, IC_1\}$
21	$\{UC_1, IC_2, IC'_1, IC'_2\} \{UC_2, IC_1\}$
22	$\{UC_2, IC_1, IC'_1, IC'_2\} \{UC_1, IC_2\}$
26	$\{UC_1, IC_1, IC_2, IC'_1\} \{UC_2\} \{IC'_2\}$
27	$\{UC_2, IC_1, IC_2, IC'_1\} \{UC_1\} \{IC'_2\}$
30	$\{UC_1, IC_1, IC_2, IC'_2\} \{UC_2\} \{IC'_1\}$
31	$\{UC_2, IC_1, IC_2, IC'_2\} \{UC_1\} \{IC'_1\}$
33	$\{UC_1, IC_1, IC'_1, IC'_2\} \{UC_2\} \{IC_2\}$
34	$\{UC_2, IC_1, IC'_1, IC'_2\} \{UC_1\} \{IC_2\}$
35	$\{UC_1, IC_2, IC'_1, IC'_2\} \{UC_2\} \{IC_1\}$
36	$\{UC_2, IC_2, IC'_1, IC'_2\} \{UC_1\} \{IC_1\}$
40	$\{UC_1, IC_1, IC_2\} \{UC_2, IC'_1, IC'_2\}$
41	$\{UC_1, IC'_1, IC'_2\} \{UC_2, IC_1, IC_2\}$
44	$\{UC_1, IC_1, IC'_1\} \{UC_2, IC_2, IC'_2\}$
45	$\{UC_1, IC_1, IC'_2\} \{UC_2, IC_2, IC'_1\}$
46	$\{UC_1, IC_2, IC'_1\} \{UC_2, IC_1, IC'_2\}$
47	$\{UC_1, IC_2, IC'_2\} \{UC_2, IC_1, IC'_1\}$
50	$\{UC_1, IC_1, IC_2\} \{UC_2, IC'_1\} \{IC'_2\}$
51	$\{UC_2, IC_1, IC_2\} \{UC_1, IC'_1\} \{IC'_2\}$
54	$\{UC_1, IC_1, IC'_1\} \{UC_2, IC_2\} \{IC'_2\}$
55	$\{UC_2, IC_2, IC'_1\} \{UC_1, IC_1\} \{IC'_2\}$
56	$\{UC_1, IC_2, IC'_1\} \{UC_2, IC_1\} \{IC'_2\}$
57	$\{UC_2, IC_1, IC'_1\} \{UC_1, IC_2\} \{IC'_2\}$
62	$\{UC_1, IC_1, IC_2\} \{UC_2, IC'_2\} \{IC'_1\}$
63	$\{UC_1, IC_1, IC_2\} \{IC'_1, IC'_2\} \{UC_2\}$
64	$\{UC_2, IC_1, IC_2\} \{UC_1, IC'_2\} \{IC'_1\}$
65	$\{UC_2, IC_1, IC_2\} \{IC'_1, IC'_2\} \{UC_1\}$
68	$\{UC_1, IC_1, IC'_1\} \{UC_2, IC'_2\} \{IC_2\}$
69	$\{UC_1, IC_1, IC'_1\} \{IC_2, IC'_2\} \{UC_2\}$
70	$\{UC_2, IC_1, IC'_1\} \{UC_1, IC'_2\} \{IC_2\}$
71	$\{UC_2, IC_1, IC'_1\} \{IC_2, IC'_2\} \{UC_1\}$
72	$\{UC_1, IC_2, IC'_1\} \{UC_2, IC'_2\} \{IC_1\}$
73	$\{UC_1, IC_2, IC'_1\} \{IC_1, IC'_2\} \{UC_2\}$
74	$\{UC_2, IC_2, IC'_1\} \{UC_1, IC'_2\} \{IC_1\}$
75	$\{UC_2, IC_2, IC'_1\} \{IC_1, IC'_2\} \{UC_1\}$
76	$\{IC_1, IC_2, IC'_1\} \{UC_1, IC'_2\} \{UC_2\}$
77	$\{IC_1, IC_2, IC'_1\} \{UC_2, IC'_2\} \{UC_1\}$
80	$\{UC_1, IC_1, IC'_2\} \{UC_2, IC_2\} \{IC'_1\}$
81	$\{UC_2, IC_2, IC'_2\} \{UC_1, IC_1\} \{IC'_1\}$
82	$\{UC_1, IC_2, IC'_2\} \{UC_2, IC_1\} \{IC'_1\}$
83	$\{UC_2, IC_1, IC'_2\} \{UC_1, IC_2\} \{IC'_1\}$
88	$\{UC_1, IC_1, IC'_2\} \{UC_2, IC'_1\} \{IC_2\}$
89	$\{UC_2, IC'_1, IC'_2\} \{UC_1, IC_1\} \{IC_2\}$
90	$\{UC_1, IC_1, IC'_2\} \{IC_2, IC'_1\} \{UC_2\}$
91	$\{IC_2, IC'_1, IC'_2\} \{UC_1, IC_1\} \{UC_2\}$
92	$\{UC_1, IC'_1, IC'_2\} \{UC_2, IC_1\} \{IC_2\}$
93	$\{UC_2, IC_1, IC'_2\} \{UC_1, IC'_1\} \{IC_2\}$
94	$\{UC_2, IC_1, IC'_2\} \{IC_2, IC'_1\} \{UC_1\}$
95	$\{IC_2, IC'_1, IC'_2\} \{UC_2, IC_1\} \{UC_1\}$
96	$\{UC_1, IC_2, IC'_2\} \{UC_2, IC'_1\} \{IC_1\}$
97	$\{UC_2, IC'_1, IC'_2\} \{UC_1, IC_2\} \{IC_1\}$
98	$\{UC_1, IC_2, IC'_2\} \{IC_1, IC'_1\} \{UC_2\}$
99	$\{IC_1, IC'_1, IC'_2\} \{UC_1, IC_2\} \{UC_2\}$
100	$\{UC_1, IC'_1, IC'_2\} \{UC_2, IC_2\} \{IC_1\}$
101	$\{UC_2, IC_2, IC'_2\} \{UC_1, IC'_1\} \{IC_1\}$

Table 2: ...

102	$\{UC_2, IC_2, IC'_2\}\{IC_1, IC'_1\}\{UC_1\}$
103	$\{IC_1, IC'_1, IC'_2\}\{UC_2, IC_2\}\{UC_1\}$
104	$\{UC_1, IC'_1, IC'_2\}\{IC_1, IC_2\}\{UC_2\}$
105	$\{IC_1, IC_2, IC'_2\}\{UC_1, IC'_1\}\{UC_2\}$
106	$\{UC_2, IC'_1, IC'_2\}\{IC_1, IC_2\}\{UC_1\}$
107	$\{IC_1, IC_2, IC'_2\}\{UC_2, IC'_1\}\{UC_1\}$
110	$\{UC_1, IC_1, IC'_2\}\{UC_2\}\{IC'_1\}\{IC'_2\}$
111	$\{UC_2, IC_1, IC_2\}\{UC_1\}\{IC'_1\}\{IC'_2\}$
113	$\{UC_1, IC_1, IC'_1\}\{UC_2\}\{IC_2\}\{IC'_2\}$
114	$\{UC_2, IC_1, IC'_1\}\{UC_1\}\{IC_2\}\{IC'_2\}$
115	$\{UC_1, IC_2, IC'_1\}\{UC_2\}\{IC_1\}\{IC'_2\}$
116	$\{UC_2, IC_2, IC'_1\}\{UC_1\}\{IC_1\}\{IC'_2\}$
117	$\{IC_1, IC_2, IC'_1\}\{UC_1\}\{UC_2\}\{IC'_2\}$
119	$\{UC_1, IC_1, IC'_2\}\{UC_2\}\{IC_2\}\{IC'_1\}$
120	$\{UC_2, IC_1, IC'_2\}\{UC_1\}\{IC_2\}\{IC'_1\}$
121	$\{UC_1, IC_2, IC'_2\}\{UC_2\}\{IC_1\}\{IC'_1\}$
122	$\{UC_2, IC_2, IC'_2\}\{UC_1\}\{IC_1\}\{IC'_1\}$
123	$\{IC_1, IC_2, IC'_2\}\{UC_1\}\{UC_2\}\{IC'_1\}$
124	$\{UC_1, IC'_1, IC'_2\}\{UC_2\}\{IC_1\}\{IC_2\}$
125	$\{UC_2, IC'_1, IC'_2\}\{UC_1\}\{IC_1\}\{IC_2\}$
126	$\{IC_1, IC'_1, IC'_2\}\{UC_1\}\{UC_2\}\{IC_2\}$
127	$\{IC_2, IC'_1, IC'_2\}\{UC_1\}\{UC_2\}\{IC_1\}$
129	$\{UC_1, IC_1\}\{UC_2, IC_2\}\{IC'_1, IC'_2\}$
130	$\{UC_1, IC_2\}\{UC_2, IC_1\}\{IC'_1, IC'_2\}$
133	$\{UC_1, IC_1\}\{UC_2, IC'_1\}\{IC_2, IC'_2\}$
134	$\{UC_1, IC_1\}\{UC_2, IC'_2\}\{IC_2, IC'_1\}$
135	$\{UC_1, IC'_1\}\{UC_2, IC_1\}\{IC_2, IC'_2\}$
136	$\{UC_1, IC'_2\}\{UC_2, IC_1\}\{IC_2, IC'_1\}$
137	$\{UC_1, IC_2\}\{UC_2, IC'_1\}\{IC_1, IC'_2\}$
138	$\{UC_1, IC_2\}\{UC_2, IC'_2\}\{IC_1, IC'_1\}$
139	$\{UC_1, IC'_1\}\{UC_2, IC_2\}\{IC_1, IC'_2\}$
140	$\{UC_1, IC'_2\}\{UC_2, IC_2\}\{IC_1, IC'_1\}$
141	$\{UC_1, IC'_1\}\{UC_2, IC'_2\}\{IC_1, IC_2\}$
142	$\{UC_1, IC'_2\}\{UC_2, IC'_1\}\{IC_1, IC_2\}$
144	$\{UC_1, IC_1\}\{UC_2, IC_2\}\{IC'_1\}\{IC'_2\}$
145	$\{UC_1, IC_2\}\{UC_2, IC_1\}\{IC'_1\}\{IC'_2\}$
148	$\{UC_1, IC_1\}\{UC_2, IC'_1\}\{IC_2\}\{IC'_2\}$
149	$\{UC_1, IC_1\}\{IC_2, IC'_1\}\{UC_2\}\{IC'_2\}$
150	$\{UC_1, IC'_1\}\{UC_2, IC_1\}\{IC_2\}\{IC'_2\}$
151	$\{UC_2, IC_1\}\{IC_2, IC'_1\}\{UC_1\}\{IC'_2\}$
152	$\{UC_1, IC_2\}\{UC_2, IC'_1\}\{IC_1\}\{IC'_2\}$
153	$\{UC_1, IC_2\}\{IC_1, IC'_1\}\{UC_2\}\{IC'_2\}$
154	$\{UC_1, IC'_1\}\{UC_2, IC_2\}\{IC_1\}\{IC'_2\}$
155	$\{UC_2, IC_2\}\{IC_1, IC'_1\}\{UC_1\}\{IC'_2\}$
156	$\{UC_1, IC'_1\}\{IC_1, IC_2\}\{UC_2\}\{IC'_2\}$
157	$\{UC_2, IC'_1\}\{IC_1, IC_2\}\{UC_1\}\{IC'_2\}$
161	$\{UC_1, IC_1\}\{UC_2, IC'_2\}\{IC_2\}\{IC'_1\}$
162	$\{UC_1, IC_1\}\{IC_2, IC'_2\}\{UC_2\}\{IC'_1\}$
163	$\{UC_1, IC_1\}\{IC'_1, IC'_2\}\{UC_2\}\{IC_2\}$
164	$\{UC_1, IC'_2\}\{UC_2, IC_1\}\{IC_2\}\{IC'_1\}$
165	$\{UC_2, IC_1\}\{IC_2, IC'_2\}\{UC_1\}\{IC'_1\}$
166	$\{UC_2, IC_1\}\{IC'_1, IC'_2\}\{UC_1\}\{IC_2\}$
167	$\{UC_1, IC_2\}\{UC_2, IC'_2\}\{IC_1\}\{IC'_1\}$
168	$\{UC_1, IC_2\}\{IC_1, IC'_2\}\{UC_2\}\{IC'_1\}$
169	$\{UC_1, IC_2\}\{IC'_1, IC'_2\}\{UC_2\}\{IC_1\}$
170	$\{UC_1, IC'_2\}\{UC_2, IC_2\}\{IC_1\}\{IC'_1\}$
171	$\{UC_2, IC_2\}\{IC_1, IC'_2\}\{UC_1\}\{IC'_1\}$
172	$\{UC_2, IC_2\}\{IC'_1, IC'_2\}\{UC_1\}\{IC_1\}$
173	$\{UC_1, IC'_2\}\{IC_1, IC_2\}\{UC_2\}\{IC'_1\}$
174	$\{UC_2, IC'_2\}\{IC_1, IC_2\}\{UC_1\}\{IC'_1\}$

Table 2: ...

175	$\{IC_1, IC_2\}\{IC'_1, IC'_2\}\{UC_1\}\{UC_2\}$
176	$\{UC_1, IC'_1\}\{UC_2, IC'_2\}\{IC_1\}\{IC_2\}$
177	$\{UC_1, IC'_1\}\{IC_1, IC'_2\}\{UC_2\}\{IC_2\}$
178	$\{UC_1, IC'_1\}\{IC_2, IC'_2\}\{UC_2\}\{IC_1\}$
179	$\{UC_1, IC'_2\}\{UC_2, IC'_1\}\{IC_1\}\{IC_2\}$
180	$\{UC_2, IC'_1\}\{IC_1, IC'_2\}\{UC_1\}\{IC_2\}$
181	$\{UC_2, IC'_1\}\{IC_2, IC'_2\}\{UC_1\}\{IC_1\}$
182	$\{UC_1, IC'_2\}\{IC_1, IC'_1\}\{UC_2\}\{IC_2\}$
183	$\{UC_2, IC'_2\}\{IC_1, IC'_1\}\{UC_1\}\{IC_2\}$
184	$\{IC_1, IC'_1\}\{IC_2, IC'_2\}\{UC_1\}\{UC_2\}$
185	$\{UC_1, IC'_2\}\{IC_2, IC'_1\}\{UC_2\}\{IC_1\}$
186	$\{UC_2, IC'_2\}\{IC_2, IC'_1\}\{UC_1\}\{IC_1\}$
187	$\{IC_1, IC'_2\}\{IC_2, IC'_1\}\{UC_1\}\{UC_2\}$
189	$\{UC_1, IC_1\}\{UC_2\}\{IC_2\}\{IC'_1\}\{IC'_2\}$
190	$\{UC_2, IC_1\}\{UC_1\}\{IC_2\}\{IC'_1\}\{IC'_2\}$
191	$\{UC_1, IC_2\}\{UC_2\}\{IC_1\}\{IC'_1\}\{IC'_2\}$
192	$\{UC_2, IC_2\}\{UC_1\}\{IC_1\}\{IC'_1\}\{IC'_2\}$
193	$\{IC_1, IC_2\}\{UC_1\}\{UC_2\}\{IC'_1\}\{IC'_2\}$
194	$\{UC_1, IC'_1\}\{UC_2\}\{IC_1\}\{IC_2\}\{IC'_2\}$
195	$\{UC_2, IC'_1\}\{UC_1\}\{IC_1\}\{IC_2\}\{IC'_2\}$
196	$\{IC_1, IC'_1\}\{UC_1\}\{UC_2\}\{IC_2\}\{IC'_2\}$
197	$\{IC_2, IC'_1\}\{UC_1\}\{UC_2\}\{IC_1\}\{IC'_2\}$
198	$\{UC_1, IC'_2\}\{UC_2\}\{IC_1\}\{IC_2\}\{IC'_1\}$
199	$\{UC_2, IC'_2\}\{UC_1\}\{IC_1\}\{IC_2\}\{IC'_1\}$
200	$\{IC_1, IC'_2\}\{UC_1\}\{UC_2\}\{IC_2\}\{IC'_1\}$
201	$\{IC_2, IC'_2\}\{UC_1\}\{UC_2\}\{IC_1\}\{IC'_1\}$
202	$\{IC'_1, IC'_2\}\{UC_1\}\{UC_2\}\{IC_1\}\{IC_2\}$
203	$\{UC_1\}\{UC_2\}\{IC_1\}\{IC_2\}\{IC'_1\}\{IC'_2\}$