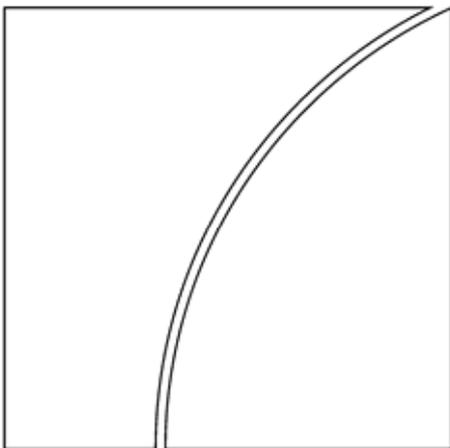


# Committee on Payment and Settlement Systems



## The interdependencies of payment and settlement systems

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## Foreword

The network of domestic and cross-border systems that comprise the global payment and settlement infrastructure has evolved significantly over recent years. These systems, like the financial markets and economies they support, are increasingly connected through a wide array of complex interrelationships. As a result, the smooth functioning of an individual system often depends on the smooth functioning of other related systems.

The safety of the global payment and settlement infrastructure requires that system operators, financial institutions, and service providers have a robust understanding of payment and settlement risks, and that they manage those risks effectively. Tighter interdependencies among systems, however, change the nature of risks present in the global infrastructure, and they also create new challenges for achieving effective risk management.

Given its long-standing focus on strengthening systems to prevent systemic risk, the CPSS developed this report to identify the various interdependencies that exist among the systems of CPSS countries, analyse the risk implications of these interdependencies, and assess any associated risk management challenges.

The report concludes that interdependencies have important implications for the safety and efficiency of the global payment and settlement infrastructure. Tighter interdependencies have contributed to strengthen the global infrastructure by reducing several sources of settlement costs and risks. At the same time, interdependencies have increased the potential for disruptions to spread quickly and widely across multiple systems.

To address the potential for a disruption to spread quickly to many systems, the report suggests that system operators, financial institutions, and service providers take several actions in order to adapt their existing risk management practices to the more complex, integrated environment resulting from tighter interdependencies. To that end the report underlines the importance of broad risk management perspectives, risk management controls that are commensurate with the role played in the global payment and settlement infrastructure, and wide coordination among interdependent stakeholders.

The report also suggests that central banks and other authorities review, and where necessary, adjust their policies in light of the challenges posed by interdependencies. In this context, the CPSS will pursue a number of objectives to increase the resilience of the global payment and settlement infrastructure.

The report has been prepared for the Committee on Payment and Settlement Systems by the Working Group on System Interdependencies. The CPSS is very grateful to the members of the working group and its chairman, Denis Beau, for their excellent work in preparing this report.

Timothy F Geithner, Chairman  
Committee on Payment and Settlement Systems



# Contents

|  |           |
|--|-----------|
| Foreword.....  | iii       |
| <b>Executive summary</b> .....   | <b>1</b>  |
| The characteristics of interdependencies in CPSS countries.....                    | 1         |
| Impact on the safety of the global payment and settlement infrastructure .....     | 2         |
| Implications for the effectiveness of risk management.....                         | 3         |
| Conclusions and suggested actions .....  | 4         |
| Introduction.....  | 6         |
| <b>Part I: The characteristics of interdependencies in CPSS countries</b> .....    | <b>7</b>  |
| 1. Forms of interdependencies.....   | 7         |
| 1.1 Diversity of relationships .....   | 8         |
| 1.2 Taxonomy .....   | 9         |
| 1.2.1 System-based interdependencies .....   | 10        |
| 1.2.2 Institution-based interdependencies .....                                    | 12        |
| 1.2.3 Environmental interdependencies .....  | 13        |
| 2. Factors contributing to the development of interdependencies.....               | 14        |
| 2.1 Globalisation and regional integration.....                                    | 14        |
| 2.2 Consolidation .....  | 15        |
| 2.3 Public policies .....  | 16        |
| 2.4 Technological innovations.....   | 16        |
| 3. Extent of interdependencies of systems in CPSS countries .....                  | 17        |
| 3.1 System-based interdependencies.....  | 17        |
| 3.1.1 Domestic clearing and settlement relationships .....                         | 17        |
| 3.1.2 Cross-currency clearing and settlement relationships .....                   | 18        |
| 3.1.3 Operational and risk management relationships .....                          | 21        |
| 3.2 Institution-based interdependencies .....                                      | 22        |
| 3.2.1 Domestic clearing and settlement relationships .....                         | 22        |
| 3.2.2 Cross-border clearing and settlement relationships .....                     | 22        |
| 3.3 Operational environmental interdependencies .....                              | 25        |
| 3.4 Summary.....   | 25        |
| <b>Part II: Implications for risk, risk transmission and risk management</b> ..... | <b>26</b> |
| 4. Introduction .....  | 26        |
| 5. Implications for payment and settlement risks .....                             | 27        |
| 5.1 Several important sources of risk have been eliminated or reduced .....        | 28        |
| 5.2 New sources of liquidity and operational risk have been introduced .....       | 28        |

|       |   |    |
|-------|---|----|
| 5.3   | The concentration of sources of risks in a few critical systems, participants and service providers has been accentuated .....                      | 30 |
| 5.4   | Summary of implications for payment and settlement risks .....  | 30 |
| 6.    | Implications for the transmission of payment and settlement disruptions .....   | 31 |
| 6.1   | Interdependencies can allow disruptions to spread widely and quickly .....  | 31 |
| 6.1.1 | Interdependencies can transmit disruptions widely, including across borders .....   | 32 |
| 6.1.2 | Interdependencies can transmit disruptions quickly .....  | 33 |
| 6.2   | Disruptions may spread to multiple financial markets .....  | 33 |
| 6.3   | Interdependencies can either dampen or amplify the intensity of disruptions .....   | 36 |
| 6.4   | Systems' and institutions' actions influence the transmission of disruptions .....  | 37 |
| 6.5   | Summary of implications for the transmission of disruptions .....   | 37 |
| 7.    | Implications for risk management .....  | 38 |
| 7.1   | A broad risk management perspective is important .....  | 38 |
| 7.2   | The risk management procedures of systems, institutions and service providers at the centre of key interdependencies are especially important ..... | 40 |
| 7.2.1 | Operational risk management .....   | 40 |
| 7.2.2 | Liquidity risk management .....   | 40 |
| 7.2.3 | The scope of operational and risk management tests .....  | 42 |
| 7.3   | Interdependencies increase the importance of coordination and information sharing among key stakeholders .....                                      | 42 |
| 7.3.1 | Coordination among key stakeholders is important .....  | 42 |
| 7.3.2 | The widespread distribution of accurate information is key .....  | 43 |
| 7.4   | Summary of implications for risk management .....   | 43 |
|       | <b>Conclusion and suggested actions</b> .....   | 43 |
|       | <b>Boxes</b>  |    |
|       | Box 1: Modelling interdependencies .....  | 20 |
|       | Box 2: Payment and settlement risks for financial institutions .....  | 27 |
|       | Box 3: Market events in August and September 2007 .....   | 36 |
|       | <b>Annexes</b>  |    |
|       | Annex 1: Domestic clearing and settlement relationships .....   | 50 |
|       | Annex 2: Cross-currency CCP-to-CCP links .....  | 68 |
|       | Annex 3: CSD-to-CSD links .....   | 70 |
|       | Annex 4: Global banking group scenario analysis .....   | 74 |
|       | Annex 5: Members of the working group .....   | 77 |

## Executive summary

The numerous payment and settlement systems that underpin the global financial system are growing more interconnected. Tighter direct relationships between systems, stronger indirect relationships arising from the activities of large financial institutions in multiple systems, and broader commonalities, such as the use of common third-party service providers, all contribute to this trend. As a result, the settlement flows, operational processes and even risk management procedures of many systems have become more interdependent.

The development of tighter interdependencies has helped to strengthen the global payment and settlement infrastructure by reducing several sources of cost and risk. Yet, tightening interdependencies have also increased the potential for disruptions to spread quickly and widely across multiple systems and markets.

This report identifies three important challenges that, if met, would help systems, institutions and service providers adapt their risk management efforts to this increased potential for disruptions to spread quickly and widely across systems. These challenges include: (i) adopting broad risk management perspectives; (ii) having risk management controls that are commensurate with the system's, institution's or service provider's role in the global infrastructure; and (iii) implementing wide coordination among interdependent stakeholders.

The report suggests several actions that relevant systems, institutions and service providers could take to effectively address those challenges. It also suggests a number of related actions for central banks. Taking these steps would reinforce the benefits of tightening interdependencies and make the global payment and settlement infrastructure more resilient to potential disruptions. While this report focuses on the development of interdependencies within and among CPSS countries, the analysis and suggested actions in this report may also be relevant to other countries.

***The characteristics of interdependencies in CPSS countries.*** Over the past 30 years, technological innovations, globalisation and financial sector consolidation have fostered a broad web of interconnections among a large number of payment and settlement systems, both within and across CPSS countries. These interconnections reflect efforts on the part of systems and institutions to seek new business opportunities and to reduce clearing and settlement costs. They also reflect efforts by central banks and the financial industry to promote the low-cost and safe transfer of money and financial instruments. The focus of the CPSS on reducing foreign exchange settlement risk and the work of the G30 to reduce risk in securities settlement systems, for example, have both led to tighter, more integrated settlement processes. The development of these numerous interconnections has helped to create tighter interdependencies among systems.

Systems can be interconnected in a variety of ways. In some cases, interdependencies arise from direct relationships among systems. For example, central securities depositories (CSDs) and large-value payment systems (LVPSs) may establish technical links or account relationships to facilitate efficient delivery versus payment (DVP) settlement of securities transfers. Similarly, the continuous linked settlement (CLS) system depends on the account relationships that CLS Bank has established with the central banks of CLS-eligible currencies to facilitate the funding process that supports the payment versus payment (PVP) settlement of foreign exchange trades across the books of CLS Bank.

But, systems can also be interdependent in less direct and more complicated ways. Financial institutions that have settlement activities in several systems or that provide services to several systems can create indirect relationships among those same systems. Interdependencies can also result, for example, from the dependence of a number of systems on a common messaging service provider like SWIFT, or on a common third-party service provider for their IT systems.

Some types of interdependencies are more prevalent than others. Interdependencies are particularly strong on a domestic, same-currency basis.<sup>1</sup> The central counterparties (CCPs), CSDs and LVPSs supporting the financial markets of a given currency are strongly interdependent in several, distinct ways. In most cases, these systems are directly connected through technical or account relationships. CCPs typically depend directly both on the LVPS and the CSD to conduct settlement and manage risk. The CSD and LVPS often are interconnected in some way to achieve DVP for securities settlements. And in many cases, an institution's use of central bank intraday credit within an LVPS can be dependent in part on their ability to deliver collateral through one or more CSDs. Furthermore, the key participants of these domestic systems overlap significantly. This overlap can increase the interdependence of domestic systems, as an institution's settlement flows in one system can have a strong influence on its ability to make transfers in other domestic systems. Finally, in a few cases, domestic systems become interdependent because of their reliance on common service providers or common risk management policies or resources.

Currently, cross-border and cross-currency interdependencies appear to be less extensive than domestic interdependencies, though some are quite significant. The arrangements used by CLS to facilitate PVP settlement constitute the most prominent set of cross-currency interdependencies.<sup>2</sup> In addition, many systems and institutions depend on SWIFT for messaging services. Yet with respect to relationships among systems arising from the activities of institutions, it appears that only a very few institutions both have significant cross-border activities and are direct participants in many payment and settlement systems. Nonetheless, further globalisation and consolidation could raise the importance of cross-border, institution-based interdependencies going forward.

***Impact on the safety of the global payment and settlement infrastructure.*** The development of interdependencies has several, sometimes conflicting, implications for the safety of the global payment and settlement infrastructure. On the one hand, interdependencies have facilitated significant reductions in specific payment and settlement-related risks. Most importantly, direct relationships among systems play an important role in facilitating DVP and PVP processes and therefore in eliminating the risk of loss of the full value of securities or foreign exchange transactions (principal credit risk). In addition, technical relationships among systems that facilitate the standardisation, automation and integration of processes have helped to reduce operational risks. The relationships of domestic CCPs, CSDs and ancillary payment systems with the domestic LVPS to facilitate the use of central bank money also eliminate a different source of credit risk, namely the potential default of the settlement institution. Also, central banks' role as settlement institutions provides more assurance of continuity in the provision of intraday liquidity to LVPS participants, reducing the liquidity risk they otherwise face.

On the other hand, interdependencies raise the potential for disruptions to spread widely and quickly across the financial system in at least three ways. First, interdependencies can propagate disruptions sequentially from one system to another. This potential effect arises when the smooth functioning of one or more systems is conditional on that of another system. For example, in the case that a LVPS participant experiences an operational disruption or liquidity shortfall, it may be unable to transfer funds to its counterparties. As a result, other LVPS participants may have lower balances than expected. This shortage of funds could prevent these institutions from receiving incoming securities transfers in a linked CSD, causing securities fails. In this way, a disruption in the LVPS could pass to the CSD.

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<sup>1</sup> In this report, "domestic" generally refers to a currency area, unless indicated otherwise by context.

<sup>2</sup> While other multicurrency and cross-border systems exist, including international CSDs, these other systems either do not have the same high level of activity or do not have the same cross-currency settlement mechanisms present in CLS.

This type of interdependency creates what might be called a “cross-system” risk between the CSD and the LVPS. The settlement arrangement of CLS Bank poses a similar set of risks.

Second, interdependencies can also act to spread disruptions simultaneously to many systems. This potential effect stems from many systems depending in common on other critical systems, on large financial institutions or on key service providers. From an international perspective, many systems are dependent on SWIFT. As such, a SWIFT outage could have direct and immediate implications for many systems. From a domestic perspective, many systems are critically dependent on the primary LVPS, and a disruption affecting a LVPS could impair the functioning of those other systems.

Third, in some circumstances, interdependencies may transmit disruptions beyond systems and their participants to financial markets. The functioning of markets with relatively short settlement cycles, such as the markets for uncollateralised overnight loans and repurchase agreements, might be particularly affected.

The actual impact of a given disruption will depend on many factors, and is difficult to predict. First, and most importantly, systems’ and institutions’ risk management procedures can help prevent the transmission of disruptions across systems. Second, interdependencies can sometimes be useful in mitigating the impact of a disruption. For example, “liquidity bridges” can allow institutions to move available liquidity resources between systems, potentially helping to manage potential liquidity disruptions, and preventing their further transmission. Third, the reaction of systems and institutions to a particular disruption may significantly influence whether and how a disruption spreads. These reactions may be very difficult for other parties to anticipate. Moreover, market conditions can influence both the initial intensity of a disruption as well as systems’ and institutions’ reactions to it.

***Implications for the effectiveness of risk management.*** To address the increased potential that disruptions quickly spread across many interdependent systems, it is important that systems, institutions and service providers adapt their risk management efforts. To that end, at least three challenges should be met. First, it is important that these stakeholders adopt broad risk management perspectives, and look beyond their direct operations and exposures to identify the broad range of disruptions that might affect them because of interdependencies. It is also crucial that they understand their role in the broader global infrastructure and in creating significant interdependencies among other systems.

Second, it is important that systems, institutions, and service providers at the centre of key interdependencies have especially strong risk management controls. Strong business continuity arrangements become increasingly critical, as operational outages can have widespread effects. The ability of systems to provide minimum service levels and the ability of systems and institutions to continue to conduct activity in the event of a problem are especially useful in containing the impact of a disruption. As such, the capacity of “offline” processing facilities, the availability of alternative arrangements to settle transactions and the ability to reroute transactions rise in importance. The liquidity risk management techniques of key systems and large institutions also take on greater importance. Central banks’ provision of intraday credit, securities lending programmes and measures to prevent “liquidity sinks”, may be particularly effective at containing disruptions at the system level. And at the institution level, contingency funding plans that incorporate the possibility that liquidity strains arise in multiple payment and settlement systems simultaneously, including on an intraday basis, are particularly important.

Third, because interdependencies allow disruptions to pass among systems through complex paths and with uncertain intensity, interdependencies also call for wide coordination of risk management and crisis management efforts. For example, an effective response to a particular disruption may be dependent on the actions of many parties. As such, timely and yet sufficiently secure information sharing can facilitate systems’ crisis management arrangements. In addition, cooperation among central banks and other authorities, including on a cross-border basis, is also important. Such cooperation may be critical both in crisis

management situations and in normal circumstances for authorities to meet their responsibilities.

**Conclusions and suggested actions.** The CPSS encourages system operators, financial institutions, and service providers to strengthen further the global payment and settlement infrastructure by addressing the challenges posed by interdependencies. For that purpose, the CPSS suggests a set of actions to be undertaken by these stakeholders. Taking these steps would reinforce the benefits of tightening interdependencies and make the global payment and settlement infrastructure more resilient to potential disruptions.

#### *Challenge 1: Broad risk management perspectives*

**Suggested action:** System operators, financial institutions and third-party service providers should regularly review the risks they bear from and pose to other entities as a result of interdependencies.

When taking this action, a stakeholder might consider whether its risk management framework allows it to:

- identify the systems, institutions, service providers and financial markets (a) that are critical to the normal performance of its clearing and settlement activities, and (b) that could be materially affected by its inability to provide services or conduct settlement as expected.
- understand the type of risks borne from and posed to those interdependent entities.

#### *Challenge 2: Risk management commensurate with stakeholders' roles*

**Suggested action:** System operators, financial institutions and third-party service providers should regularly assess whether their risk management tools are proportionate to the risks they bear from and pose to other interdependent entities.

When taking this action, a stakeholder might assess:

- whether it has implemented risk management tools that are well fitted to the operational and liquidity risks arising from interdependencies. Such tools might include business continuity arrangements that allow for the rapid recovery and resumption of critical activities, alternative settlement channels to process key transactions (eg "offline" capacity) and liquidity risk management techniques, for both systems and institutions, that help address market-wide stress conditions.
- whether those tools effectively limit the likelihood of spreading disruptions to multiple interdependent entities, both by preventing new disruptions and by effectively managing those disruptions that have already occurred. From an operational risk perspective, systems, institutions and service providers could assess this capacity by organising or participating in business continuity tests that include interdependent entities, potentially including market-wide tests. With respect to liquidity risks, systems and institutions could conduct failure-to-settle simulations or stress tests of contingency funding plans that assume wide-ranging disruptions affecting multiple other systems or institutions.

#### *Challenge 3: Wide coordination*

**Suggested action:** System operators, financial institutions and third-party service providers should regularly review whether their crisis management arrangements allow effective coordination among interdependent entities.

When taking this action, a stakeholder might assess:

- whether its crisis arrangements address the need to communicate with other interdependent entities, as well as central banks and other relevant authorities on a domestic and international basis.
- whether crisis arrangements, including business continuity plans, are tested with all relevant parties on a regular basis.

While systems, institutions and service providers bear the responsibility for addressing these three challenges, tightening interdependencies also have implications for public authorities in their oversight, supervisory or regulatory roles. In this light, the CPSS suggests several potential steps to be taken by central banks.

- Central banks should have a clear understanding of how interdependencies can affect the systems they oversee.
- Central banks should review whether their policies provide entities with proper incentives to address sufficiently the risks brought by interdependencies. Bank supervisors, securities regulators and other authorities may also wish to consider similar steps where relevant.
- Central banks should regularly review whether their cooperative efforts with other central banks and relevant public authorities sufficiently address the coordination challenges brought by interdependencies.

At the same time, collective efforts may also serve to complement the actions of individual central banks or public authorities. In this context, the CPSS will continue to pursue several objectives related to the challenges of interdependencies, including:

- identifying the relative importance of those systems, institutions and service providers that are most critical to the safety of the global payment and settlement infrastructure;
- reviewing and, where necessary, adapting the internationally recognised principles and recommendations for the management of payment and settlement risks, especially operational and liquidity risks, to reflect the challenges posed by interdependencies;
- improving cooperative efforts with bank supervisors, securities regulators and other authorities at the international level to bring about consistent progress in the management of liquidity and operational risks by entities that are subject to different regulatory or oversight frameworks.

## Introduction

The global payment and settlement infrastructure has changed significantly over the last decade. The myriad of domestic and cross-border systems that make up the global infrastructure are increasingly interconnected through a web of direct and indirect relationships. Through these relationships, the smooth functioning of a single system often becomes contingent on the performance of one or more other systems. In addition, individual systems are often reliant on common third parties, financial markets or other factors. Consequently, the settlement flows, operational processes and even risk management procedures of individual systems are often materially interdependent with those of other systems. As a result, the numerous systems that make up the global clearing and settlement infrastructure have become more tightly interdependent.

This increasing interdependence is driven by several interrelated factors, including technological innovations, globalisation and financial sector consolidation. In addition, a number of initiatives by the financial industry and by public authorities to reduce the costs and risks of settlement have purposely promoted greater integration among the numerous components of the global payment and settlement infrastructure. For example, the 1989 G30 recommendations for T+3 securities settlement, central bank policies encouraging the development and reliance on systems with intraday finality, and the CPSS focus on reducing foreign exchange settlement risk have provided incentives for more straight through processing and tighter relationships among individual systems.<sup>3</sup> While these explicit initiatives explain one aspect of tightening interdependencies, institutions' profit-seeking and cost management incentives also foster interdependencies.

Interdependencies have important implications for the safety and efficiency of the global payment and settlement infrastructure. Some forms of interdependencies have facilitated significant improvements in the safety and efficiency of payment and settlement processes. At the same time, interdependencies increase the potential for a given disruption to spread quickly to many different systems. This potential was noted in the 2000 G10 report on *Financial sector consolidation* (the Ferguson report), which suggested that interdependencies might accentuate the role of payment and settlement systems in the transmission of disruptions across the financial system, and is further analysed in this report.

The potential for interdependencies to reduce key sources of risk, and yet create new sources of risk, highlights the numerous trade-offs faced by payment and settlement systems, their participants and public authorities. The reduction of one form of risk often comes at the expense of increasing another source of risk, or of increasing costs.

Strengthening systems to prevent and contain systemic risks has been a long-standing focus of the CPSS and its member central banks. As a result, many elements of the CPSS Core Principles for Systemically Important Payment Systems (Core Principles), CPSS/IOSCO Recommendations for Securities Settlement Systems (RSSS), and CPSS/IOSCO Recommendations for Central Counterparties (RCCP) address some of the challenges posed by interdependencies, including the potential for disruptions to spread across systems.<sup>4</sup> The RSSS and RCCP standards, for example, contain explicit recommendations on links between two CSDs and two CCPs, respectively. Moreover, all three sets of standards address the management of settlement risk, including settlement asset risk, and the related potential for disruptions to affect other systems.

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<sup>3</sup> *Clearance and Settlement Systems in World's Securities Markets*, Group of Thirty, 1989.

<sup>4</sup> See CPSS, *Core Principles for Systemically Important Payment Systems*, January 2001; CPSS/IOSCO, *Recommendations for Securities Settlement Systems*, November 2001; and CPSS, *Recommendations for Central Counterparties*, November 2004.

Nonetheless, these principles and recommendations generally address systemic risk concerns by focusing on the resilience of individual components of the global infrastructure. As the components of the global payment and settlement infrastructure become more interdependent, however, the effectiveness of this perspective could diminish. As such, the risk management efforts of individual systems, institutions and service providers may need to be adapted to their more interdependent environments, and additional coordination among key stakeholders may be required, for example.

Given the potential for new challenges, the CPSS formed a working group to study the development of interdependencies, and their implications for risk and risk management. This report presents the findings of the working group, drawing in part on a fact-finding exercise involving selected payment and settlement systems and large globally active financial institutions.<sup>5</sup> The intention of this report is to describe comprehensively the form and extent of interdependencies among the payment and settlement systems of CPSS countries, to identify the implications of these interdependencies for the risks present in the global payment and settlement infrastructure, and to assess the risk management challenges posed by tightening interdependencies. The report focuses on interdependencies among large-value payment systems, central securities depositories and central counterparties, including domestic, cross-border and multicurrency systems.<sup>6</sup>

## **Part I: The characteristics of interdependencies in CPSS countries**

Part I of this report is organised into three sections. Section 1 presents an overview of the varied forms of interdependencies observed among systems in CPSS countries. Section 2 discusses the key factors that have influenced the development of interdependencies. Section 3 describes the extent of these interdependencies within and across CPSS countries.

### **1. Forms of interdependencies**

Direct relationships between systems, indirect relationships arising from the activities of large financial institutions in multiple systems, and broader commonalities have led to a complex web of interconnections among numerous payment and settlement systems. As a result, the smooth functioning of one system can be dependent on that of another system. In addition, the smooth functioning of two or more systems may be dependent on a third party or factor (eg common financial markets). This conditionality can cause the settlement flows, operational processes and even risk management procedures of multiple systems to become interdependent. This section describes the different forms interdependencies that arise from these various relationships among systems.

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<sup>5</sup> This fact-finding was conducted in the second half of 2006.

<sup>6</sup> A *central counterparty* (CCP) is an entity that interposes itself between counterparties to contracts in one or more financial markets, becoming a buyer to every seller and seller to every buyer, concentrating risk and risk management responsibilities. A *central securities depository* (CSD) is an institution for holding immobilised or dematerialised securities that enables securities transactions to be processed by means of book-entry. A *large-value payment system* (LVPS) is a funds transfer system primarily designed to process large-value or urgent payments. See CPSS, *A glossary of terms used in payment and settlement systems*, March 2003.

## 1.1 Diversity of relationships

A payment or settlement system typically provides clearing or settlement services for a specific set of financial instruments or assets, has a defined group of direct participants, and is governed by a detailed set of rules and procedures. As such, a system is often viewed and analysed as distinct and separate from other systems.

Payment and settlement systems, however, do not operate in a vacuum. To function effectively, systems establish relationships with other systems, as well as with financial institutions and service providers. These relationships can take several forms. In particular, this report distinguishes between direct and indirect relationships. Direct relationships are tangible links between two systems. Indirect relationships are created through a common participant or some other intermediary or third party common to two or more systems.

Consider the example of a CCP established by market participants to support the settlement of securities. To function effectively, a CCP first needs to transfer securities between its participants. It is common for a CCP to establish a direct relationship for this purpose by opening an account with the CSD in which the securities are held in safekeeping. Alternatively, the CCP could open accounts with one or more custodian banks that are direct participants in the CSD, and consequently the relationship between a CCP and the associated CSD would be indirect. Second, money, as well as securities, must be transferred between the CCPs' participants in order to settle securities transactions. Some CCPs have become a direct participant in a domestic large-value payment system, which creates a direct relationship. Other CCPs rely on one or more commercial banks as a settlement bank. This alternative creates a direct relationship between a CCP and the settlement banks, as well as an indirect relationship with the domestic large-value payment system. In addition to securities and money transfers, a CCP needs to receive and deliver collateral, in the form of cash or securities, that is collected as margin. This function requires a CCP to create still more direct or indirect relationships with its associated CSD, its settlement banks or a large-value payments system.

The example above provides only a partial list of the arrangements that a CCP might establish in order to serve its participants. A complete list would involve a larger circle of systems and financial institutions, as well as third-party service providers. Adding to the web of relationships enveloping a CCP is the payment and settlement activity that many of its participants conduct in other systems. A CCP's largest participants are also likely to be among the largest participants in the same CSD and large-value payment system in which the CCP has established arrangements for transferring securities, money and margin.

Figure 1 takes the CCP example used above as a starting point and expands upon it. Figure 1 is a two-country illustration in which each country has a central bank, a CSD, one or two CCPs, and one or two large-value payment systems. In addition, the payments infrastructure includes a PVP system to settle FX transactions and an international central securities depository (ICSD).<sup>7</sup> The figure also depicts three banks with different approaches to conducting cross-border activities.

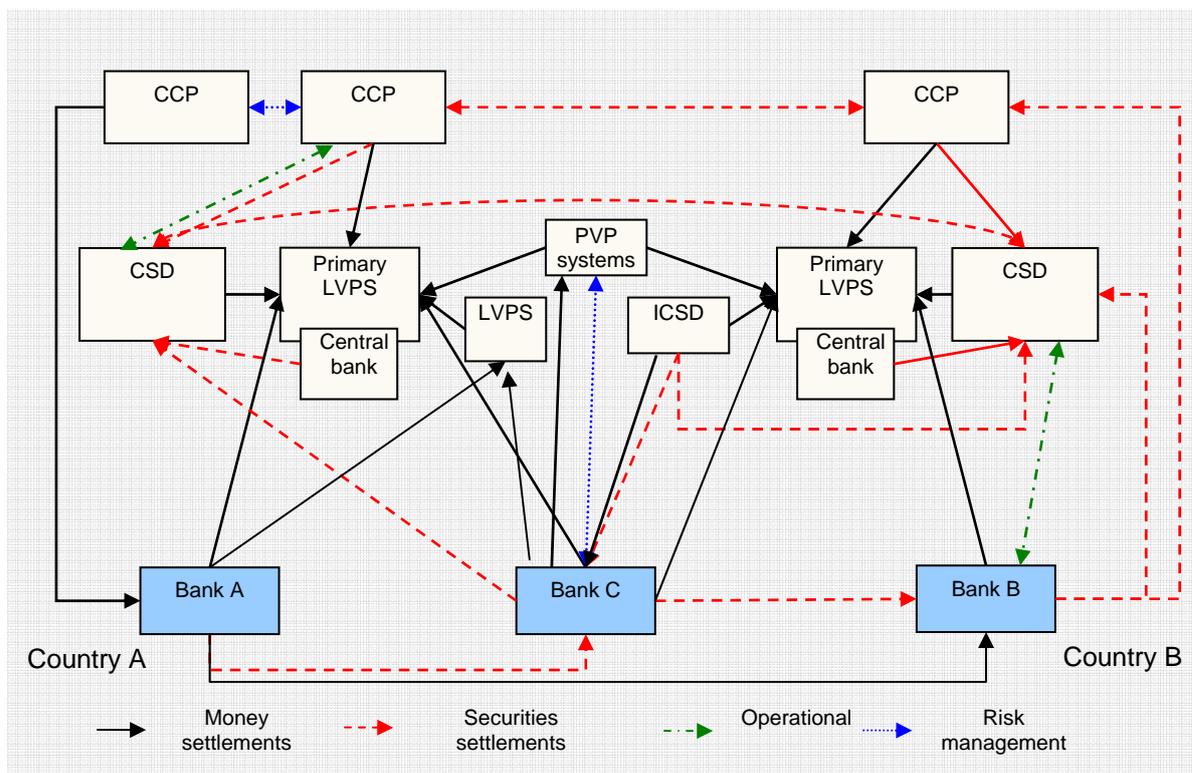
Large-value payment systems, PVP systems and CSDs, like CCPs, often establish several arrangements among each other in order to function effectively. The solid and broken arrows and their colours signify the type of relationship between systems or between a system and its participants. Further complicating the picture are domestic or cross-border links between CSDs and between CCPs, as well as correspondent or custodial arrangements between banks. In sum, this figure illustrates the diversity of clearing and settlement, operational and

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<sup>7</sup> An ICSD is a central securities depository that settles trades in international securities and in various domestic securities, usually through direct or indirect links. See the CPSS Glossary.

risk management relationships that can create material interdependencies among systems. Figure 1 is far from a complete illustration of the relationships among systems, as it does not depict their relationships with the financial markets and third-party providers. If we were to attempt to incorporate these factors, the picture would grow even more complex.

Figure 1  
Diversity of roles and relationships



## 1.2 Taxonomy

The various relationships between two or more systems, together with those between a system and its participants, service providers and the financial markets, create multiple forms of interdependencies among systems. Some are relatively simple to identify because they result from direct relationships between two systems. Others are more difficult to identify because they result from a myriad of indirect or informal relationships, potentially involving a large number of systems, institutions or third parties.

For analytical purposes, interdependencies among payment and settlement systems can be organised into three broad categories: (i) those arising from direct cross-system relationships (system-based interdependencies); (ii) those arising from the activities of one financial institution in two or more systems (institution-based interdependencies); and (iii) those arising from broader commonalities, including the use of a common service provider (environmental interdependencies) (see Figure 2).

Within these first three categories, relationships among systems, and the resulting interdependencies, may be grouped into three additional categories: relationships affecting the clearing and settlement process, those affecting the risk management process, and those affecting general operations. Examples of interdependencies that arise from these various types of relationships among different parties are provided in Table 1, and further described below.

Figure 2  
Forms of interdependencies

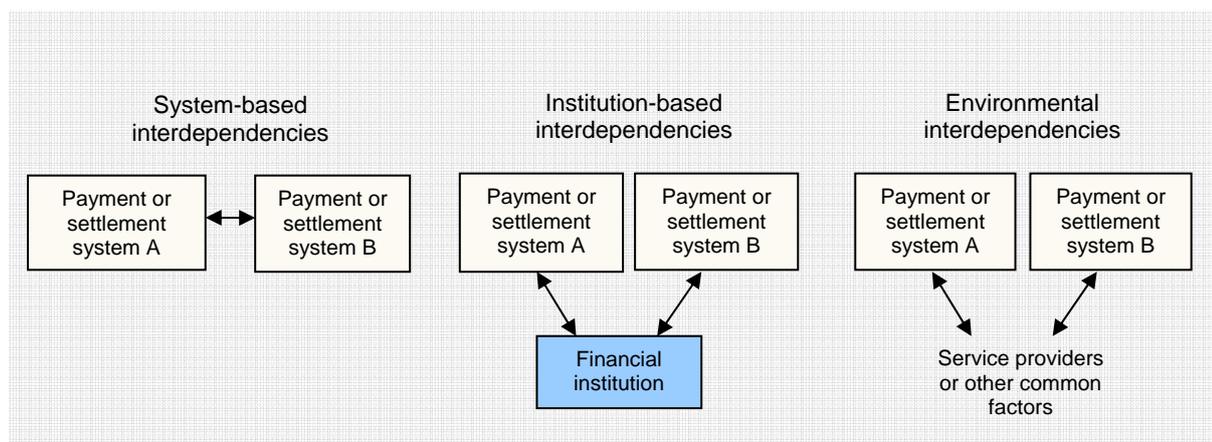


Table 1  
Selected examples of interdependencies arising from relationships

| Type of relationship:                      | Clearing and settlement   | Risk management   | General operations  |
|--|---|---|---|
| Form of interdependencies:<br>System-based | CCP and CSD links to LVPS systems for money settlements                               | Cross-margining between two CCPs  | Shared operational resources or facilities between systems under common ownership |
| Institution-based                          | Direct and indirect participation of large financial institutions in multiple systems | Provision of backup liquidity to a system by large financial institutions | Provision of operational services to systems by large financial institutions      |
| Environmental                              |   | Common collateral valuation methodologies for CCPs                        | Common third-party IT or telecommunications service providers to multiple systems |

### 1.2.1 System-based interdependencies

System-based interdependencies result from relationships among two or more systems where one system's performance relies upon the performance of another system.

**Clearing and settlement relationships.** Relationships among systems for the purpose of facilitating the clearing and settlement of financial transactions often occur along two general lines. Within a particular market or sector, vertical relationships may develop among systems along the clearance and settlement chain. Across markets, horizontal relationships may

develop among systems to widen the scope of markets, instruments or institutions accessible through a particular system.

Vertical relationships occur, for example, between the CCP, CSD and LVPS that support the clearing and settlement process for a particular securities market. Many CCPs use the services of a CSD to complete delivery of the net securities positions they assume as a central counterparty. Examples of this situation include LCH.Clearnet SA in France, Belgium and the Netherlands, Eurex Clearing AG (ECAG) in Germany and Switzerland, LCH.Clearnet Ltd in the United Kingdom, x-clear in Switzerland, the JASDEC DVP Clearing Corporation (JDCC) in Japan or the National Securities Clearing Corporation (NSCC) in the United States. Similarly, for the settlement of money obligations, many CSDs are linked to an LVPS in order to achieve delivery versus payment.<sup>8</sup>

Vertical relationships also exist between certain LVPS systems that rely on CSDs in order to obtain collateral or settle intraday repurchase agreements for intraday credit.<sup>9</sup> RTGS systems and other payment systems also have vertical relationships for funding and settlement purposes. For example, CHIPS uses Fedwire to conduct its initial and final funding, CLS Bank is connected to the LVPS systems whose currencies are eligible in CLS such that members can fund their positions, and EURO1 uses TARGET to complete its settlement. Annex 1 provides more information on these types of clearing and settlement relationships within each CPSS country.

In addition, horizontal links sometimes exist between two CCPs, two CSDs or two or more payment systems. A prominent example of horizontal relationships among payment systems existed in the original TARGET system. TARGET interlinked 17 different payment systems, allowing credit institutions throughout the European Union to send funds transfers to each other.<sup>10</sup> A number of horizontal links also exist between two or more CSDs and two or more CCPs.<sup>11</sup> These types of links are further described in Annexes 2 and 3.

**Risk management relationships.** Risk management relationships occur when two or more systems manage risk on a centralised or coordinated basis, have other formal agreements to share risks or risk mitigation resources (eg margin or collateral), or respond to risk events in a coordinated or correlated manner. For example, within the Depository Trust and Clearing Corporation (DTCC) complex, a common staff group at the holding company level performs the risk management function for affiliated systems, including the Depository Trust Company (DTC), the NSCC and the Fixed Income Clearing Corporation (FICC). As a result, the measurement and monitoring of risk exposures and the reaction to risk events may be more tightly coordinated or correlated than if the affiliated systems maintained separate risk management staffs. Another risk management interdependency may occur if a system defines an “event of default” in its rules and procedures such that the default of a participant in another system may be deemed to be a default in the first system. These so-called cross-default provisions may cause more closely correlated reactions among otherwise independent systems to the settlement failure of a common participant. Finally, some

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<sup>8</sup> See CPSS, *Delivery versus payment in securities settlement systems*, 1992.

<sup>9</sup> See CPSS, *Cross-border collateral arrangements*, 2006.

<sup>10</sup> TARGET2 was launched on 19 November 2007 and will successively replace the decentralised technical platforms operating under the name TARGET. According to the Eurosystem’s country window approach, the central bank and the respective national banking community, the changeover to TARGET2 will occur over a range of dates. TARGET2 is a single technical platform; however, from a legal point of view, each national central bank (NCB) participating in it remains its own RTGS system.

<sup>11</sup> See CPSS, *Cross-border securities settlement*, 1995. Also see European Central Securities Depository Association, *Cross border clearing and settlement through CSD links*, 2006.

systems, primarily in the United States, have entered into formal cross-margining, cross-guarantee or cross-netting agreements covering common participants.

**General operational relationships.** Two or more systems also may rely on common operational facilities or staff. For example, in Europe, Euroclear’s consolidation model is based on the implementation of a single custody and settlement platform supporting several distinct (I)CSD affiliates. Also in Europe, Clearstream Banking Frankfurt relies on the Deutsche Börse for the programming and operations of certain systems, and on Clearstream Banking Luxembourg for technical and operational support of certain activities. In the United States, the operations of the NSCC, the FICC and the DTC are supported by a common IT platform.

### 1.2.2 Institution-based interdependencies

Institution-based interdependencies result from indirect relationships between two or more systems through a common financial institution. These relationships importantly include two or more systems having common participants, but can also be based on a financial institution providing services to two or more systems, for example. In some cases, large financial institutions have multiple relationships with a given system, such as acting as a committed liquidity provider, settlement bank and custody bank, while at the same time also being a participant for clearing and settlement purposes. They can also play these several roles in several systems.

**Clearing and settlement relationships.** As intermediaries and market players, financial institutions have clearing and settlement needs both in their domestic markets and in other countries. To conduct this activity, financial institutions participate either directly, or indirectly via correspondents or custodians, in multiple payment and settlement systems.<sup>12</sup> Table 2 shows the median and mean number of systems accessed directly by selected large financial institutions in the CPSS countries.

Table 2

#### Levels of direct participation of selected institutions

| Number of systems accessed | LVPs | CSDs | CCPs | Total |
|----------------------------|------|------|------|-------|
| Median                     | 8    | 7    | 4    | 17    |
| Mean                       | 16   | 7    | 5    | 28    |

In addition to being participants in systems for the purpose of clearing and settling transactions, many large financial institutions provide services directly to the systems themselves. These services include acting as settlement banks or providing cash correspondent services or securities custody services. For instance, some CCPs and CSDs

<sup>12</sup> A financial institution’s decision to participate in multiple payment and settlement systems is driven largely by its business strategies and customer demands. Large financial institutions interviewed noted that the main criteria governing their decision to become either a direct or indirect participant in a given payment or settlement system included the size and nature of the underlying business requirements (volume of operations to be treated, specific requirements of clients, liquidity needs), required local market and legal knowledge, the need for access to the local overnight interbank money market and, in some cases, the need to access central bank emergency liquidity.

have designated certain financial institutions as “concentration banks” or “settlement banks” that conduct the money settlement among the system’s participants.<sup>13</sup>

Similar to settlement bank services, some systems rely on financial institutions for cash correspondent services in multiple currencies. International CSDs such as Euroclear Bank, Clearstream Banking Luxembourg and SIS SegalInterSettle all rely on a large number of correspondent banks to facilitate their participants’ cash funding in multiple currencies. Although CLS Bank has accounts at the central banks of issue for its funding process, many of the participants in CLS use nostro banks to execute their pay-ins and receive their payouts in various currencies. Large financial institutions also provide a variety of securities custody services to systems. Euroclear Bank, Clearstream Banking Luxembourg and SIS SegalInterSettle, for example, maintain large networks of local custodians.

**Risk management relationships.** Interdependencies may also arise when multiple systems establish risk management-related relationships with a common financial institution(s). In particular, many systems have established failure-to-settle procedures that rely upon committed backup liquidity facilities from designated financial institutions. These facilities may take the form of committed lines of credit, typically collateralised, or repo/swap facilities. For example, a number of large financial institutions act as liquidity providers to CLS in order to allow CLS Bank to fulfil its payout obligations should a participant be unable to fulfil its pay-in obligations. Similarly, DTC has committed collateralised lines of credit with several banks to allow it to settle should a participant fail to settle its net, end-of-day money obligation. Many other CCPs and CSDs have similar arrangements.

Another risk management relationship is where systems hold their collateral and margin assets in custody with a financial institution(s). These assets are integral to a system’s risk management regime and access to these assets on a timely, often intraday, basis is critical.<sup>14</sup>

**General operational relationships.** Though it does not appear common, institutions sometimes support the operations of a given system. In particular, some institutions can act as a service provider to a system, providing operational support on either an ongoing or a contingency basis.

### 1.2.3 Environmental interdependencies

Environmental interdependencies result from indirect relationships between two or more systems that arise from broader factors, including a common reliance on a service provider or financial market. Examples include common third-party IT or network providers, common elements of the physical infrastructure (power, water, etc), common financial markets or even common risk management procedures.

**Risk management relationships.** Environmental interdependencies arise in the risk management realm when two or more systems rely upon the same types of collateral and hence face similar exposures to common financial markets (eg falling asset prices, increased volatility, lack of market liquidity, etc). Two or more systems may face similar exposures if they depend upon collateral or margin assets that are correlated in terms of price movements, as is the case with many securities and derivatives markets.

Interdependencies may arise if two or more systems use the same or similar financial risk models. For example, a number of different CCPs rely upon the same methodologies to

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<sup>13</sup> In some cases, participants are required to use these system-designated settlement banks, while in other cases they may select any bank that meets the system’s criteria for a settlement bank (eg access to the LVPS).

<sup>14</sup> See Recommendation 7 of the CPSS-IOSCO *Recommendations for Central Counterparties*, November 2004, page 31.

determine collateral and margin requirements. Depending on each system's assumptions and inputs to these models (eg about price volatilities, price correlations, historical periods, etc), the use of similar risk management models may cause systems to react to risk events in a similar, correlated manner.

**General operational relationships.** The reliance of two or more systems on a common third-party service or infrastructure provider also creates an environmental interdependency. The dependence of many different payment and settlement systems on SWIFT services is one example. Such interdependencies also arise where one or more domestic or regional service providers offer network services, operational support for information technology or key software components to multiple systems or institutions. The dependence of multiple systems on general infrastructure providers, such as telecommunications providers, is another example of an operational environmental interdependency.

## **2. Factors contributing to the development of interdependencies**

During the past few decades, several well established and widely recognised forces have been influencing both the design and management of payment and settlement systems, as well as how financial institutions use them. The globalisation and regional integration of the financial sector, consolidation of financial institutions, and advances in computer and telecommunications technology have all fostered the development of interdependencies.<sup>15</sup> The business needs of financial institutions and the public policy goals of central banks and other authorities have also influenced the development of interdependencies. In many cases, these forces have worked in conjunction with one another and have been mutually reinforcing in their effects on the evolution of interdependencies. This section discusses the forces in the financial system and the public policies which have exerted the greatest influence in the evolution of interdependencies among payment and settlement systems within and across CPSS countries.

### **2.1 Globalisation and regional integration**

As documented in several CPSS reports and other studies, the liberalisation and internationalisation of financial markets has resulted in growing levels of cross-border payments and securities settlements.<sup>16</sup> Such growth in cross-border payment and settlement flows has increased incentives for financial institutions to reduce the risks and costs of their payment and settlement activities. It has also allowed system operators to meet that demand with new services.

Regional integration initiatives, such as the implementation of monetary union within the European Union, create new opportunities for cost reductions, including through the supply of new services for cross-border transactions. A number of recent regulatory and market initiatives within the European Union have addressed the market for payment and settlement services, including the markets in financial instruments directive (MiFID) and the European Code of Conduct on Clearing and Settlement, both implemented in 2007.<sup>17</sup> Such initiatives

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<sup>15</sup> See the following CPSS reports, for example: *Policy issues for central banks in retail payments* (March 2003), *The role of central bank money in payment systems* (August 2003) and *New developments in large-value payments systems* (May 2005).

<sup>16</sup> See the CPSS report on *Cross-border securities settlements*, and the 1994 BIS *Annual Report*, for example.

<sup>17</sup> According to the MiFID directive (article 46), regulated markets have the right to enter into appropriate arrangements with European CCPs and securities settlement systems (SSSs) in order to provide for the clearing and settlement of trades concluded by market participants under their systems. At the same time, the European Code of Conduct for Clearing and Settlement contains commitments for interoperability and access rules among post-trading infrastructures (notably CCP and SSS providers). The ultimate aim of the Code is to

will offer new possibilities for market participants to choose their clearing and settlement arrangements through a range of links.

With these incentives, some financial institutions have reduced their reliance on correspondent banking arrangements. This has been particularly relevant within the euro area following the implementation of monetary union and TARGET. In some cases, institutions have rationalised their correspondent relationships, while in others institutions have become direct participants in additional payment and settlement systems.<sup>18</sup> Similarly, a number of systems have expanded the types of services they provide by developing cross-border horizontal links with other systems, giving rise to system-based interdependencies.

## **2.2 Consolidation**

Mergers, acquisitions and other forms of consolidation continue to occur among financial institutions as well as payment and settlement systems. As discussed in the Ferguson report, payment and settlement issues generally do not drive institutions' merger or acquisition strategies. Nonetheless, a merger may significantly affect how the combined entity conducts its payment and settlement activities. For example, in a domestic merger, an institution may find itself holding duplicate accounts or memberships in one system, or having multiple subsidiaries in one system. In a cross-border merger, the institution may find itself participating in additional systems, using multiple correspondents, or using both correspondents and direct participation to conduct a particular kind of payment and settlement activity. In addition, the merged institution may have a number of other roles, such as providing correspondent or custodian banking services, and being a committed liquidity provider for one or more systems.

As with the effects of globalisation, the newly merged entity will have significant incentives to reap economies of scale and scope in the management of those activities. As a result, it may seek to eliminate redundant system memberships or correspondent accounts. It may also eventually coordinate or centralise the management of liquidity flows and risks across different systems, relying on common IT and staff resources. These developments affect how the settlement flows of multiple systems are related, and increase institution-based interdependencies. In addition, large financial institutions resulting from mergers may seek to leverage their participation, and potentially ownership interest, in multiple systems to encourage standardisation across multiple systems, or other new system functionalities. Such efforts have contributed to the development of system-based interdependencies through incentives similar to those triggered by globalisation and regional integration.

Finally, in some instances, interdependencies have developed through mergers and acquisitions among different payment and settlement systems. These developments are particularly evident in securities settlement systems, and include mergers among central securities depositories and central counterparties.<sup>19</sup> As a result of these mergers, and the underlying incentive to reduce cost, consolidation can lead multiple systems to rely on common operational facilities or human resources. In addition, systems under common

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offer market participants the freedom to choose their preferred provider of services separately at each layer of the transaction chain and to make the concept of "cross-border" redundant for transactions between EU member states.

<sup>18</sup> While risk and cost are prominent factors for institutions' decisions to participate directly in systems, legal requirements may also be relevant. In some countries, participation in a particular financial market may be restricted to institutions that have a legal presence in the jurisdiction and a direct membership in the relevant system.

<sup>19</sup> For example, those between Clearstream Banking Frankfurt and Clearstream Banking Luxembourg, the Euroclear group (ie the different (I)CSDs of Euroclear SA) and the creation of LCH.Clearnet, as well as the consolidation of multiple systems into the DTCC.

ownership may also consolidate risk management practices and procedures, manage participants' positions on a consolidated basis, or otherwise share risks and risk management resources.

### **2.3 Public policies**

As discussed in the 1990 CPSS report on multicurrency netting schemes (the Lamfalussy Report), the initial increase in settlement activity resulting from technological innovations and the internationalisation of financial markets had, by the early 1980s, begun to strain existing payment and settlement systems. In addition, a number of market risk events had pointed out weaknesses both in the design of individual payment and settlement systems as well as in the processes used to settle foreign exchange and securities transactions.

In response to these developments, the central banks of CPSS countries took a number of steps to improve the safety and efficiency of payment and settlement systems. These actions occurred through central banks' various roles in payment and settlement systems and in cooperation with other central banks, other national authorities, and the financial industry (eg the 1989 G30 recommendation in favour of DVP securities settlement). Over this period, the CPSS published a number of reports, including the 1992 report on *Delivery versus payment in securities settlement systems*, the 1995 report on *Cross-border securities settlements* and the 1996 report on *Settlement risk in foreign exchange transactions*, which discuss the relative risks and costs of different clearing and settlement arrangements for particular kinds of transactions.

Considering the trade-offs among the risks and costs related to different payment and settlement arrangements, these reports led central banks to promote a series of policies. For example, from the domestic perspective, deferred net settlement systems were encouraged to move, over time, from next day (or later) settlement in commercial bank money to same day settlement in central bank money. In the 1990s, many central banks developed large-value payment systems that provide intraday finality, such as RTGS systems. This change also facilitated the establishment of improved money settlement arrangements for other payment and settlement systems. Delivery versus payment mechanisms were also introduced over time, significantly reducing the principal counterparty risk that might otherwise arise from securities settlements. In addition, securities markets increasingly adopted central counterparties, which centralised risk management and, through the use of legally robust netting, reduced the value and volume of required settlements. And importantly, the long-term strategy of the CPSS to reduce FX settlement risk encouraged the creation of a mechanism to provide payment versus payment settlement of foreign exchange transactions, and resulted in the development of CLS. Each of these initiatives has fostered the development of system-based interdependencies, including many direct links between systems.<sup>20</sup>

### **2.4 Technological innovations**

In combination with globalisation, financial consolidation and public policies, new and lower-cost information and communication technologies have facilitated the development of interdependencies. Technological developments have enabled innovative forms of clearing and settlement arrangements with the potential to reduce both cost and risk. In some cases, these new arrangements also increase interdependencies. The 2005 CPSS report *New*

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<sup>20</sup> Central banks have reviewed the impact of these changes, including the development of RTGS systems, for liquidity needs within systems, and for central banks' provision of intraday credit. In addition, some systems have developed new liquidity savings features. See the 2005 CPSS report, *New developments in large-value payment systems*.

*developments in large-value payment systems* explores how new technology can improve the terms of the trade-off among the risks and costs inherent in large-value payment systems.

Technological innovations have been notably instrumental to the development of new forms of system-based interdependencies that significantly reduce payment and settlement risk, including the real-time and continuous interfacing of CSDs and LVPs in support of DVP securities settlement and the reliance of CLS and various ancillary domestic payment systems on LVPs for required funding. Technological developments have also facilitated the interoperability of multiple CSDs and the development of “real-time liquidity bridges” among systems, which allow participants to transfer liquidity between systems intraday. New types of risk management relationships that result in interdependencies with other systems, for example the cross-margining of participants’ positions in different systems, also rely in part on increased degrees of cross-system standardisation and straight through processing.

In addition, standardised communication protocols, scalable computing resources and off the shelf processing packages, for example, can reduce the costs of institutions’ direct participation in a system, causing more systems to have common participants and increasing institution-based interdependencies. And, as discussed in the Ferguson report, technological developments have combined with other factors to foster the development of specialised institutions and service providers that provide services to multiple institutions and systems, increasing environmental interdependencies as well.

### **3. Extent of interdependencies of systems in CPSS countries**

This section identifies six prominent forms of interdependencies that currently exist within and across CPSS countries. It also discusses the relative importance of these interdependencies to the settlement flows, operational process and risk management procedures of systems. Three of the six prominent interdependencies belong to the category of system-based interdependencies, two to institution-based interdependencies and one to environmental interdependencies.

#### **3.1 System-based interdependencies**

##### *3.1.1 Domestic clearing and settlement relationships*

In all CPSS countries, the relationships that exist among domestic systems lead to significant interdependencies. While each country or currency exhibits slightly different clearing and settlement relationships among the specific systems in that jurisdiction, many CPSS countries exhibit relationships that follow the general pattern stylised in Figure 3. Annex 1 provides additional information on these relationships within each CPSS country.

A few deviations from this basic model of interaction among domestically-focused systems can be observed. For example, in the euro area countries, numerous clearing and settlement relationships also exist between systems of the same type in order to facilitate financial integration and the implementation of monetary policy (eg between two or more CCPs, two or more CSDs, or two or more LVPs).<sup>21</sup> In addition, in several other countries multiple CCPs or CSDs exist. There are also some cases where CCPs do not have a direct

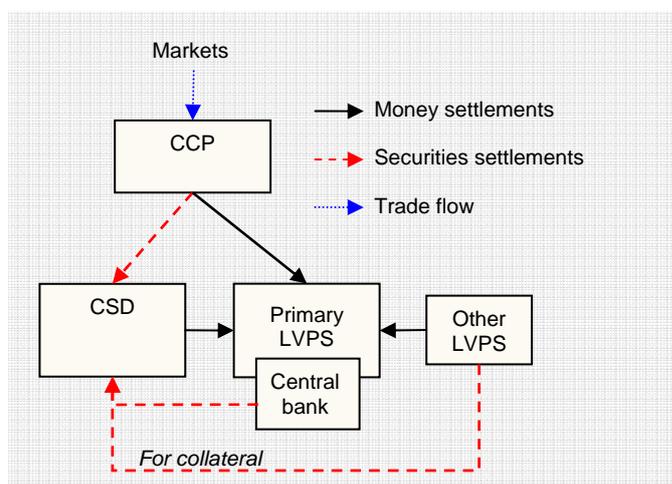
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<sup>21</sup> For example, TARGET (see footnote 10) operated through the interlinking of 17 different payment systems. Moreover, LCH.Clearnet SA and CC&G have established a link to support some trading platforms where Italian government bonds are traded. In addition, the Eurosystem has approved more than 60 different links among euro area CSDs as eligible for Eurosystem credit operations, though their use is limited and largely concentrated among a few links. These links may grow as a result of the recent initiatives discussed in Section 2.1. See Annexes 2 and 3 for more information on CCP-to-CCP and CSD-to-CSD links, respectively.

relationship with the primary LVPS for a currency, nor with the issuing CSD for a particular type of security. Instead, these systems rely upon the services of settlement and custodian (clearing) banks to conduct required payments or securities settlements.

Figure 3

**Traditional domestic interdependencies**



These domestic clearing and settlement relationships between systems make the settlement flows of the related systems significantly interdependent. For example, in many instances, balances in the primary LVPS (usually an RTGS system settling in central bank money) are used to settle payment obligations in other payment systems (eg interbank net settlement systems), securities settlement systems and CCPs. As a result, the primary LVPS is involved in the settlement processes of all the other payment and settlement systems and any delay in the settlement of one system may have an impact on the settlement of another system, for example where a participant relies on liquidity received from the settlement of one system to fund its obligations to another system.

The extent to which settlement flows between systems are interdependent is likely to be driven by four key factors, including: (i) the extent to which participants rely on balances stemming from the settlement of transactions in one system to meet settlement needs in another system, including if two systems settle in the same account; (ii) the settlement time frames of the different systems composing the domestic infrastructure; and (iii) the level of overnight balances at the central bank, as well as the potential recourse of institutions to central bank intraday credit or interbank borrowings.

**3.1.2 Cross-currency clearing and settlement relationships**

A number of payment and settlement systems in CPSS countries provide multicurrency or foreign currency payment and settlement services. To support these services, these systems generally rely on a web of clearing and settlement relationships with other systems, either directly as participants or indirectly through institutions. With a few notable exceptions, however, systems in different currency areas are less tightly linked than systems operating in the same country or currency area.

**Relationships between payment systems.** Of the 17 systems listed in Table 3, the CLS system is clearly the most important in terms of value of transactions processed, settling more than \$2.5 trillion in foreign exchange-related payments on a daily basis in 2006. Of these payments, slightly less than half are in US dollars, while the euro and Japanese yen comprise 22% and 10% of CLS settlements, respectively.

Table 3

**Multicurrency and offshore settlement systems  
average daily gross settlements in 2006**

In billions of US dollars, as of 31 December 2006

| System                                 | Primary currency |                                   | Other currencies |                                   |
|--|------------------|-----------------------------------|------------------|-----------------------------------|
|  | Currency         | Daily average gross value settled | Currencies       | Daily average gross value settled |
| <b>Multicurrency PVP</b>               |                  |                                   |                  |                                   |
| CLS                                    |                  |                                   | USD              | 1252                              |
|  |                  |                                   | EUR              | 561                               |
|  |                  |                                   | JPY              | 241                               |
|  |                  |                                   | GBP              | 206                               |
|  |                  |                                   | CHF              | 121                               |
|  |                  |                                   | CAD              | 52                                |
|  |                  |                                   | SEK              | 53                                |
|  |                  |                                   | HKD              | 29                                |
|  |                  |                                   | SGD              | 19                                |
| CHATS PVP                              |                  |                                   | USD              | 2                                 |
|  |                  |                                   | EUR              | 1                                 |
| <b>Offshore systems</b>                |                  |                                   |                  |                                   |
| USD CHATS                              | USD              | 6                                 |                  |                                   |
| EUR CHATS                              | EUR              | 2                                 |                  |                                   |
| <b>Central securities depositories</b> |                  |                                   |                  |                                   |
| Euroclear Bank                         | EUR              | 668                               | 35 others        | 302                               |
| Clearstream Banking Luxembourg         | EUR              | 114                               | 41 others        | 55                                |
| CREST                                  | GBP              | 628                               | EUR, USD         | 11                                |
| SIS SegalInterSettle                   | CHF              | 8                                 | 34 others        | 4                                 |
| Clearstream Banking Frankfurt          | EUR              | 212                               | 41 others        | 2                                 |
| CDS                                    | CAD              | 212                               | USD              | 1                                 |
| DTC                                    | USD              | 713                               | CAD              | 1                                 |
| VPC                                    | SEK              | 65                                | EUR              | 0                                 |
| <b>Central counterparties</b>          |                  |                                   |                  |                                   |
| CDS                                    | CAD              |                                   | USD              |                                   |
| ECAG                                   | EUR              |                                   | CHF, GBP, USD    |                                   |
| LCH.Clearnet Ltd                       | GBP              |                                   | 14 others        |                                   |
| OMX                                    | SEK              |                                   | 4 others         |                                   |
| x-clear                                | CHF              |                                   | 6 others         |                                   |

## Box 1

### Modelling interdependencies

A number of central banks and research institutions have been investigating the issue of system interdependencies from a modelling point of view. A joint effort of the Federal Reserve Bank of New York, Sandia National Laboratories, the Helsinki University of Technology and the Bank of France led to the creation of a simple mathematical model describing the interdependencies between two RTGS systems interacting through FX transactions.

In the model, the two RTGS systems are linked through the dual participation of a few global banks that are direct participants in both systems and exchange FX transactions between themselves (institution-based interdependency). Each RTGS processes its own local payments, as well as the corresponding legs of the FX transactions performed by the global banks. The two RTGS systems are also linked through a possible payment versus payment (PVP) mechanism that ensures the simultaneous gross settlement of both legs of the FX transactions (system-based interdependency). In the model, the PVP mechanism can be turned on ("PVP case") or off ("non-PVP case", in which the two legs of the FX trades are settled independently).

The model captures how, due to these two interdependencies, activities within the two systems can become correlated, in the sense that a period with a high settlement rate in one system will statistically correspond to a period with a high settlement rate in the other system, while a period of congestion in one system will also correspond to a period of congestion in the other system. At low levels of liquidity, Figures 4 and 5 clearly illustrate how the introduction of a PVP mechanism shifts the two RTGS systems from a completely uncorrelated situation (Figure 4; the circular shape of the scatter plot indicates that in the non-PVP case, a high settlement rate in one system can correspond indifferently to a high or a low settlement rate in the other) to a highly correlated situation (Figure 5; the "comet" shape of the scatter plot indicates that in the PVP case, a high settlement rate in one system is very likely to correspond to a high settlement rate in the other).

In addition, another type of correlation appears between the two RTGS systems. When FX trades are settled non-PVP, the bank which pays the first leg of the transaction will bear FX settlement risk until the second leg of the transaction is settled in the other RTGS. It is well known that time zone differences between RTGS systems result in such systematic exposures for non-PVP FX trades. The simulations also demonstrated that when one system has a significantly higher level of liquidity than the other system – and therefore a significantly lower average settlement delay – similar systematic exposures will arise. The banks selling the currency exchanged in the liquidity-rich system will face an exposure vis-à-vis the banks selling the currency exchanged in the other system. Simulations also showed that using a higher priority for FX payments than for local payments sharply decreases the overall level of credit risk.

Figure 4  
Non-PVP

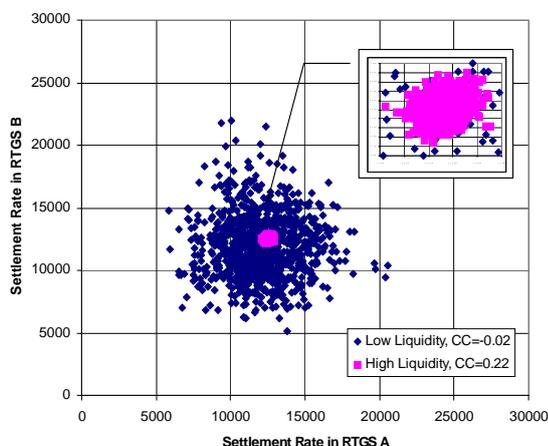
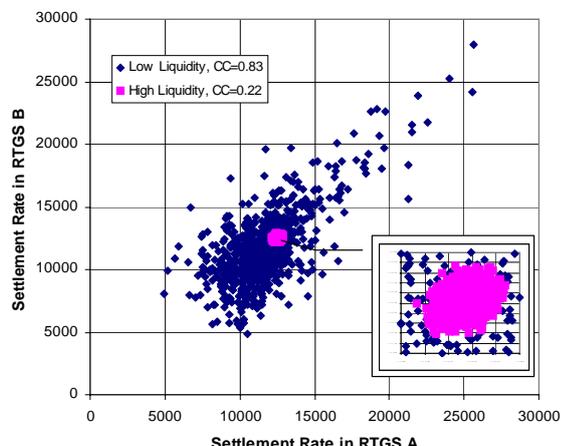


Figure 5  
PVP



Renault, F, W Beyeler, R Glass, K Soramäki and M Bech (2007): "Congestion and cascades in coupled payment systems", proceedings of the Joint Bank of England/ECB Conference on "Payments and monetary and financial stability", 12–13 November.

The CLS system has significantly contributed to the development of clearing and settlement relationships among payment systems. To facilitate its settlement process, CLS has established account relationships with the central banks of those currencies eligible for settlement, and participates in the associated LVPSs. This arrangement creates direct interdependencies in the settlement flows of the LVPSs involved. For example, the inability of a CLS participant to provide funding to CLS in one currency (and LVPS) may have a direct impact on the timing and value of funds to be received by this participant's counterparties in that LVPS, as well as in others. This impact may be significant only under extreme circumstances, however, given the usually limited scale of central bank money funding flowing to and from CLS, and the substantial protection CLS provides against liquidity risk through committed liquidity facilities with major banks. The links that exist among the Hong Kong large-value systems (HKD CHATS, USD CHATS and EUR CHATS) to enable banks to settle USD/HKD, EUR/USD and EUR/HKD foreign exchange transactions on a PVP basis provide another example of cross-currency clearing and settlement arrangements.<sup>22</sup> These so-called "offshore payment systems", however, are transferring limited aggregate value and have a limited currency scope. As a result, their impact on the interdependence of the settlement flows across other systems is less than in the case of CLS.

**Relationships between CSDs, CCPs and payment systems.** As shown in Table 3, a number of (I)CSDs and CCPs conduct clearing and settlement activities in multiple currencies. The extent to which these cross-border relationships create significant interdependencies between the settlement flows of systems is somewhat limited, for several reasons.

First, those systems with the largest currency scope (ie Euroclear Bank, Clearstream Banking Luxembourg and SIS SegalInterSettle) have settlements heavily weighted towards the primary currency settled (roughly two-thirds of settlement for each system). Second, for other systems, the volume and value of foreign payment and securities settlement activities is very limited (eg DTC, CDS, CREST, VPC and Clearstream Banking Frankfurt). Third, all these systems largely rely upon commercial settlement banks to conduct foreign currency settlements and may rely upon intermediaries to access foreign central securities depositories as well.

### 3.1.3 Operational and risk management relationships

As discussed in Section 2, globalisation and consolidation have created incentives for systems to share key components of operational processes and resources. This phenomenon has led to the development of significant operational relationships, primarily between systems established within a given country or currency area. In more limited circumstances, particularly in the United States, systems also have established relationships that cause interdependencies in systems' risk management procedures.

**Operational relationships.** In the EU, some of the existing operational infrastructures either are currently being consolidated or are planned to be consolidated as the result of mergers among systems, such as the (I)CSDs of the Euroclear group. This phenomenon has also occurred in the United States, where the different DTCC systems all rely on certain common IT facilities or telecommunication networks.

**Risk management relationships.** With respect to risk management relationships among systems, a small number of cross-margining arrangements have developed among different CCPs, primarily in the United States. The Government Securities Division of the Fixed

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<sup>22</sup> In addition, in November 2006 the USD payment system in Hong Kong established a PVP linkage with the ringgit payment system in Malaysia for the settlement of MYR/USD transactions. CNY/HKD transactions are also possible.

Income Clearing Corporation (FICC-GSD) has established cross-margining agreements with both the Chicago Mercantile Exchange (CME) and the Clearing Corporation (CCorp). While a cross-margining agreement also exists between LCH and CME for eurodollar futures, it is not used to a significant extent.

## **3.2 Institution-based interdependencies**

### *3.2.1 Domestic clearing and settlement relationships*

In most of the CPSS countries, a limited number of common participants contribute a significant share of the activity occurring in all domestic systems. This overlap in system participation creates strong interdependencies between domestic payment and settlement systems. The large, globally active banks covered by the working group's fact-finding exercise, for example, generally noted that they were direct participants in the key CCPs, CSDs and LVPSs supporting the local financial markets of their home jurisdictions. Major securities firms are generally participants in the key CCPs and CSDs and may rely upon domestic banks for payment services.<sup>23</sup> As another example of this phenomenon, nearly all CHIPS participants are also participants in Fedwire, and all EURO1 participants also participate in a TARGET component.

This situation can translate into significant interdependencies in the settlement flows across domestic systems if, for instance, a globally active bank does not receive payments or securities deliveries in one system and, as a result, cannot release payments or securities in another system. Many institutions interviewed by the working group noted that such interdependencies can be significant within a country or a currency zone as a result of their direct clearing and settlement relationships in their home jurisdiction.

In some countries, major payment and settlement banks also play a significant role as correspondents to smaller domestic banks and to foreign banks (see below) within domestic clearing and settlement arrangements. As described in the Ferguson report, the provision of these correspondent and custodian banking services can increase the relative importance of these institutions to payment and settlement systems, concentrating the activities of several institutions. As a result, and as shown in column 1 of Table 4, settlement activities within some systems remain very highly concentrated among their largest users.

### *3.2.2 Cross-border clearing and settlement relationships*

The clearing and settlement relationships of large globally active financial institutions also contribute to creating interdependencies in the settlement flows of CCPs, CSDs and LVPSs across different currency zones. A large financial institution could simultaneously disrupt the normal functioning of multiple systems in which it actively participates, resulting in a common dependence for those systems. It is also possible, though perhaps less likely, that a problem with a system in one currency may be transferred to systems in another currencies via a large financial institution, in particular if it manages its liquidity in an integrated manner across the two currencies.

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<sup>23</sup> The direct participation of securities firms in LVPSs may be limited in some jurisdictions. See the CPSS 2003 report on *The role of central bank money in payment systems*.

Table 4

## Share of LVPS settlement values related to select participants

| Systemically important payment systems in CPSS countries |                               | Concentration (top 5) | Foreign participation <sup>1</sup> | Selected large banks <sup>2</sup> |
|--|-------------------------------|-----------------------|------------------------------------|-----------------------------------|
|  |                               | %                     | %                                  | %                                 |
|  |                               | 2006                  | December 2007                      | December 2007                     |
| Canada   | LVTS                          | 77                    | 9                                  | 87                                |
| European Union   | EURO1                         | 45                    | na                                 | na                                |
| European Union   | TARGET <sup>3</sup>           | 22                    | 16                                 | na                                |
| Belgium  | ELLIPS <sup>3</sup>           | 91                    | na                                 | na                                |
| France   | TBF <sup>3</sup>              | 61                    | 8                                  | 67                                |
| Germany  | RTGS <sup>plus 3</sup> T2-BBk | 51                    | 38                                 | 56                                |
| Italy  | BI-REL <sup>3</sup>           | 51                    | 27                                 | 46                                |
| Netherlands  | TOP <sup>3</sup>              | 72                    | 6                                  | 69                                |
| France   | PNS                           | 78                    | 7                                  | 72                                |
| Hong Kong SAR  | HKD CHATS                     | 51                    | 54                                 | 61                                |
| Hong Kong SAR  | USD CHATS                     | 56                    | 49                                 | 50                                |
| Hong Kong SAR  | EUR CHATS                     | 97                    | 27                                 | 52                                |
| Japan  | BOJ-NET FTS                   | 37                    | 18                                 | 47                                |
| Japan  | Zengin System                 | 64                    | 2                                  | na                                |
| Japan  | FXYCS                         | 75                    | 35                                 | na                                |
| Singapore  | MEPS+                         | 52                    | 55                                 | 54                                |
| Sweden   | RIX                           | 86                    | 12                                 | 57                                |
| Switzerland  | SIC                           | 70                    | 20                                 | 60                                |
| United Kingdom   | CHAPS                         | 76                    | 17                                 | 64                                |
| United States  | CHIPS                         | 63                    | 37                                 | 64                                |
| United States  | Fedwire Funds                 | 54                    | 26                                 | 54                                |

Notes: All TARGET and EURO1 figures for December 2006. BOJNET FTS, Zengin System, FXYCS concentration figures for December 2007. HKD CHATS, USD CHATS and EUR CHATS concentration figures for December 2007. MEPS+ replaced MEPS in December 2006. RIX was previously named K-RIX.

<sup>1</sup> Foreign participants include all branches, subsidiaries and affiliates of an organisation whose highest-level entity is foreign-based. In general, figures for foreign participants in TARGET and its components exclude other euro area organisations. <sup>2</sup> Those banks contacted in the preparation of this report. <sup>3</sup> See footnote 9 and Annex 1 for an explanation of the transition to TARGET2.

However, the importance of these factors in making the settlement flows of systems in different currency zones interdependent is difficult to assess. From one perspective, and as shown in Figure 6, a very limited number of financial institutions are direct participants in a large number of systems. As shown in column 3 of Table 4, however, the small set of large globally active financial institutions interviewed for this report constitute a relatively large share of the settlements occurring in the LVPSs of CPSS countries (ranging from 46% to 87%). As shown in column 2, foreign institutions generally make up a lower share of the total

activity in each system (ranging from 2% to 55%).<sup>24</sup> By comparing columns 2 and 3 of Table 4, it can be seen that in many countries a large portion of the percentages reported in column 3 reflect the activity of domestic institutions in their home country systems, and that most of the top 5 participants in a given system are often domestic institutions. Nonetheless, the share of activity in each system that is conducted by foreign institutions probably represents the activities of a few foreign institutions that are also included in column 3. Moreover, a significant portion of the activities processed by large domestic institutions can also reflect the payments of other large foreign institutions, who continue to rely upon local correspondent and custodian banks.<sup>25</sup>

Figure 6  
**Profile of institutions' activities and access choices, 2006**  
 Number of financial institutions<sup>1</sup> in parentheses

|  |   |   |  |   |
|--|---|---|--|---|
| Very significant international settlement activity |   |   | 4  | 4   |
| Significant international settlement activity      | 2   | 1   | 3  | 1   |
| Moderate international settlement activity         | 10  | 12  | 3  |   |
|  | Primary reliance on correspondents and custodians beyond home currency; direct participation in CLS and one or more ICSDs | Mixed approach: significant self-clearing in multiple currency zones, but moderate levels of direct participation |  | Significant self-clearing in most CPSS currencies, and beyond |
|  |   | Domestic, plus one or two of: EUR, USD or YEN   | Domestic, plus more than three CPSS currencies |   |

<sup>1</sup> Selected institutions, at the highest holding company level.

Globally active financial institutions' clearing and settlement activities are likely to affect the degree of interdependence in systems' settlement flows in three key ways: (i) the degree to which the processing and settlement of obligations in one system is made dependent on the processing and settlement of instructions in another system; (ii) the degree of centralisation in the institution's internal technical infrastructures and resulting concentration in operational risk; and (iii) the extent of direct participation in systems compared to the use of correspondents. Institutions contacted for this report, however, indicated that, at least at this time, these factors would not lead to strong interdependencies in the settlement flows of systems.

<sup>24</sup> In this case, "foreign institution" has been defined at the highest group level.

<sup>25</sup> Institutions also indicated that they had limited roles in providing correspondent services outside of their home currency. As pointed out in the 2003 Payments Risk Committee report *Managing payments liquidity in global markets*, more than 50% of the total value of payments of select PRC banks was conducted outside the United States.

### **3.3 Operational environmental interdependencies**

Operational environmental interdependencies are significant in CPSS countries primarily because of the dependence of many payment and settlement systems on SWIFT as a message carrier. SWIFT provides network services to 16 large-value payment systems within CPSS countries and to an increasing number of systems outside the CPSS countries. SWIFT also supports a substantial, but smaller, number of CSDs and CCPs and plays an important role in supporting several CSD-to-CSD links. Moreover, SWIFT message services are also used for correspondent banking, which, as discussed above, remains an important channel for conducting cross-border payments. This common reliance on SWIFT significantly contributes to the interdependence of operational processes of payment systems and, to a lesser extent, securities clearing and settlement systems in CPSS countries.

Several other key third-party providers also contribute to the importance of operational environmental interdependencies, but with a limited geographical scope. Three different third-party service providers each play important operational roles for multiple systems in Italy, Switzerland and France, respectively. Beyond this, multiple systems, especially within a given country, are often dependent on a very small number of telecommunications providers.

### **3.4 Summary**

Overall, it appears that some types of interdependencies are more prevalent than others. Interdependencies are particularly strong on a domestic, same-currency basis. The CCPs, CSDs and LVPSs supporting the financial markets of a given currency are strongly interdependent in several, distinct ways. In most cases, these systems are directly connected through technical or account relationships. CCPs typically depend directly both on the LVPS and the CSD to conduct settlement and manage risk. The CSD and LVPS are often interconnected in some way to achieve DVP for securities settlements. And in many cases, an institution's use of central bank intraday credit within an LVPS can be dependent in part on their ability to deliver collateral through one or more CSDs. Furthermore, the key participants of these domestic systems overlap significantly. This overlap of participants can increase the interdependence of domestic systems, as an institution's settlement flows in one system can have a strong influence on its ability to make transfers in other domestic systems. Finally, in a few cases, domestic systems have become interdependent because of their reliance upon a common service provider (other than SWIFT), or because of common risk management policies or resources.

Currently, cross-border and cross-currency interdependencies appear to be less extensive than domestic interdependencies, though some are quite significant. The arrangements used by CLS to facilitate PVP settlement constitute the most prominent set of cross-currency interdependencies.<sup>26</sup> In addition, many systems and institutions depend on SWIFT for messaging services. Yet with respect to relationships among systems arising from the activities of institutions, it appears that only a very few institutions both have significant cross-border activities and are direct participants in many payment and settlement systems. Nonetheless, further globalisation and consolidation could raise the importance of cross-border, institution-based interdependencies going forward.

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<sup>26</sup> While other multicurrency and cross-border systems exist, including international CSDs, these other systems either do not have the same high level of activity or do not have the same cross-currency settlement mechanisms present in CLS.

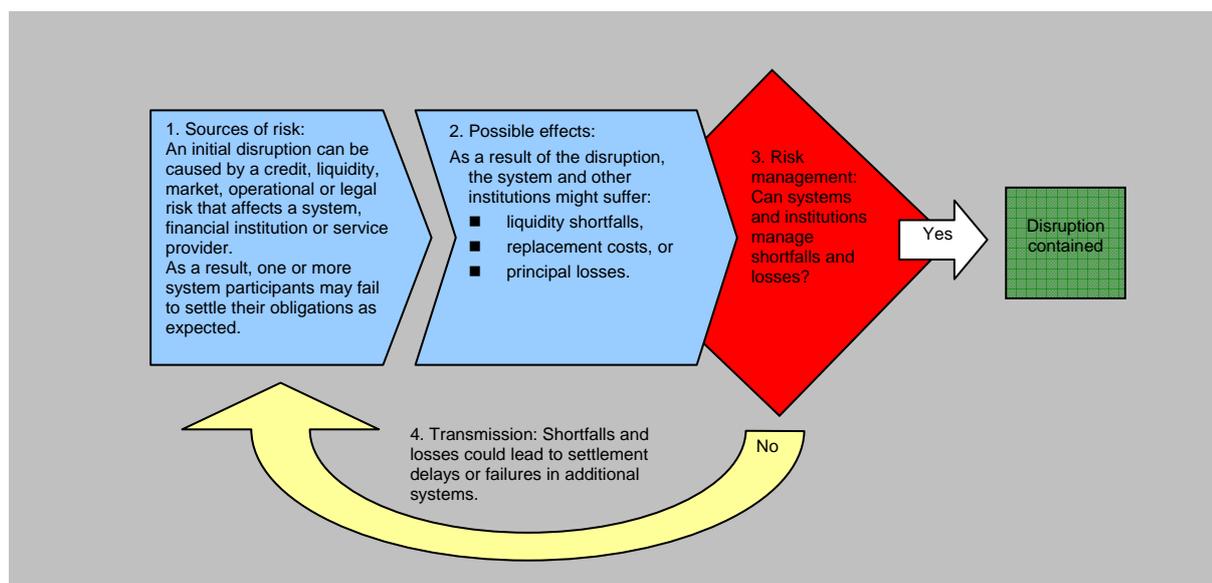
## Part II: Implications for risk, risk transmission and risk management

### 4. Introduction

As noted in several CPSS and G10 reports, payment and settlement systems are a major channel by which disruptions can be transmitted across the financial system.<sup>27</sup> Figure 7 depicts a stylised process by which disruptions might spread across systems. As shown at point 1 of the figure, several sources of risk can affect payment and settlement systems, including risks posed by financial institutions and service providers. The realisation of a risk can result in a disruption to the system. This disruption can cause one or more system participants to fail to settle transactions as expected in that system (either temporarily or permanently). As a result, and as described in point 2, the system and other participants may suffer liquidity shortfalls, replacement costs or principal losses, depending on the design of that particular system. At point 3, systems and institutions generally will have risk management procedures and resources in place to deal with potential disruptions. If these procedures and resources are sufficient, shortfalls or losses can be contained and may not be transmitted to other systems. Alternatively, if participants' or systems' risk controls and resources are unable to contain the shortfalls or losses, institutions' abilities to settle obligations in other systems as expected can be impaired. In this way, a disruption that initially affected one system may be transmitted (ie spread) to other clearing and settlement systems, as shown at point 4.

Figure 7

#### Simple model of risk transmission



Part II of this report addresses whether and how the development of interdependencies among payment and settlement systems affects the overall safety of the global financial system. In support of this objective, the working group analysed how the major forms of interdependencies identified in Part I affect the simple model of risk transmission depicted in Figure 7. In particular, the working group analysed the implications of interdependencies (i) for the sources of risk faced by systems and their participants (Section 5), (ii) on the

<sup>27</sup> See, for example, the 2001 CPSS report *Core Principles for Systemically Important Payment Systems*.

potential paths through which disruptions can be transmitted across systems (Section 6), and (iii) for the effectiveness of risk management policies in preventing the transmission of disruptions across systems (Section 7).

## 5. Implications for payment and settlement risks

In conducting their settlement and payment activities, financial institutions can be exposed to potential financial losses. As explained in Box 2, these losses may materialise when payment and settlement obligations are not settled as expected. A number of CPSS reports discuss how different settlement methods and system designs affect the type of risks actually faced by participants to payment and settlement systems.

### Box 2

#### **Payment and settlement risks for financial institutions**

In conducting their payment and settlement activities, financial institutions can become subject to a number of different risks. These “payment and settlement risks” can include credit risks, liquidity risks, operational risks, legal risks and market risks. The specific forms and level of payment and settlement risks faced by a given institution are primarily determined by the particular settlement method used for a given transaction and the design of relevant payment and settlement systems. A number of different CPSS reports discuss how different settlement methods and system designs affect the forms of risk faced by financial institutions, and the distribution of these risks across financial institutions.

The potential losses that underlie most payment and settlement risks arise from institutions’ financial activities. Institutions engage in a range of financial activities that require the settlement of obligations and transfer of assets. When these transfers do not occur as expected, institutions can face costs. In some cases, these costs may take the form of principal credit losses. In other cases, they may take the form of replacement costs, which reflect the realisation of market risks. Realised operational and legal risks in payment and settlement systems also lead to unexpected settlement positions, and as such provoke underlying credit or market risks. Liquidity risks and failed securities trades (pre-settlement risks) generally cause losses by invoking replacement costs.

Depending on the design and risk management features of a system, its settlement institution can also both bear and pose different payment and settlement risks. In some cases that settlement institution may redistribute this risk back to its participants through loss-sharing arrangements. Some types of loss-sharing arrangements may shift risks to participants that did not have transactions with the failing party, while others do not. In yet other cases, the settlement institution may bear no risk, and the implication of any disruption can be directly and fully placed on system participants.

In most situations, the realisation of a given payment and settlement risk is likely to impose costs on multiple parties. While the system, institution or service provider that is the source of an initial credit, liquidity or operational disruption may face losses as a result of its problem, additional costs or losses may also be borne by the customers and counterparties of that entity. For example, an operational outage affecting one system participant may lead it to lose revenue or face replacement costs. To complete all of their own obligations, however, the counterparties of that institution might also need to purchase additional funds or securities at a potentially higher market price, leading to replacement costs. Moreover, as discussed in the main body of the report, some types of interdependencies among systems can allow an initial disruption to activate a chain of different risks and transmit an initial disruption through multiple systems. Considering these various factors, payment and settlement risks have the potential to impose losses on the entity not only at the source of a disruption, but also on its direct counterparties or customers, and in some circumstances, their counterparties or customers.

Interdependencies among systems can significantly influence these risks. Because different forms of interdependencies arise from different relationships, they can influence payment and settlement risks in very different ways. Some of the interdependencies identified in part I

of this report help eliminate sources of risks (Section 5.1). However, interdependencies can also create new, “cross-system” sources of liquidity and operational risks (Section 5.2) and contribute to a growing concentration of risks with a few systems, participants and service providers (Section 5.3). In summary, interdependencies have both positive and negative implications for payment and settlement risks (Section 5.4).

### **5.1 Several important sources of risk have been eliminated or reduced**

A number of the key interdependencies described in this report arise from relationships among systems that help to eliminate or reduce several important sources of payment and settlement risks. In many cases, these relationships create new forms of interdependencies between two systems, rather than causing two previously unrelated systems to become newly interdependent. These additional relationships and interdependencies have allowed several specific sources of credit risk, liquidity risk and operational risk to be reduced or eliminated.

Most notably, some interdependencies facilitate the elimination of credit risk from securities settlement and foreign exchange settlement processes. The relationships established in most CPSS countries between CSDs and LVPSs to achieve efficient delivery versus payment (DVP) settlement of securities transactions are a key example. These relationships help ensure that the transfer of securities from the seller to the buyer is final if and only if transfer of funds from the buyer to the seller is final. The relationships between CLS and the LVPS systems of those countries whose currencies are eligible for CLS settlement facilitate a similar process for foreign exchange trades. These relationships facilitate the payment versus payment (PVP) of foreign exchange trades in which the transfer of the currency sold from the seller to the buyer is final if and only if the transfer of the currency bought is also final. In both cases, the coordination of the settlement finality of both sides of a trade eliminates the potential that counterparties face losses equivalent to the full value of the trade (principal credit risk).

The direct relationships of domestic CCPs, CSDs and ancillary payment systems with an LVPS to achieve settlement in central bank money have helped to reduce another source of credit, as well as liquidity, risk. In particular, these arrangements reduce settlement asset risk, or the risk of default of the institution that provides the settlement asset (the settlement institution). As such, the use of a central bank as settlement institution generally entails less credit risk for system participants than the use of a commercial bank. Moreover, the central bank’s role as settlement institution provides more assurance of continuity in the provision of intraday liquidity to system participants, reducing the liquidity risk faced by those institutions.<sup>28</sup>

In addition, direct relationships among systems may facilitate a reduction in specific sources of operational risk by favouring the standardisation, automation and integration of different payment and settlement processes. Such developments in the functioning of payment and settlement processes can reduce the complexity of payment and settlement operations and minimise the potential for human error. As a result, key sources of operational risk can be eliminated.

### **5.2 New sources of liquidity and operational risk have been introduced**

Interdependencies can also introduce new sources of liquidity and operational risks for the interdependent systems. In particular, some forms of interdependencies create situations

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<sup>28</sup> For a discussion of the role and risks of settlement institutions in payment and settlement systems, see the CPSS report *The role of central bank money in payment systems*, August 2003.

where the smooth functioning of one system becomes dependent on the smooth functioning of another system. As such, one system faces risk from the other. These new sources of risk might be termed “cross-system” liquidity or operational risks.<sup>29</sup>

*Cross-system liquidity risks* arise when transactions in one system become conditional on transactions or balances in a second system.<sup>30</sup> In this situation, liquidity shortages or securities fails in one system could affect the settlement flows of other interdependent systems. *Cross-system operational risks* arise when either the technical operations or settlement flows of one system become dependent on the technical operations of another system or on a link between systems.

For example, relationships between securities and payment systems to facilitate efficient DVP settlement can create significant cross-system sources of both liquidity and operational risk. While these arrangements eliminate principal credit risk, settlement disruptions or operational problems in one of the linked systems have the potential to lead to settlement disruptions in the other. The specific implications will vary by the design of the link (eg the DVP model used, the type and frequency of interactions across systems, etc), but all models have some cross-system implications.

The settlement arrangements of CLS Bank create similar risks and could allow an operational or liquidity disruption in one LVPS to cause liquidity disruptions in the other LVPSs. Such effects would be particularly pronounced during the CLS funding and settlement windows. Of course, the use of CLS also achieves PVP, and as such, prevents the possibility of principal losses for FX trades settled in CLS.

In contrast, ICSDs generally do not have direct links with payment systems. Instead, they conduct money settlement on their own books (ie in commercial bank money) and rely upon commercial correspondents to send and receive funds arising from participants’ settlement positions. As a result, ICSD participants are exposed to settlement asset risk, but the relationships between the ICSDs and payment systems do not yield the same level of direct cross-system liquidity risks that can arise from other DVP arrangements.<sup>31</sup> On the securities side, the ICSDs have set up a large network of links with local securities markets.<sup>32</sup> If the ICSD’s ability to make “external settlement” transfers to counterparties in these local markets is disrupted, cross-system settlement risks could occur since securities might fail to settle in another (I)CSD. Due to the high internalisation in the books of the ICSDs, however, the importance of this external settlement is currently rather low.

Cross-system risks may also arise from financial institutions’ activities in multiple systems. For example, an institution’s willingness or ability to submit a settlement instruction in one system may be dependent on the receipt of a transfer in another system. This risk can arise irrespective of whether institutions are direct participants in multiple systems or whether they

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<sup>29</sup> These cross-system risks can be viewed as chains of unique risks, where the realisation of one leads to the realisation of another. Cross-system credit risks can also exist.

<sup>30</sup> In some cases, a specific transfer in one system may be uniquely linked to a specific transfer in a second system. For example, in model 1 DVP systems, each securities transfer in the CSD is uniquely linked to a specific payment, typically in the RTGS. In other cases, transfers in one system may be conditional on aggregate liquidity or securities positions in the second system. If expected money or securities are not received in one system, and alternative sources of liquidity or securities are not available, then these assets cannot be forwarded on as expected in the second system.

<sup>31</sup> Maintaining both securities and cash accounts on behalf of their participants, ICSDs conduct DVP transactions in their own books without real-time or batch interlinking with LVPS systems, preventing cross-system risks in that respect.

<sup>32</sup> For a fuller explanation of the different risks related to cross-border securities settlements see CPSS, *Cross-border securities settlements*, 1995.

rely on correspondent banks. This source of risk can be significantly present across systems that settle the same assets, including all domestic systems (see Section 3.2.1).

### **5.3 *The concentration of sources of risks in a few critical systems, participants and service providers has been accentuated***

As discussed in Part I, some interdependencies arise from the dependence of two or more systems on a common third party, such as a critical system, institution or service provider. These forms of interdependencies reflect concentrated sources of risks in the global payment and settlement infrastructure. The reliance of many systems and institutions on SWIFT for messaging services is a key example of this phenomenon. In addition to SWIFT, several service providers serve multiple systems, largely on a domestic basis (see Section 3.3). These entities are also a potential source of risk that is common to multiple systems.

Other forms of interdependencies also reflect this concentration of risk. For example, the numerous CCPs, CSDs and ancillary payment systems supporting domestic financial markets often depend on the smooth functioning of an LVPS, typically an RTGS system settling in central bank money. In those circumstances, the LVPS can be a source of significant operational risk that is common to those other systems.

In addition, large financial institutions can have settlement activities in multiple systems, both domestically and cross-border. As a result, systems are increasingly subject to common sources of operational, liquidity and credit risks introduced by this limited number of institutions with significant activities in multiple systems. A number of factors will contribute to the degree of common risk shared by systems that are connected by institution-based interdependencies. For example, an institution may have either combined or separate operational processes or facilities for each system.

Concentrated sources of risk that affect multiple systems lead to two important, but opposing implications. First, the concentration of risk in a given system, institution or service provider could potentially allow a reduction in the aggregate likelihood of operational disruptions. This potential arises if concentration leads to a reduction and consolidation in operational steps that could potentially fail. For example, the reliance of many systems on SWIFT for network services might be viewed as promoting straight-through-processing and allowing institutions a high level of standardisation across different payment and settlement operations. Assuming that processing facilities and risk management procedures can handle the increased activity, this type of consolidation or standardisation could reduce the likelihood of operational disruptions. In addition, the risk of operational failures might also be reduced if consolidation allowed for more effective and efficient risk mitigation measures.

Second, working in the opposite direction, the concentration in the sources of risk also means that a larger number of parties could be affected if a disruption occurred. This implication is discussed further in section 6.

### **5.4 *Summary of implications for payment and settlement risks***

The analysis provided above shows that the development of interdependencies has significantly altered the risk profiles of payment and settlement systems in CPSS countries. On the positive side, interdependencies improve the safety of the global payment and settlement infrastructure by facilitating DVP and PVP processes and thereby eliminating a key source of principal credit risk.<sup>33</sup> In addition, interdependencies can reduce credit and

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<sup>33</sup> For instance, the 2007 CPSS consultative report, *Progress in reducing foreign exchange settlement risk* shows that approximately 55% of foreign exchange transactions are settled in CLS and are therefore no longer exposed to principal risk.

liquidity risk by facilitating the use of central bank money as a settlement medium. Interdependencies can also help to reduce operational risk through better integration of the different steps across systems.

These clear benefits, however, come at some cost. In particular, interdependencies can lead to new, cross-system sources of liquidity and operational risks. In addition, risks have become increasingly concentrated in a limited number of critical systems, institutions and service providers. In some cases, such as that of CLS, this trade-off has been anticipated and accepted, especially in the light of the reduction of principal credit risk.

Overall, the increasing interdependence of payment and settlement systems has reduced some specific risks in the global clearing and settlement system. But, interdependencies change the nature of remaining risks such that a given disruption may have implications for multiple systems. The following section further explores this topic, analysing whether and how interdependencies affect the transmission of risk across systems.

## **6. Implications for the transmission of payment and settlement disruptions**

The increasing interdependence of payment and settlement systems has significant implications for whether and how disruptions spread across multiple systems. As discussed in Section 5, the smooth functioning of a system can be conditional on that of another system. Moreover, two or more systems can be subject to the same concentrated sources of risk. Given these effects, interdependencies create the potential for payment and settlement disruptions to spread among many systems. Nonetheless, the role of interdependencies in transmitting disruptions is complicated by many factors.

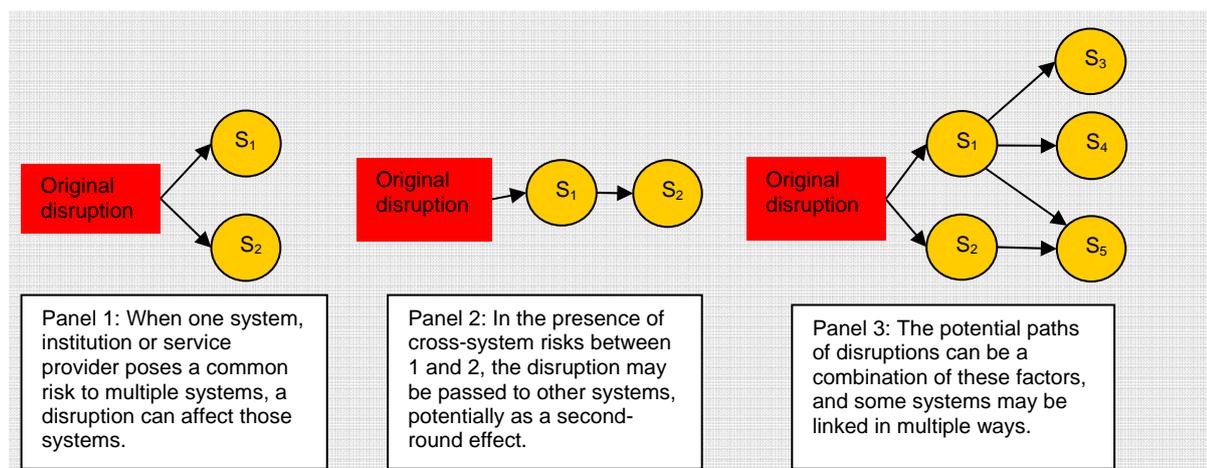
This section explains the different roles of interdependencies in determining how disruptions might spread. As described in Section 6.1 below, interdependencies create the potential for disruptions to spread widely and quickly across many systems. Section 6.2 explains how disruptions may spread beyond systems to financial markets. Then, Section 6.3 shows that interdependencies can either dampen or amplify the intensity of disruptions. Finally, Section 6.4 discusses how idiosyncratic factors, and particularly the actions of systems and institutions, can have a significant influence on how disruptions spread. Section 6.5 summarises these effects, noting that while interdependencies clearly create the potential for disruptions to spread widely and quickly, the actual implications of a given disruption will be difficult to predict.

### **6.1 *Interdependencies can allow disruptions to spread widely and quickly***

As discussed in the previous section, interdependencies can introduce cross-system risks and concentrate sources of risks for multiple systems into a few key entities. As shown in Figure 8, these distinct phenomena may have different effects on the potential paths by which disruptions might spread. Interdependencies arising from the dependence of several systems on a common service provider or participant may contribute to the direct and simultaneous transmission of disruptions to multiple payment and settlement systems (panel 1). Interdependencies arising from direct relationships among systems (eg a DVP link between a CSD and an LVPS) may contribute to the sequential transmission of disruptions from one system to another (panel 2). Some interdependencies may exhibit both characteristics. Moreover, as shown in the third panel of Figure 8, different forms of interdependencies may act in combination to spread disruptions across systems, potentially in second-round effects.

Figure 8

### The potential paths of disruptions



Whether working in isolation or together, these different forms of interdependencies potentially allow numerous systems to be quickly affected by a given disruption. This wide and quick transmission of disruptions is not certain to occur, however. Appropriate risk management policies and tools would play an important role in preventing disruptions from spreading to multiple systems. Nonetheless, there may also be circumstances in which these policies and tools might not be sufficient or effective, and disruptions spread across multiple systems.

#### 6.1.1 Interdependencies can transmit disruptions widely, including across borders

Given these factors, interdependencies create a number of circumstances where disruptions could potentially spread well beyond their original source, including across borders. In some cases, a given disruption could directly affect many systems, while in other cases, widespread problems might only occur due to second-round effects. Of course, these situations would only arise if existing risk management arrangements were overwhelmed.

The descriptions in Section 5 of the cross-system risks associated with the CLS system, and the concentrated risks associated with SWIFT, provide clear examples of how disruptions might have widespread effects. If SWIFT were unavailable for a sustained period of time, a large number of other systems would be affected. If CLS faced operational difficulties, liquidity flows within several large-value payment systems could be disrupted. The failure of one or more CLS participants to meet their expected pay-in requirements could also cause liquidity disruptions in several other systems.

Given these factors, interdependencies create a number of circumstances where disruptions could potentially spread well beyond their original source, including across borders. In some cases, a given disruption could directly affect many systems, while in other cases, widespread problems might only occur due to second-round effects. Of course, these situations would only arise if existing risk management arrangements were overwhelmed.

The descriptions in Section 5 of the cross-system risks associated with the CLS system, and the concentrated risks associated with SWIFT, provide clear examples of how disruptions might have widespread effects. If SWIFT were unavailable for a sustained period of time, a large number of other systems would be affected. If CLS faced operational difficulties, liquidity flows within several large-value payment systems could be disrupted. The failure of one or more CLS participants to meet their expected pay-in requirements could also cause liquidity disruptions in several other systems.

This potential arises in many other circumstances, to varying degrees. An operational disruption that affected an ICSD, for example, would prevent settlement activity within the system, and thereby affect a large number of institutions and systems participating in the system. In addition, if the ICSD were not able to complete its transactions in linked CSDs, those CSDs could see higher settlement fails. The degree of this effect would depend on the ICSD's turnover in the local CSDs, and could be reduced by the local CSD's risk controls, including securities borrowing and lending programmes. The operational failure of a global custodian, which has relationships similar to those of ICSDs, might have different effects due to the fact that such custodians may settle fewer transactions internally.

In another example, the operational failure of a domestic third-party service provider could directly impact several systems and cause the resulting liquidity and settlement disruptions to spread to interdependent systems.

An institution's inability to submit payment instructions, due to either operational or financial difficulties, could also quickly affect the normal functioning of many payment and settlement systems, and as a result could lead to widespread liquidity dislocations. To improve its understanding of how such disruptions might play out, the working group conducted a detailed scenario analysis. This analysis and its main conclusions are described in Annex 4.

#### *6.1.2 Interdependencies can transmit disruptions quickly*

In addition to influencing the number of systems affected by a given disruption, interdependencies might also influence the speed at which disruptions might spread. Many prominent forms of interdependencies allow disruptions to spread across systems quickly. Operational disruptions affecting the key systems, institutions or service providers that contribute to creating interdependencies might have immediate implications for multiple systems. Liquidity or settlement disruptions might also be transmitted in real time. Interdependencies arising from relationships that facilitate model 1 DVP arrangements (where securities and funds both settle on a gross basis), for example, could also transmit disruptions quickly.

In other cases, disruptions might spread at a slower pace. For example, if an institution faces a liquidity shortfall in one system, it may still be able to process transactions in other systems for some period of time. In this case, the speed at which the disruption passes across systems might depend on the designs and settlement schedules of the respective systems, as well as on whether the participant is expecting to use outflows from one system to fund transactions in the other system.

### **6.2 Disruptions may spread to multiple financial markets**

Reflecting the interplay between financial markets and payment and settlement systems more generally, interdependencies may influence how financial markets are affected by payment and settlement disruptions, as well as how systems are affected by market events. While the deteriorating condition of financial markets in the second half of 2007 did not lead to significant payment and settlement disruptions, it did pose a number of challenges to individual systems. If such challenges had not been effectively met by systems and their participants, operational or liquidity disruptions could have spread through interdependencies to many systems.

As shown in Table 5, a given financial market can be dependent on several payment and settlement systems. Disruptions that affect one or more of these systems could possibly impair the functioning of dependent markets, especially for market segments with same day settlement cycles. Because several markets may be dependent on one system, such as an LVPS, several markets may be impaired by an outage affecting one system.

Table 5

**Dependence of financial markets  
on payment and settlement systems**

| Infrastructure components         | Financial markets                             |                 |                                |   |                                  |                  |
|-----------------------------------|---|-----------------|--------------------------------|---|----------------------------------|------------------|
|                                   | Securities and exchange-traded derivatives    | OTC derivatives | FX (spot and derivatives)      | Short-term money markets                                      |                                  |                  |
|                                   |   |                 |                                | Same-day FX swaps   | Repurchase agreements            | Uncollateralised |
| CCPs                              | Yes   | In some cases   | No                             | No  | In some cases                    | No               |
| CSDs                              | Yes   | In some cases   | No                             | No  | Yes                              | No               |
| ICSDs                             | For international securities, or as custodian | No              | No                             | No  | Yes, for EUR triparty            | No               |
| CLS Bank                          | No  | Yes             | Yes                            | In some cases for return legs                                 | No                               | No               |
| LVPSs                             | Yes   | Yes             | Yes, including for CLS funding | Yes, for same day legs as well as return legs via CLS funding | Yes, especially for USD triparty | Yes              |
| Correspondent and custodian banks | Yes   | Yes             | Yes                            | Yes   | Yes                              | Yes              |

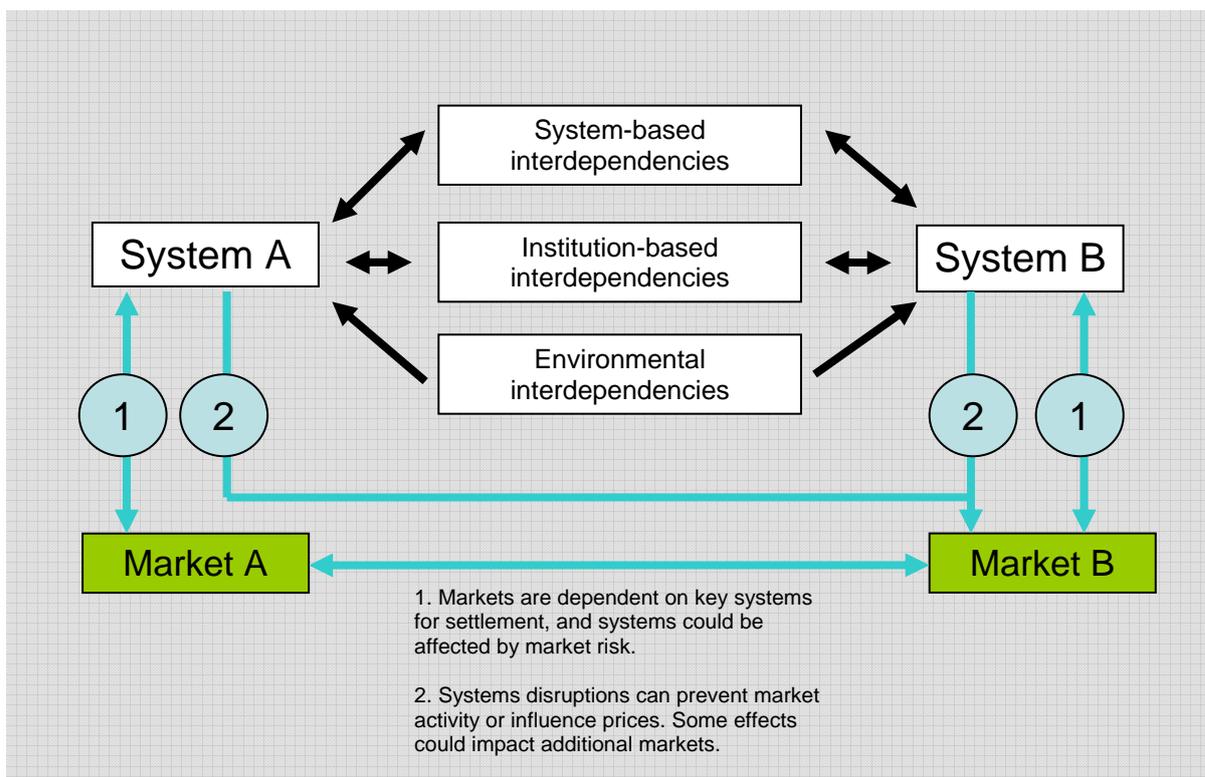
Interdependencies among systems also create the potential for multiple markets to be affected by a given disruption. For example, disruptions that originate in the CSD may pass through interdependencies to also affect the LVPS. As such, both securities markets and money markets might be affected.<sup>34</sup>

Markets can also act as additional transmission channels to those discussed in Part I (see Figure 9). Payment and settlement disruptions may pass through markets and affect other systems that support the affected market. The illiquidity or inoperability of government securities markets, for example, could reduce the availability of collateral used to obtain intraday credit from the central bank, and as a result affect the settlement flows within the LVPS. In turn, uncollateralised money markets might also be affected.

<sup>34</sup> Local money markets may be particularly affected by payment and settlement disruptions for at least two reasons. First, many different systems are interdependent with the LVPS and thus could affect the money markets. Second, money markets can involve very short settlement cycles (same day settlement, sometimes only minutes after trading), and the reputation and replacement costs associated with failed transactions may be quite high. As such, an extended disruption within the LVPS would essentially halt trading in these markets.

Figure 9

**Interplay of interdependencies and markets.**



Finally, market conditions can affect the smooth functioning of systems. For example, a sharp increase in trading activities can impair the functioning of payment and settlement systems supporting the market segments concerned if the resulting volume of transactions to be settled were to exceed the operational capacity of the systems. In addition, a significant change in trading volumes or increased volatility may also have adverse consequences for the functioning of payment and settlement systems. This would be especially true if the market liquidity of financial instruments used by those systems for risk management purposes (eg posting of collateral and margins) decreased or accurate price information became unavailable. In addition, if price volatility increased sharply, additional and unexpected margin calls might be required by one or more CCPs, CSDs, or even correspondent or custodian banks. This could, in turn, magnify the existing liquidity difficulties. These difficulties might be further transmitted through interdependencies. While systems and their participants could have faced these several potential scenarios in late summer 2007 and thereafter, several factors, including strong operational and liquidity risk controls, helped to prevent payment and settlement disruptions (see Box 3).

### Box 3

#### **Market events in August and September 2007**

In the two months following the onset of market turmoil in August 2007, increased market volumes, price volatility and precautionary demand for liquidity created unusual operating conditions for some payment and settlement systems. In this period, systems were able to meet these three challenges, and participants maintained their confidence in the smooth functioning of payment and settlement systems.<sup>1</sup>

Because of increased trading volumes and the shift towards short-term funding, transaction volumes increased significantly in a few key systems, especially in central counterparties and securities settlement systems, as well as in the CLS system. This unexpected increase in transaction volumes raised the possibility that technological capacity constraints might be reached. In some situations, the processing capacities of individual banks were also strongly tested, especially with respect to the processing of foreign exchange trades. At the same time, the strong growth of OTC derivatives contracts over the summer led to significant confirmation delays, particularly for credit default swaps, and counteracted to some degree the progress market participants had made in reducing such backlogs. Nonetheless, these potential difficulties did not impact the smooth functioning of systems or financial markets.

Increased asset price volatility led financial institutions to face larger and more frequent margin calls from some central counterparties, and a few CCPs conducted multiple margin calls within the same day. Because financial institutions met these calls, however, wider disruptions did not arise in the clearing and settlement infrastructure.

Difficulties in money markets led financial institutions to increase significantly the amount of collateral pledged or provided to some central banks to meet potential intraday and overnight credit needs, in part to ensure their ongoing ability to meet payment and settlement obligations. Institutions apparently found sufficient collateral to mobilise for this purpose, and central banks were able to process additional collateral deliveries without difficulty. The increase in collateral significantly outpaced the additional levels of liquidity provided by central banks on an overnight or longer basis through standing facilities, however. In some cases, central banks saw increased demands for intraday credit, as some large-value payment systems experienced somewhat higher processing values (but not higher transaction volumes).

A number of system features and central bank policies were particularly important in helping systems to manage the unusual conditions discussed above. First, effective capacity planning has been a long-standing focus within many systems, and as a result, processing capacities were well calibrated to handle the recent peaks. Second, the effective risk management and position netting provided by CCPs allowed margin calls to be smaller and fewer than might otherwise be the case. Third, institutions' often have high levels of collateral already posted, or ready to be posted, to one or more central banks to meet their normal demand for daylight credit. Moreover, several central banks showed some flexibility in adjusting their eligible collateral lists in the light of the turmoil.

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<sup>1</sup> These challenges continued after this period and through March 2008, system operations have not led to significant disruptions.

### **6.3 Interdependencies can either dampen or amplify the intensity of disruptions**

In addition to allowing disruptions to spread widely and quickly, interdependencies can also affect the intensity of a disruption. In some cases, the intensity may grow as it passes to multiple systems. For example, the outage of a messaging or IT service provider supporting multiple systems could cause significant liquidity dislocations in many different systems. The resulting outages of systems, such as LVPSs, would then have second-round effects, which could also be quite large, if no activity could also take place in those systems.

In other situations, interdependencies might be useful in mitigating and dampening the intensity of disruptions. For example, the relationships established between systems to support DVP and PVP settlement processes prevent the possibility of principal losses, and

thereby dampen the potential effects of a settlement disruption. In addition, interdependencies can sometimes provide opportunities to manage liquidity disruptions in a given system and prevent their further transmission across systems. If an institution faced a liquidity shortage in a given system, for example, the ability of that institution or others to transfer additional funds into that system via a liquidity bridge with another system might help contain or manage the disruption. Similarly, the relationships that a few central banks have established with foreign CSDs allow a broader range of assets to be accepted as collateral for intraday credit in the LVPS for which they act as settlement institution. This could in turn facilitate the absorption of liquidity shortfalls by participants in that LVPS.

As a result of these different effects, interdependencies could have both positive and negative implications for the potential transmission of disruptions across systems. Interdependencies clearly have the potential to enable a disruption to spread widely and quickly to multiple systems. But they can also play a positive role in the containment and management of disruptions, in particular by reducing the potential for principal losses and by facilitating the delivery of assets to absorb liquidity disruptions or securities fails.

#### **6.4 Systems' and institutions' actions influence the transmission of disruptions**

As discussed in Sections 6.1 and 6.2, interdependencies may significantly influence the potential paths by which disruptions might spread. The actual paths that a disruption will follow, however, will be influenced by many other factors and may be difficult to predict. Key among those factors is the behaviour of systems and participants in reaction to the disruption. This behaviour may be particularly difficult to anticipate. Importantly, systems' and institutions' responses to disruptions may either amplify or dampen the impact of a disruption, and can also influence the role of interdependencies in transmitting disruptions across systems.

For example, in the light of uncertainty regarding the liquidity position or operational capacity of a particular institution, the counterparties of that institution might delay outgoing payments to it. This could exacerbate, or even cause, the liquidity problem potentially faced by the institution. In addition, the practices of correspondents and custodians in providing intraday credit or securities lending services may affect how and whether disruptions are transmitted. In case of financial problem affecting a global banking group, correspondents and custodians might cut the group's credit lines, exacerbating its difficulties.

Systems' reactions to disruptions will also influence how the disruptions may spread. In the case of a financial problem affecting a global banking group, it would be difficult to predict what steps CCPs, CSDs and other systems might take given the latitude that they have. It is possible, nonetheless, that multiple systems may take strong actions if a global banking group failed to meet a financial obligation to a system (even if it is to another system), or one system takes a visible action against a member of the group (even if such action is automatically triggered by system rules).

In addition, the types of actions taken by systems and institutions in response to an initial disruption may vary significantly under different economic conditions. In relatively benign conditions, institutions may be willing to take on more credit and liquidity risk from their normal counterparties on an intraday basis, trusting that the problem will be resolved prior to the end of the day. In stressed conditions, actions would be much more conservative. This could further exacerbate the impact of an operational or financial disruption to payment and settlement systems.

#### **6.5 Summary of implications for the transmission of disruptions**

As discussed above, the cross-system risks and concentration of risks that arise from interdependencies potentially allow disruptions to spread widely and quickly across many systems. Interdependencies can also act to spread disruptions across multiple markets.

At the same time, however, the intensity of disruptions may be affected both positively and negatively by interdependencies. In some circumstances, disruptions may amplify as they spread across systems. In other situations, interdependencies may help dampen the effect of disruptions, in particular by allowing liquidity to flow more rapidly across different elements of the global payment and settlement infrastructure. Moreover, the actual path that a disruption will follow can be influenced by many other factors, including the reactions of systems and institutions. As a result, it may be very difficult to predict how an actual disturbance might spread.

## **7. Implications for risk management**

Given the numerous factors discussed in Section 6, interdependencies create a complicated process through which disruptions might spread across the global payment and settlement infrastructure. This complexity reinforces the importance of effective risk management policies and tools applied by all of the different stakeholders in the functioning of payment and settlement processes. The effectiveness of risk management is a critical factor in determining whether and how payment and settlement disruptions spread across multiple systems.

From one perspective, interdependencies can be beneficial to the effectiveness of risk management. As noted in Section 5, for example, a number of interdependencies facilitate DVP and PVP settlement processes or allow the greater use of central bank money, reducing credit risk. And the presence of interdependencies among systems can sometimes help to dampen the intensity of disruptions, and as such can play a role in systems' risk management procedures.

From another perspective, interdependencies also impact the effectiveness of systems' and their participants' risk management efforts. First, interdependencies can make payment and settlement risks more complex and less transparent. It can thus be more difficult for systems and institutions to understand the various risks they face from other systems. It may also be difficult to understand how the risk controls of two systems interact. Second, even if these risks are understood, interdependencies may accentuate the externalities and collective action problems that can affect the market for payment and settlement services. Such market failures could reduce the incentives of systems, institutions and service providers to manage risks adequately. Finally, information asymmetries, difficulties in sharing information or coordination challenges are inherently greater between two or more systems and their participants than in a single system. These information and coordination challenges may hamper risk management.

This last section of the report focuses on the risk management policies and tools which may help the various stakeholders to understand and manage the potential negative implications of interdependencies. Section 7.1 discusses the importance of a broad and comprehensive view of the potential risks that can impact a given system or institution. Section 7.2 discusses the critical role of specific risk controls at key systems, institutions and service providers that operate at the centre of important interdependencies. Finally, Section 7.3 discusses the importance of information sharing and coordination.

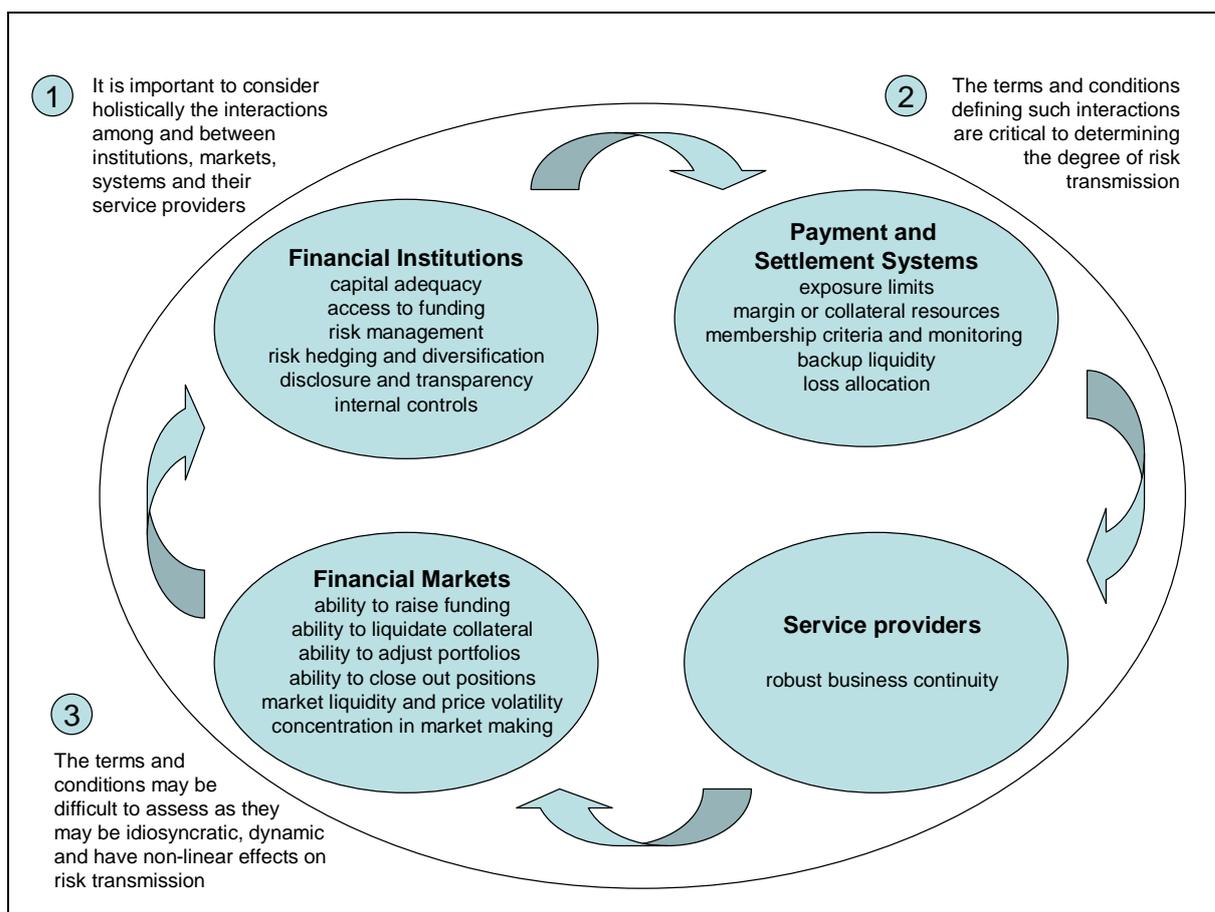
### **7.1 A broad risk management perspective is important**

As discussed in Section 6, the development of interdependencies has led to additional complexity in how disruptions can spread in the global payment and settlement infrastructure. Given this growing complexity, it is increasingly important for systems and institutions to look beyond their own operations and direct exposures to understand the broad range of disruptions that might affect them. It is also important to consider how disruptions might develop under various market and behavioural assumptions.

Correspondingly, it is critical that systems' and institutions' risk management procedures reflect these wider views and incorporate the potential effects of interdependencies.

Figure 10 highlights several of the numerous factors that can influence whether and how disruptions might spread through interdependencies and which might be relevant to systems' and institutions' risk management procedures. The key message of this diagram is that, in the light of interdependencies, many different factors can be relevant in determining the effectiveness of a given system's risk management procedures.

Figure 10



To varying degrees, a number of systems already implement risk management approaches that aim at incorporating this broad perspective. The risk management activities of CLS are one example. In addition to membership criteria, limits on participants' positions and resources to deal with settlement disruptions, CLS has also adopted a range of other risk management procedures. Some of these additional arrangements address the risks that CLS faces from its dependencies on other institutions (eg nostro banks), other systems (LVPSs) or service providers (eg SWIFT). Stress testing is used to help manage risks related to its indirect dependencies on nostro/correspondent banks, financial markets and settlement agents (for third-party services), for example.

ICSDs are another example of systems that have implemented a number of risk control measures which take a broader perspective. Collateralised intraday credit and securities lending facilities and the use of multiple, highly rated correspondent banks to perform cash pay-ins and payouts, for example, are helpful in this regard.

Based on anecdotal information collected by the working group, some institutions have formal policies and procedures, as well as dedicated staff, to review their payment and settlement system risks. These reviews do not necessarily consider the implications of interdependencies, however.

## **7.2 *The risk management procedures of systems, institutions and service providers at the centre of key interdependencies are especially important***

To prevent the spread of disruptions through interdependencies, it is important for systems, institutions and service providers that substantially contribute to those interdependencies to have especially strong risk management controls. The business continuity plans of key large-value payment systems, major financial institutions and key service providers become increasingly critical, as outages affecting them can have widespread effects. The liquidity risk management techniques of key systems and large institutions also take on increased importance. It is also critical that these arrangements be tested effectively, and that such tests reflect the complexity of interdependencies.

### **7.2.1 *Operational risk management***

Interdependencies widen the scope of parties that could be affected by an operational disruption of a system, one of its participants or their service providers. In that context, business continuity arrangements aimed at ensuring processing and settlement service levels are of critical importance. It is especially important that the key systems, participants and service providers, which concentrate risks for a large number of systems as a result of their position at the centre of interdependencies between systems (see Section 5.3), are able to recover and resume their operations rapidly in case of operational disruption.

In addition, given the speed at which a disruption might be transmitted from one system to another, the capability of those key systems, participants and service providers to provide a minimum service level is also of critical importance, so as to ensure the processing of critical transactions in the systems with which they are linked.

From that perspective, alternative access methods can become critical in various situations. In the event of participant-level operational disruptions, tools like “offline” or “manual” transfers can be quite useful as they can significantly moderate systems’ and institutions’ dependence on the LVPS, for example. However, the benefits of these disaster procedures (both in LVPSs and SSSs) may be somewhat limited by capacity constraints and by the increased risk of human error. In the event of a general network disruption, alternative network arrangements may also be useful. Some systems, such as CHIPS, have implemented this approach.

The availability of alternative settlement channels for systems and their participants may also be quite useful to limit the transmission of disruptions between interdependent systems in case of an operational problem affecting one of them. Although maintaining alternative settlement channels could be costly, including in terms of the fragmentation of liquidity, the potential benefits are significant.

### **7.2.2 *Liquidity risk management***

The speed and complexity with which interdependencies might transmit disruptions across systems reinforces the importance of systems’ and institutions’ capacities to manage quick and abrupt changes in expected settlement positions. Moreover, such disruptions could simultaneously arise in several systems. The ability of institutions to complete their settlement activity as expected can help to prevent the transmission of disruptions. In that context, specific system features, central bank services and institutions’ risk management practices can improve the capacity of participants to cope effectively with liquidity shortfalls, replacement costs and principal losses they may face.

**Systems features.** System features that prevent “liquidity sinks” are an important mechanism to manage liquidity strains that may result in a system from an operational disruption of a participant. Liquidity sinks generally arise when one participant suffers an operational disruption, and as a result, accumulates significant account balances, as it can receive but not initiate payments. A number of different system options could help prevent the development of liquidity sinks. These controls can range from simple “stop sending” broadcasts to centrally managed sending limits. In addition, the use of central queues and offsetting algorithms could also help prevent the development of liquidity sinks. Moreover, the design of such liquidity saving mechanisms could also influence how participants decide to submit payments and discourage participant behaviour that exacerbates liquidity disruptions. For example, sending limits and queuing algorithms could encourage institutions to continue to submit instructions to the payment system, even in case of counterparty difficulties, without running the risk of unlimited unilateral outflows. This could actually facilitate the transfers of the institution facing a liquidity disruption without putting other institutions at significant risk.

Securities lending programmes are also an important system-level risk control mechanism. As with money markets and central bank credit, these programmes can help a CSD to prevent additional delivery failures, potentially preventing disruption from being transmitted through interdependencies.

**Central bank services.** In most CPSS countries, the clearing and settlement relationships established between the domestic systems are structured in such a way that an LVPS settling in central bank money (typically an RTGS system) is most often involved in the settlement processes of all the other payment and settlement systems. Consequently, the intraday credit and collateral policy of central banks and the associated operational procedures are likely to be an important contributor to the capacity of system participants to mitigate liquidity disruptions’ spread through interdependent systems.

**Institutions’ practices.** As pointed out in Part I, many large institutions conduct payment and settlement activities in most major currencies. A significant, if small, number of institutions are direct participants in the key payment and settlement systems for USD, EUR and to some extent other currencies. As a result, a disruption that affects a major institution could have implications in multiple systems, and could potentially affect many counterparties in different systems. In particular, liquidity disruptions may flow more quickly across multiple systems. Moreover, institutions may also need to raise liquidity in many different systems and currencies simultaneously. Such needs will likely arise on an intraday basis, but could also have implications for overnight funding needs.

Given these considerations, interdependencies make it increasingly important for institutions to have effective liquidity and collateral management frameworks. It is also important that these frameworks address the potential for payment and settlement disruptions, institutions’ needs to meet time-critical payments, and other intraday liquidity management considerations. The inclusion of payment and settlement issues in liquidity risk management frameworks could be critical in preventing the transmission of liquidity disruptions across systems and financial institutions. Along these lines, one important issue is the level of collateral an institution has provided to the central bank to access intraday credit. It may be helpful for institutions to provide such collateral to central banks in advance of a disruption, and also to be able to mobilise additional collateral quickly if needed.

It is also important for institutions’ contingency funding plans to accurately reflect the time and steps required to move liquidity across currencies and systems. While financial markets and institutions’ clearing and settlement arrangements theoretically allow an institution to transform any type of asset into funds in any currency, these mechanisms can take time. Market settlement conventions, business practices and settlement procedures (eg cut-off times for submitting instructions) can directly influence the amount of time required to acquire and use backup liquidity sources. Assets denominated in one currency may also need to be

converted into the required currency through a foreign exchange transaction. And, in some cases, conducting settlement on a date earlier than that expected by normal market conventions may preclude the use of standard settlement methods, potentially increasing risk. FX transactions for same day settlement, for example, cannot currently settle in CLS, and as such may be subject to principal credit risk.

Moreover, different liquidity (and collateral) management models might not be equally effective under all circumstances. Centralised liquidity management may allow a bank to apply a wider range of liquidity sources to a problem, provided that assets can be converted into the right currency in a timely and safe manner. But, in stress situations, a bank which manages liquidity on a centralised basis may try to “buy time” by arranging for FX swaps that potentially result in liquidity shortages in the market with the latest operating hours for a particular day – an “east to west” flow of liquidity. However, national regulators may require sufficient liquidity be held to meet local obligations. Reliance on decentralised liquidity management and local sources of liquidity to meet local disruptions could mitigate some of the risks of centralised management, but may require a bank to hold more liquidity. A group’s overall business model and the role of its head office in emergency situations, for example, may also influence the relative merits of the different approaches. Whether an institution is a direct participant in the LVPS or relies on a correspondent bank may also be relevant, as intraday funding from correspondents may be withdrawn in case of financial difficulties, for example.

### *7.2.3 The scope of operational and risk management tests*

While these key controls are critical to preventing widespread payment and settlement disruptions, it is also important to test their effectiveness. Interdependencies make testing both more challenging and more critical. The benefits and challenges of testing risk management controls in the context of increasing interdependencies arise from the increased complexity inherent in interdependencies.

As already shown in Figure 10, a number of factors interact to determine the effectiveness of the key risk management tools discussed above. More comprehensive and holistic technical and risk management testing, which involves all relevant parties, will be more effective in anticipating the actual effectiveness of existing controls and identifying remaining gaps. Given that some interdependencies are cross-border in nature, it may be appropriate to include a range of markets, currencies and countries in such tests. Moreover, analyses that contemplate a range of market conditions and participant reactions may also be beneficial.

## **7.3 Interdependencies increase the importance of coordination and information sharing among key stakeholders**

Interdependencies allow disruptions to pass among systems through complex paths and with uncertain levels of intensity. At the same time, the effective resolution or management of a problem may also be dependent on the actions of many parties. As such, coordination among these parties, both before and after a disruption occurs, also grows in importance. The timely, broad and yet sufficiently secure exchange of information among relevant parties is a key element of this coordination.

### *7.3.1 Coordination among key stakeholders is important*

In addition to the timely exchange of relevant information, ex ante and ex post coordination among different parties may sometimes be a necessary component of effective risk management. In some cases, coordination may be required at multiple levels and over different lengths of time. As with other elements of risk management, the coordination of relevant parties is already a significant component of some systems’ and service providers’ risk management and business continuity procedures.

A number of key systems and service providers have established detailed communication procedures for use in the event of major operational disruptions. In some cases, these arrangements involve a broad range of stakeholders, including participants or customers, as well as relevant central banks. Many central banks have also established national-level crisis communication networks for timely exchange of information among key stakeholders. Some arrangements also exist at the international level, including among central banks as system operators.

### *7.3.2 The widespread distribution of accurate information is key*

In addition, the availability of accurate information is a critical component of risk management. Given how disruptions may pass among systems, the initial source of a problem may not always be obvious. A wrong assessment of the source of a problem and its potential impacts through interdependencies may contribute to amplifying the transmission of disruptions. Global banks have a complicated set of arrangements to handle their payments and settlements which makes it difficult for market participants and central banks to react to a problem.

For instance, if an operational disruption occurs and market participants identify it as such, they can probably manage its implications and prevent its further transmission. If correspondent and custodian banks inadvertently interpret an operational disruption as a financial one then they may dramatically reduce the affected bank's credit lines. As a result, the affected bank may have difficulty meeting its commitments, and second-round effects might arise. Thus, a relatively minor operational disruption could produce relatively severe disruptions because participants did not have the right information.

In order to help prevent such misperceptions and their adverse consequences, it is important that proper information is transmitted to all relevant parties. The methods used for this communication, however, should provide a high degree of security for this potentially sensitive information. Beyond sharing proper information, there may also be a need to coordinate some of the actions of all relevant parties in addressing the disruptions in order to reach an effective and appropriate response.

## **7.4 Summary of implications for risk management**

Given their multiple and complex implications, interdependencies make risk management more challenging. As such, it is critical that systems', institutions' and service providers' risk management procedures look beyond their own operations and direct exposures and incorporate the broad context of relationships in which the systems or institutions operate. To prevent the spread of disruptions through interdependencies, it is also important for systems, institutions and service providers at the centre of key interdependencies to have especially strong risk management controls to address operational and liquidity risks in particular. In addition, interdependencies call for additional coordination and information sharing among these parties, both before and after a disruption occurs.

Meeting these risk management, information and coordination challenges can help reduce the adverse implications of interdependencies for the potential transmission of disruptions. As a result, the overall net benefits of interdependencies would be reinforced, and the global payment and settlement infrastructure would be strengthened further.

## **Conclusion and suggested actions**

The settlement flows, operational processes and risk management procedures of the numerous payment and settlement systems that underpin financial markets are growing more interdependent. This has contributed significantly to the reduction of costs and the

elimination of important sources of credit, liquidity and operational risk in the global payment and settlement infrastructure.

Yet, tightening interdependencies have brought new, cross-system sources of liquidity and operational risk. In addition, they have helped to concentrate sources of risk in a limited number of critical systems, institutions and service providers. Interdependencies have thus increased the potential for disruptions to spread quickly and widely across multiple systems and markets. As a result, the resilience of the global payment and settlement infrastructure increasingly depends on the effective management of the cross-system and concentrated sources of risk that arise from tightening interdependencies.

Achieving the effective management of these risks, however, may be difficult. Interdependencies make it less easy for system operators and participants to understand the various disruptions that could affect a given system. In addition, the externalities and collective action problems in payment and settlement systems may be accentuated by tightening interdependencies. As such, the incentives of systems, institutions and service providers to manage risks appropriately may be altered. Moreover, information asymmetries and coordination needs are inherently greater between two or more systems and their participants compared to a single system.

In this light, three risk management challenges need to be addressed. First, it is important that stakeholders (system operators, financial institutions and service providers) adopt a broad risk management perspective that better anticipates the range of potential settlement disruptions that could affect them, or that they could pose to other entities. Second, it is important that systems, institutions and service providers at the centre of key interdependencies have risk management controls that are commensurate with the critical role they play in the global infrastructure. Third, strong coordination among interdependent stakeholders is also critical in preventing and managing disruptions where numerous and potentially diverse parties may be affected.

A number of stakeholders have already made significant efforts, individually and collectively, to address the challenges presented by interdependencies. Most notably, some system operators have already taken steps to implement risk management tools that are tailored to their critical role in the global payment and settlement infrastructure. These efforts have been encouraged by central banks and other public authorities in part through the implementation of existing international minimum standards. These standards discuss a number of the risk management tools that can be effective in managing the risks posed by important forms of interdependencies, especially those associated with systems' clearing and settlement arrangements.<sup>35</sup>

While some risk management practices and standards consider interdependencies to an extent, there is still considerable room for improvement. Additional exercises to test the compatibility of different entities' business continuity plans, for example, could improve the degree of coordination among interdependent stakeholders, helping to prevent and manage potential disruptions. Moreover, the increasing interdependence of the global payment and settlement infrastructure is a dynamic phenomenon, and generally poses risks to be managed rather than eliminated. To maintain their effectiveness, risk management policies need to keep pace with the changing sources of risk arising from interdependencies.

In the light of these considerations, the CPSS encourages system operators, financial institutions and service providers to strengthen further the global payment and settlement

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<sup>35</sup> See the CPSS Core Principles for Systemically Important Payment Systems, the CPSS/IOSCO Recommendations for Securities Settlement Systems, and CPSS/IOSCO Recommendations for Central Counterparties.

infrastructure by addressing the challenges posed by interdependencies. For that purpose, the CPSS suggests a set of actions to be undertaken by these stakeholders.

While systems, institutions and service providers have responsibility for addressing the challenges of interdependencies, interdependencies also have implications for public authorities in their oversight, supervisory or regulatory roles. As a result, the CPSS also suggests several steps to be taken by individual central banks. In addition, the CPSS central banks will collectively continue to pursue several objectives related to the challenges of interdependencies.

## **Challenge 1: Broad risk management perspectives**

Interdependencies increase the potential for disruptions to spread widely and quickly across the global payment and settlement infrastructure, and make the transmission process more complex. The ability of system operators, financial institutions and third-party service providers to understand their exposure to the possibility that disruptions quickly spread to multiple interdependent systems is critical to the resilience of the global payment and settlement infrastructure. It is also critical that these stakeholders understand their contribution to creating interdependencies and the associated risks they pose to other stakeholders.

***Suggested action:*** *System operators, financial institutions and third-party service providers should regularly review the risks they bear from and pose to other entities as a result of interdependencies.*

When taking this action, these entities, including central banks in their role as a system operator, might consider whether its risk management framework allows it to:

1. identify the systems, financial institutions, third-party service providers and financial markets that (a) are critical to the normal performance of the entity's clearing and settlement-related activities, and (b) could be materially affected by the entity's inability to provide services or conduct settlement activities as expected.
2. understand the type of risks borne from and posed to those interdependent entities.

*Issues for public authorities.* As interdependencies can allow disruptions to spread widely and quickly among numerous payment and settlement systems, effective central bank oversight requires a robust analysis of the various system-based, institution-based and environmental interdependencies that can affect those payment and settlement systems overseen by a particular central bank. This analysis is critical to judging the implications of these interdependencies for creating concentrated and cross-system sources of risk. To inform their oversight policies and activities accordingly, central banks should have a clear understanding of how interdependencies can affect the systems they oversee.

Information on the risk profiles of systems, institutions and service providers is essential to this clear understanding. While central banks will generally have information about systems they directly oversee, information on other entities that pose risks to or bear risk from directly overseen systems may be more difficult to acquire, yet no less important. As a result, central banks may need to review their policies and procedures for monitoring interdependencies affecting entities they oversee. In particular, they may need to review whether they have sufficient information to identify the stakeholders that might create or be affected by interdependencies, to assess risk implications of those interdependencies and to assess their relative importance.

## Challenge 2: Risk management commensurate with stakeholders' roles

To prevent the spread of disruptions through interdependencies, it is important for systems, institutions and service providers to have risk controls that are appropriate and proportionate to their role in the global infrastructure. This is especially true for central bank systems, including large-value payment systems that are critical to the functioning of many other systems.

**Suggested action:** *System operators, financial institutions and third-party service providers should regularly assess whether their risk management tools are proportionate to the risks they bear from and pose to other interdependent entities.*

Interdependencies can widen the scope of entities affected by a given disruption, and can also transmit disruptions quickly to multiple systems. To the extent that an entity's risk management tools are tailored to the risks borne from and posed to other interdependent entities, the potential for transmitting disruptions may decrease. Moreover, because interdependencies are dynamic in nature, the sources of risk arising from interdependencies are likely to change over time. In this context, a regular review of risk controls might include assessing:

- whether the entity has implemented risk management tools that are well fitted to the operational and liquidity risks arising from interdependencies. Such tools might include business continuity arrangements that allow for the rapid recovery and resumption of critical activities, alternative settlement channels to process key transactions (eg "offline" capacity) and liquidity risk management techniques, for both systems and institutions, that help address market-wide stress conditions.
- whether those tools effectively limit the likelihood of spreading disruptions to multiple interdependent entities, both by preventing new disruptions and by effectively managing those disruptions that have already occurred. From an operational risk perspective, systems, institutions and service providers could assess this capacity by organising or participating in business continuity tests that include interdependent entities, potentially including market-wide tests. With respect to liquidity risks, systems and institutions could conduct failure-to-settle simulations or stress tests of contingency funding plans that assume wide-ranging disruptions affecting multiple other systems or institutions.

In many cases, central banks operate systems, including LVPSs, associated collateral management systems and in some cases securities settlement systems, that have significant interdependencies with other systems on a domestic and on a cross-border basis. Consequently, central banks should also ensure that these systems have risk management practices proportionate to their role.

*Issues for public authorities.* While individual systems, institutions and service providers can and do address many of the challenges related to interdependencies, externalities and collective action problems may lessen their incentives to do so. As a result, central banks should review whether their policies provide entities with proper incentives to address sufficiently the risks brought by interdependencies. Bank supervisors, securities regulators, and other authorities may also want to consider similar steps where relevant.

In conducting this type of review, central banks and other authorities may want to consider whether their policies sufficiently encourage entities to adopt risk management controls that (i) address the cross-system and concentrated sources of risk posed by interdependencies, and (ii) are commensurate with their role in the global payment and settlement infrastructure. This may require, for example, that central banks encourage, when appropriate, overseen entities to exceed the minimum standards set out in the CPSS Core Principles for Systemically Important Payment Systems, and CPSS/IOSCO Recommendations for Securities Settlement Systems and Recommendations for Central Counterparties.

Central banks could consider whether the scope of parties covered by their oversight policies is sufficient. For example, central banks, together with other authorities, may want to review the appropriateness of setting expectations for financial institutions and key service providers which significantly contribute to the creation of interdependencies between systems under their oversight, and review the various means by which such expectations might be enforced (via direct oversight, expectations covering systems' outsourcing arrangements, cooperation with supervisors and other authorities, etc).

### **Challenge 3: Wide coordination**

Interdependencies among multiple payment and settlement systems arise not only from direct relationships among systems, but also from the indirect relationships associated with the payment and settlement activities of financial institutions in multiple systems, as well as even broader factors. Moreover, interdependencies can allow disruptions to pass among multiple systems through complex paths involving many systems, institutions or service providers, including across borders. Given these considerations, the coordination of risk management and crisis management arrangements across multiple systems can be critical to preventing widespread disruptions.

***Suggested action:*** *System operators, financial institutions and third-party service providers should regularly review whether their crisis management arrangements allow effective coordination among interdependent entities.*

Given the complex nature of interdependencies, the effective resolution or management of a particular disruption may require information from and actions by many different parties. Therefore, it is important that system operators, financial institutions and third-party service providers review their crisis management arrangements to ensure they include communication with those other entities with which they are interdependent. These arrangements should be wide-ranging, and include communication with central banks and other relevant authorities on a domestic and international basis.

In addition, tightening interdependencies also increase the importance of the compatibility of the business continuity objectives and plans of relevant systems, institutions and service providers. As a result, these arrangements should be tested with all relevant parties on a regular basis.

*Issues for public authorities.* Tightening interdependencies also increase the importance of effective coordination among public authorities, on both a domestic and a cross-border basis. As a result, central banks should regularly review whether their cooperative efforts with other central banks and relevant public authorities sufficiently address the coordination challenges brought by interdependencies.

While payment and settlement systems are generally overseen by central banks, other authorities may have jurisdiction over the institutions or service providers that act to create interdependencies among systems. Given this situation, cooperation between central banks and other authorities (including securities regulators and bank supervisors) could be helpful in encouraging institutions and service providers to understand how interdependencies affect the risks they bear from and pose to the global payment and settlement infrastructure, and to adopt commensurate risk management controls for that role.

Large financial institutions' business continuity arrangements and intraday liquidity management practices are examples of topics where cooperative efforts between banking supervisors and systems' overseers may be required. If institutions have critical roles in payment and settlement systems, but insufficient risk management tools, the smooth functioning of payment and settlement systems may be directly affected. Reflecting this, there have already been a number of cooperative efforts in these areas, at both the national

and international level. In the light of increasing interdependencies, central banks and other authorities should review the need for further cooperation.

Further cooperation and coordination may also be required among central banks on a cross-border basis. For example, it may be warranted for central banks to share information about systems, institutions or service providers that may create cross-border interdependencies among systems. Such information sharing arrangements could facilitate the oversight process without imposing unnecessary costs on market participants. As discussed in more detail below, cross-border coordination may also be warranted to promote consistent public policy approaches across central banks.

### **CPSS initiatives**

Collective efforts at the CPSS level may also serve to complement the actions individual central banks in reviewing, and where necessary, adapting their policies to the tightening interdependence of systems. In this context, the CPSS will continue to pursue the following objectives:

- Identifying the relative importance of those systems, institutions and service providers that are most critical to the safety of the global payment and settlement infrastructure.
- Reviewing and, where necessary, adapting its internationally recognised principles and recommendations for the management of payment and settlement risks, especially those related to operational and liquidity risks, to reflect the challenges posed by interdependencies.
- Improving cooperative efforts with bank supervisors, securities regulators and other authorities at the international level to bring about consistent progress in the management of liquidity and operational risks by entities that are subject to different regulatory or oversight frameworks.

In working towards these objectives, the CPSS intends to take the following actions, which in some cases represent the continuation of existing work streams:

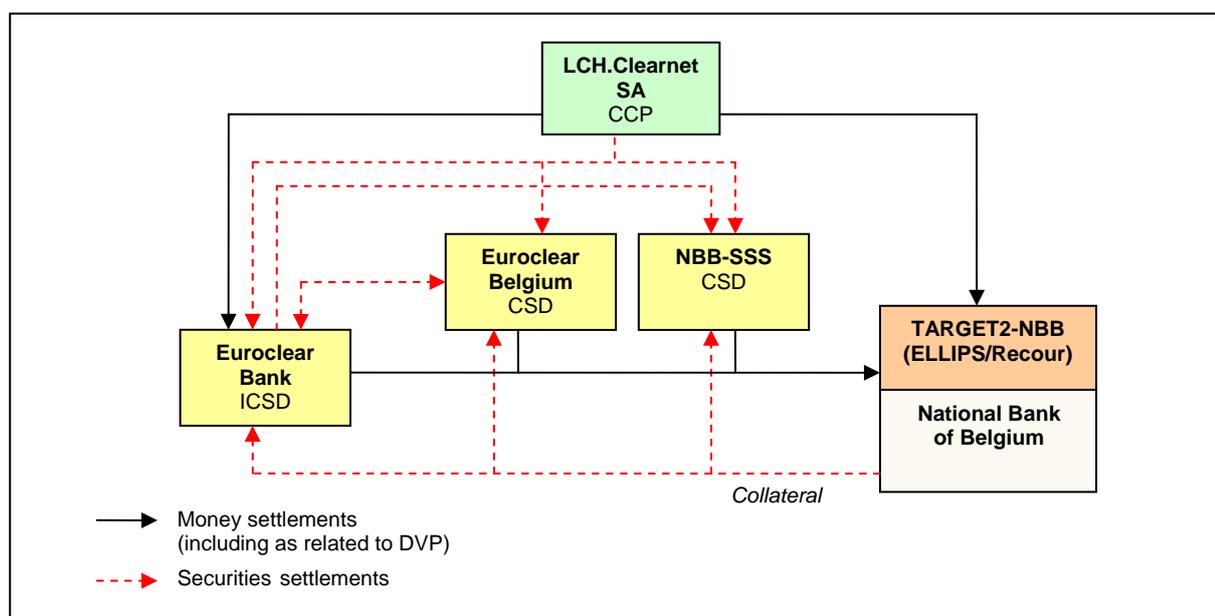
- Assessing major clearing and settlement organisations' progress in managing operational risk and promoting further progress in such fields as coordinated testing of business continuity arrangements.
- Further studying how different settlement and collateral arrangements influence central banks' flexibility in providing liquidity, including to deal with extraordinary situations.
- Revising as necessary the operational risk-related standards set out in the CPSS Core principles for systemically important payment systems, CPSS/IOSCO Recommendations for securities settlement systems and CPSS/IOSCO Recommendations for central counterparties, and the related implementation guidelines, to improve their consistency and to reflect the development of tightening interdependencies.
- Identifying sound intraday liquidity management practices in cooperation with the Basel Committee, and including these in the revised sound practices for liquidity management currently being prepared by the Basel Committee.

## **Annexes**

1. Domestic clearing and settlement interdependencies
2. CCP-to-CCP links
3. CSD-to-CSD links
4. Global banking group scenario analysis
5. Members of the working group

## Annex 1: Domestic clearing and settlement relationships

### Belgium<sup>36</sup>



#### 1. LCH.Clearnet SA

LCH.Clearnet SA is the French-based CCP which delivers clearing services to the Euronext Belgium market segment. Margin calls and deposits in cash in favour of LCH.Clearnet are collected through either the ELLIPS/Recour system (the current accounts platform of the NBB) or Euroclear Bank.

#### 2. Euroclear Belgium

Euroclear Belgium is the CSD providing settlement services on financial instruments traded on both regulated (ie Euronext Brussels) and cash OTC markets. Euroclear Belgium does not maintain cash accounts for its participants. The participants settle the cash leg of their transactions in central bank money, in the ELLIPS/Recour system at the NBB. Both stock exchange (Euronext Brussels) transactions (after netting by Clearnet, DVP model 2) and

<sup>36</sup> TARGET2 was launched on 19 November 2007 and will successively replace the decentralised technical platforms operating under the name TARGET. According to the Eurosystem's country window approach, the central bank and the respective national banking community, the changeover to TARGET2 will occur over a range of dates. Furthermore, TARGET2 is a single technical platform; however, from a legal point of view, each NCB participating in it remains its own RTGS system). TARGET2 provides cash settlement services in central bank money for several kinds of ancillary systems (ASs), including retail payment systems, large-value payment systems, foreign exchange settlement systems, money market systems, clearing houses and securities settlement systems (SSSs). Within the six settlement procedures offered, any settlement of cash positions will take place directly in the TARGET2 participant's RTGS account. This note also applies, as indicated below, for France, Germany, Italy and the Netherlands.

OTC-trades (DVP model 1) are settled via book entries in the NBB cash accounts. Cash settlement is done exclusively in euros.

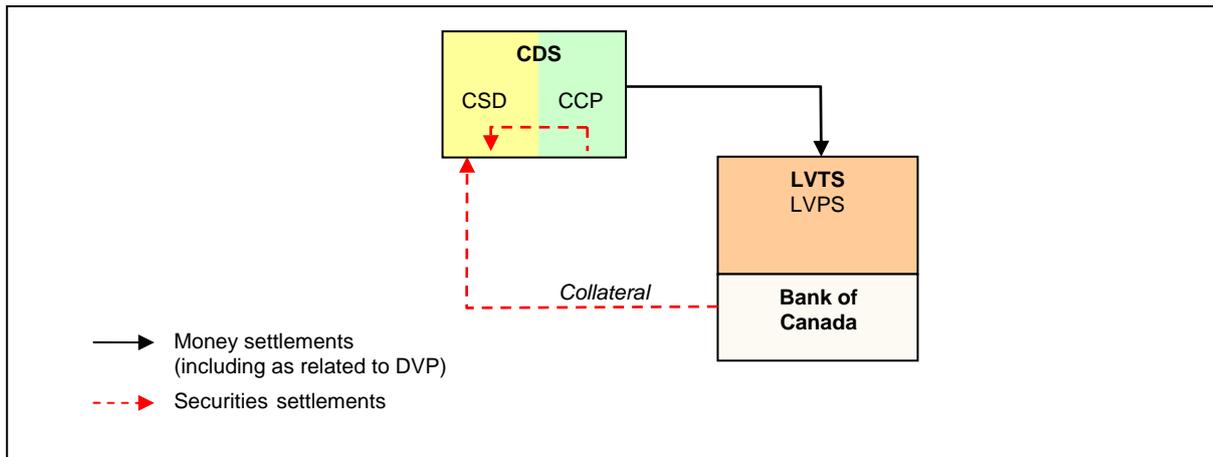
### **3. NBB-SSS**

NBB-SSS is the CSD for fixed income securities for both public and private sector debt in Belgium, operated by the NBB. Against payment transactions in EUR are settled in central bank money, in the books of NBB through the participants' cash accounts operated by the ELLIPS/Recour system. Transactions in the system are settled according to DVP model 1.

### **4. Euroclear Bank**

Euroclear Bank is a Belgian credit institution operating the Euroclear system. As an ICSD, Euroclear Bank offers its participants settlement and custody services in international securities (ie eurobonds) and a large number of domestic securities through a network of 30+ market links. In order to offer cash settlement facilities in a large number of settlement currencies, Euroclear Bank relies on a network of cash correspondent banks which provide liquidity and are the link between it and the national payment system(s) in the country of the currency. Euroclear Bank relies partly on ELLIPS/TARGET (outside its cash correspondents network) to obtain liquidity. The Euroclear system settles transactions in its books according to DVP model 1.

## Canada



### 1. CDS Clearing and Depository Services Inc (CDS)

CDS, the owner and operator of Canada's SSS (called CDSX), is both the CSD and a CCP. CDS becomes the CCP for the funds leg of all securities transactions settled in CDSX. CDS also acts as a CCP for the securities leg of: (i) equity transactions settled in its CNS service; and (ii) transactions involving future-dated Government of Canada bonds and T-bills, settled in its DetNet service.

In CDSX, transactions are settled via the simultaneous transfer of funds and securities between participants' accounts, and these intraday funds and securities transfers are final and irrevocable. In this sense, transactions in CDSX settle by DVP model 1. As a result of these intraday transfers, each participant has a net, end-of-day, Canadian dollar settlement obligation to or from CDS, which is settled via a payment made in Canada's LVPS (called the LVTS). Since CDS is not a direct participant in the LVTS, the Bank of Canada (as an LVTS direct participant) holds a settlement account on behalf of CDS to and from which participants make LVTS payments in order to settle their net funds positions in CDSX.<sup>37</sup>

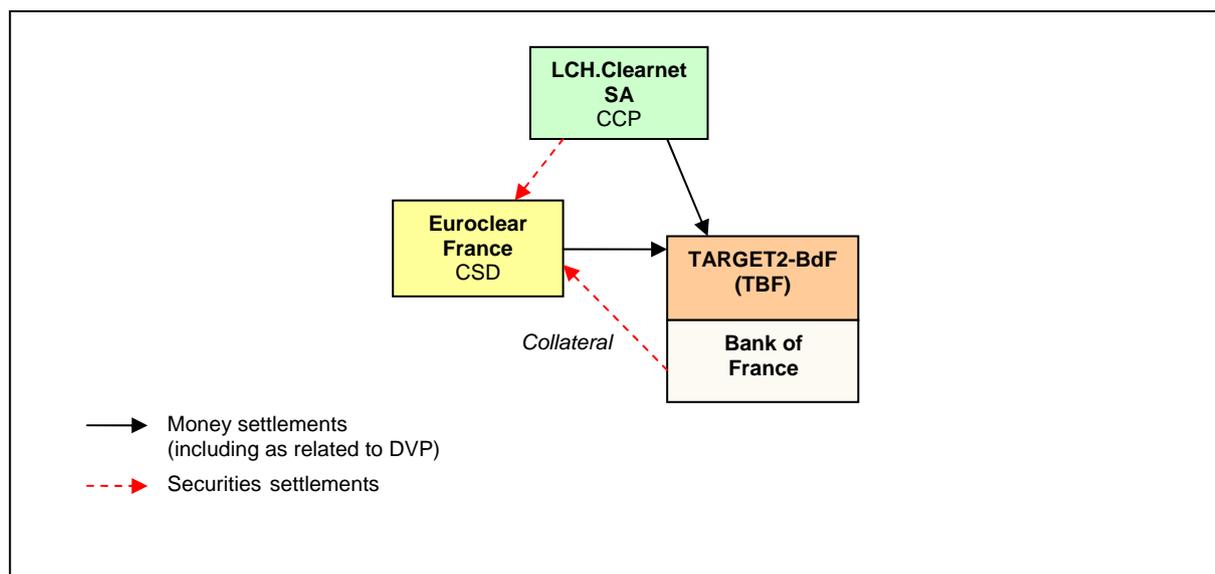
In addition to the dependence of CDSX on LVTS for money settlements, the two systems are linked through a liquidity bridge, called LVTS-CDSX Funds Transfer. This allows a participant in both systems to transfer positive balances in its CDSX funds account to its LVTS settlement account at the Bank of Canada, prior to CDSX end-of-day settlement.

Through the pledging functionality, participants in CDSX can pledge collateral to other participants for a variety of purposes. The Bank of Canada depends on this functionality for receiving collateral pledges that support the intraday LVTS credit the Bank provides to LVTS participants, as well as the overnight liquidity advances the Bank offers to help LVTS participants settle their end-of-day net payment obligations in LVTS.

A participant in both CDSX and LVTS can economise on collateral by settling its end-of-day net funds position in CDSX with an LVTS payment that is supported by collateral in which both CDS and the Bank of Canada have a security interest. Collateral that may be supporting a participant's negative funds position in CDSX can be pledged to the Bank of Canada to collateralise an LVTS payment that will ultimately extinguish the participants' obligation in

<sup>37</sup> LVTS is owned and operated by the Canadian Payments Association. The Bank of Canada provides settlement accounts and collateralised intraday credit to LVTS participants, and provides settlement agency services to CDS.

CDSX. Once the LVTS payment is made by the participant, it will no longer have a negative funds obligation in CDSX, and thus the Bank agrees that its security interest is subordinate to that of CDS until the LVTS payment is made. At this point, CDS relinquishes its security interest and the collateral pledge is effectively “transferred” to the Bank of Canada to support the intraday LVTS granted by the Bank to the participant. Thus, this mechanism avoids double collateralisation of the same payment obligation in CDSX and LVTS, in effect linking the collateral-based risk controls of both systems.



## 1. LCH.Clearnet SA

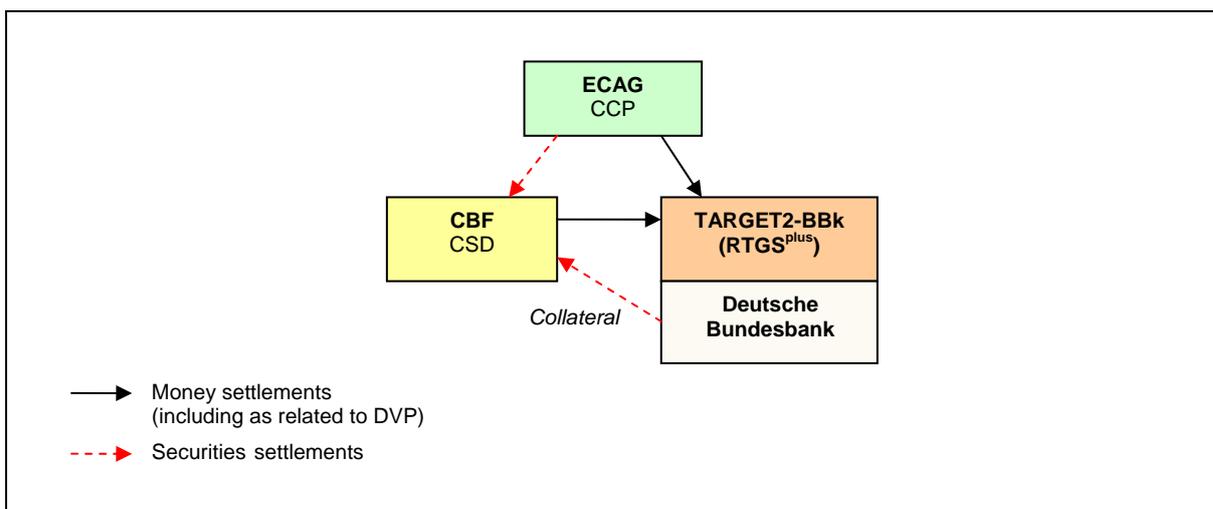
For the collection of margins deposited in cash and for the settlement of the cash market, LCH.Clearnet generally settles in central bank money. Commercial bank money is theoretically possible for the collection of margins in USD or GBP but is marginal in practice. LCH.Clearnet SA is a direct participant in the French RTGS (TBF, now replaced by TARGET2-BdF) as an ancillary system. To send and receive securities transfers for the collection of margins deposited in securities and for the settlement of the cash market, LCH.Clearnet is a direct participant in Euroclear France.

## 2. Euroclear France

Euroclear France settles in central bank money, but is not a direct participant in TBF or TARGET. Euroclear France has two different settlement channels. For the irrevocable channel, model 1 DVP is used, with an “integrated model” whereby cash accounts technically operate on the same platform as securities accounts. Cash transfers can occur between RTGS accounts and SSS cash accounts; For the revocable channel, model 2 DVP is used, with an interfaced model for cash settlement. A risk management relationship also exists between Euroclear France and the Bank of France for the management of a mutual fund and individual guarantees aimed at mitigating the settlement risk of a participant in the revocable channel.

<sup>38</sup> See note on TARGET in Annex 1, Belgium.

## Germany<sup>39</sup>



### 1. ECAG (Eurex Clearing AG)

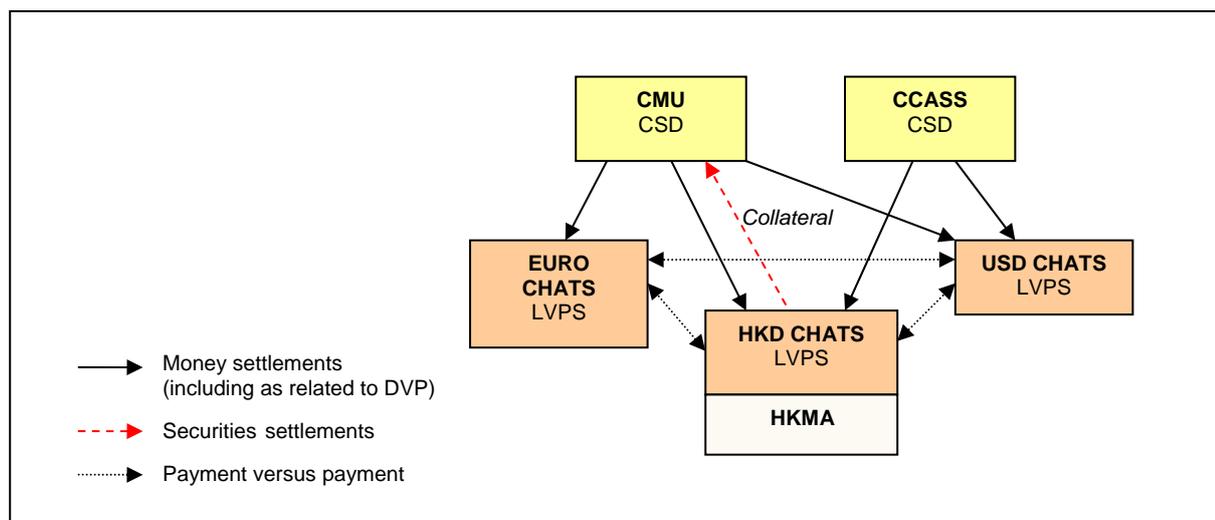
The settlement for the primary currency (EUR) takes place in central bank money, and ECAG is a direct participant in TARGET2-BBk (formerly RTGS<sup>plus</sup>) and is classified as an ancillary system. ECAG uses several (I)CSDs for net securities delivery and/or for collateral. Therefore ECAG is a direct participant in the domestic CSD, CBF (but also in CREST which is the “domestic CSD” for ECAG as the CCP for the Irish Stock Exchange) but also in non-domestic (I)CSDs such as SegalInterSettle (SIS), Clearstream Banking Luxembourg (CBL) and Euroclear Bank.

### 2. CBF

All payments in EUR resulting from the settlement of issuances, corporate actions, interest payments and redemptions are settled in central bank money through Deutsche Bundesbank. CBF operates a model 1 DVP system, as well as a model 2/3 DVP system. Both use the “interfaced model”, and CBF is a direct participant in TARGET2-BBk and is classified as an ancillary system.

<sup>39</sup> See note on TARGET in Annex 1, Belgium.

## Hong Kong SAR

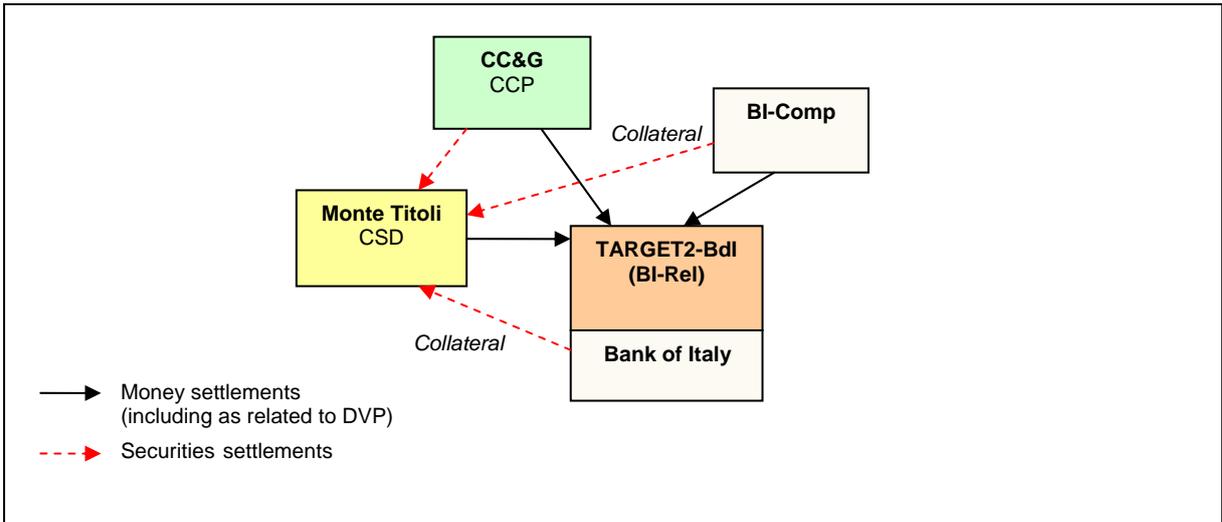


### 1. HKD CHATS, USD CHATS and EUR CHATS

HKD CHATS settles in central bank money. USD and EUR CHATS settle in commercial bank money. The three CHATS are linked to the CMU to facilitate the processing of real-time DVP transactions, including repurchase transactions. The three CHATS provide liquidity through repurchase agreements. Members have to sign repurchase agreements with the settlement institutions. USD and EUR CHATS also provide non-collateralised intraday overdraft facilities to direct participants based on predetermined limits mutually agreed between the settlement institutions and each participants based on commercial terms.

### 2. CCASS and the Central Moneymarkets Unit (CMU)

Securities transactions are classified into two categories: exchange trades and non-exchange trades (such as settlement instructions, clearing agency transactions and investor settlement transactions). Exchange trades are mainly settled on Continuous Net Settlement on a netting basis. Non-exchange trades are settled on a transaction by transaction basis. Both CCASS and CMU settle in central bank money for HKD transactions. For USD and EUR transactions, they are settled in commercial bank money. CCASS maintains interfaces with HKD and USD CHATS to offer real-time and end-of-day DVP settlement of equities denominated in HKD and USD, respectively. CMU maintains interfaces with HKD, USD and EUR CHATS to offer real-time and end-of-day DVP settlement of debt securities denominated in HKD, USD and EUR, respectively. The interfaces also facilitate the provision of liquidity through repurchase agreements in the three CHATS. Both CCASS and CMU settle in the same money accounts in different CHATS.



### 1. CC&G

CC&G is a direct participant in the settlement procedures of Monte Titoli, at which it has securities accounts for the settlement of the securities leg of cash transactions and for the collection and custody of securities collateral as initial margins. CC&G is also a direct participant in BI-Rel (the Italian RTGS system – a component of TARGET) for the settlement of the cash leg of transactions and for the collection of cash collateral as initial and variation margins.

### 2. Monte Titoli

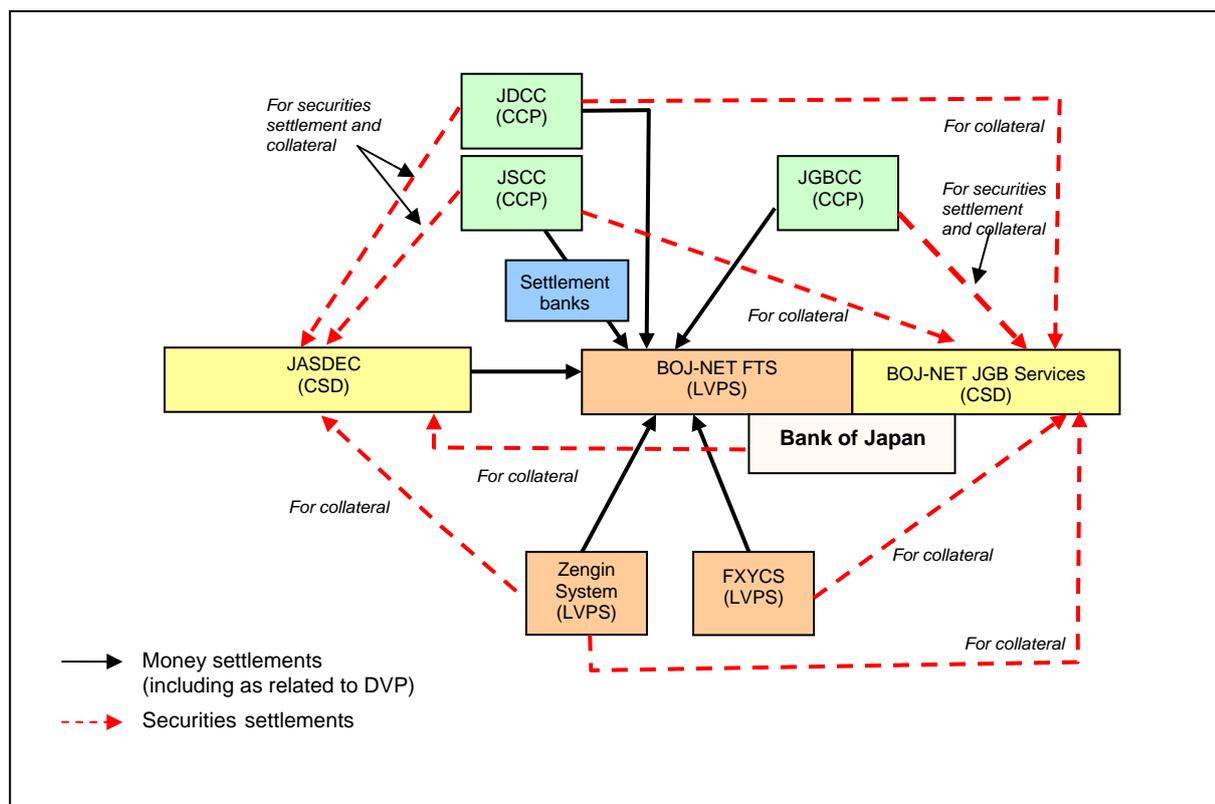
All payments in EUR resulting from the settlement of securities transactions, issuances, corporate actions, interest payments and redemptions are settled in central bank money through the Bank of Italy. Monte Titoli conducts settlement in central bank money via an interfaced model (model 1 DVP system, as well as a model 3 DVP system). Monte Titoli is not a direct participant in BI-Rel, but it has a technical account.

### 3. BICOMP

BICOMP settles multilateral balances in BI-Rel/TARGET at three predefined times.

<sup>40</sup> See note on TARGET in Annex 1, Belgium.

# Japan



## 1.1 Japan Government Bond Clearing Corporation (JGBCC)

The JGBCC is a CCP for OTC JGB transactions. Money settlements and payments of cash collateral to the JGBCC are conducted in central bank money at the Bank of Japan. The JGBCC directly participates in the BOJ-NET FTS, and uses its current account at the Bank of Japan to conduct money settlement across participants on a DVP basis.

Securities settlements as well as the provision of collateral (JGBs) to the JGBCC are conducted at the Bank of Japan, which acts as a CSD for the JGB Book-Entry System. The JGBCC directly participates in BOJ-NET JGB Services, and uses its JGB account at the Bank of Japan to conduct gross settlement of JGBs across its participants on a DVP basis.

## 1.2 Japan Securities Clearing Corporation (JSCC)

The JSCC is a CCP for securities transactions (mainly stocks) executed on the exchanges. Money settlements and payments of cash collateral to the JSCC are conducted in either central bank money or commercial bank money at cash settlement banks designated by the JSCC, consisting of six commercial banks and the Bank of Japan, according to participants' choice. The JSCC holds cash accounts at each of six cash settlement banks (commercial banks). Each of these is notified of each customer's net cash positions, and conducts net money settlements across most of its customers through the JSCC's accounts on a DVP basis. The adjustments of positions between six cash settlement banks are conducted through the JSCC's current account held at the Bank of Japan through the BOJ-NET FTS.

Securities settlements (stocks) as well as provision of collateral (stocks, non-JGB bonds (bonds other than JGBs, eg corporate, municipal and samurai bonds) and investment trusts) to the JSCC are conducted at the Japan Securities Depository Center (JASDEC, see 2.2).

The JSCC directly participates in the JASDEC's systems, and conducts net settlements of stocks across its participants on a DVP basis.

The JSCC also directly participates in BOJ-NET JGB Services and uses its JGB account to conduct net settlement of exchange-traded JGBs and to accept collateral (JGBs).

### **1.3 JASDEC DVP Clearing Corporation (JDCC)**

The JDCC is a CCP for off-exchange stock transactions. Money settlements and payments of cash collateral to the JDCC are conducted in central bank money at the Bank of Japan. The JDCC directly participates in the BOJ-NET FTS, and uses its current account at the Bank of Japan to conduct net settlement across its participants.

Securities settlements (stocks) and the provision of collateral (stocks and non-JGB bonds) to the JDCC are conducted at the JASDEC by debiting and crediting the participants' securities accounts. The JDCC also directly participates in BOJ-NET JGB Services and uses its JGB account to accept collateral (JGBs).

### **2.1 BOJ-NET JGB Services**

The Bank of Japan operates BOJ-NET JGB Services as a CSD for the JGB Book-Entry System. Money settlements for BOJ-NET JGB Services are conducted in central bank money by debiting and crediting the participants' current accounts at the Bank of Japan (there is no dedicated central bank account for securities settlement). BOJ-NET JGB Services achieves the model 1 DVP through the interface with the BOJ-NET FTS.

### **2.2 JASDEC**

The JASDEC is a CSD for CP, non-JGB bonds, investment trusts and stocks. In DVP settlement of CP, non-JGB bond and investment trust transactions, money settlements are conducted in central bank money at the Bank of Japan through the BOJ-NET FTS. In DVP settlement of stock transactions, central bank money is used for off-exchange stock transactions cleared through the JDCC, and for some exchange-traded stock transactions cleared through the JSCC. Commercial bank money is used for DVP settlement of most exchange-traded stock transactions cleared through the JSCC.

In DVP settlement of CP, non-JGB bonds and investment trusts, the model 1 DVP is achieved through the interface between the JASDEC's systems and the BOJ-NET FTS. In DVP settlement of exchange-traded stocks, the model 3 DVP is achieved by the use of the JSCC. The JSCC, which calculates net securities and cash positions of the participants, directly participates in the JASDEC's system for stocks, and uses a network of cash settlement banks including the Bank of Japan for money settlement (see 1.2 for details). In DVP settlement of off-exchange traded stocks, the model 2 DVP is achieved by the use of the JDCC. The JDCC, which calculates securities (gross) and cash (net) positions of the participants, directly participates in both the JASDEC's system and the BOJ-NET FTS to achieve DVP settlements (see 1.3 for details).

### **3.1 Foreign Exchange Yen Clearing System (FXYCS)**

The FXYCS is an LVPS for foreign exchange transactions which operates in RTGS and DNS modes. In the FXYCS, money settlements for both RTGS and DNS modes are conducted in central bank money using the system participants' current accounts at the Bank of Japan.

The FXYCS requires its participants to provide collateral (JGBs or cash) to cover the system's exposure. The Tokyo Bankers Association (TBA), the operator of the FXYCS, holds

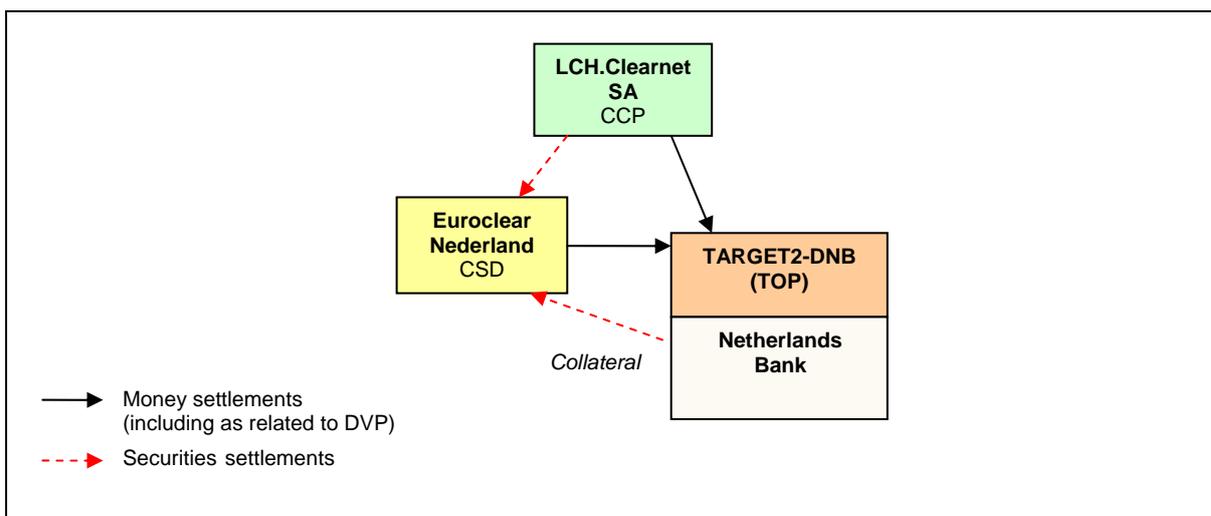
JGB and cash accounts with the Bank of Japan and has direct access to the BOJ-NET FTS and BOJ-NET JGB Services to accept collateral.

### **3.2 Zengin System**

The Zengin System is an LVPS for both customer and interbank transactions. In the Zengin System, money settlements (adjustments of the participants' positions) are conducted in central bank money. The Bank of Japan acts as the cash settlement agent for the System, and conducts net settlement across the system participants' current accounts held at the Bank of Japan.

The Zengin System requires its participants to provide collateral (JGBs, non-JGB bonds, stocks or cash) to cover their net debit positions. For the acceptance of collateral, TBA, the operator of the Zengin System, holds JGB and cash accounts with the Bank and has direct access to the BOJ-NET FTS and BOJ-NET JGB Services. For the same purpose, the TBA has direct access to the JASDEC's systems for stocks and non-JGB bonds.

## Netherlands<sup>41</sup>



### 1. LCH. Clearnet SA (subsidiary of LCH.Clearnet Group)

LCH.Clearnet initiates settlement of Euronext Amsterdam securities transactions. Information on the net positions of its clearing members is sent by LCH.Clearnet to Euroclear Nederland. The latter checks and conditionally transfers the securities involved. Next, Euroclear Nederland instructs the Netherlands Bank (DNB) with a cash transaction, and cash settlement takes place in the books of DNB, where the TOP account of LCH.Clearnet and the clearing members are credited/debited. Completion of the cash leg of the securities transaction is confirmed to Euroclear Nederland and its securities booking becomes definite. LCH.Clearnet is a direct participant in TOP and also has an account at Euroclear Nederland, which is necessary for DVP securities settlement.

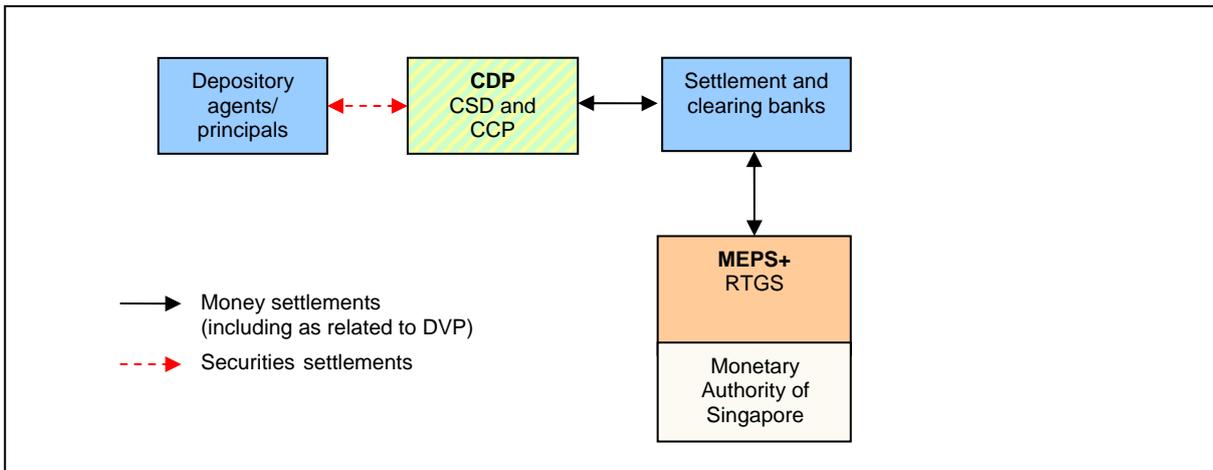
### 2. Euroclear Nederland (subsidiary of Euroclear SA)

By far the largest part of cash settlements of securities transactions takes place in central bank money. DVP model 3 is used for those transactions cleared via LCH.Clearnet SA. DVP model 1 is used for OTC securities transactions via the interfaced model. These transactions, for which market participants send receipt and delivery instructions directly to Euroclear, can be settled at DNB any time during the day. Settlement of securities transactions which are cleared via LCH.Clearnet happens three times a day.

Euroclear Nederland has a TOP account, which is used for corporate actions and the like, related to the collective DNB collateral account at Euroclear Nederland. For access to DNB credit facilities, the direct participants in TOP generally have collateral accounts at DNB as well, via the collective DNB account in Euroclear Nederland.

<sup>41</sup> See note on TARGET in Annex 1, Belgium.

# Singapore



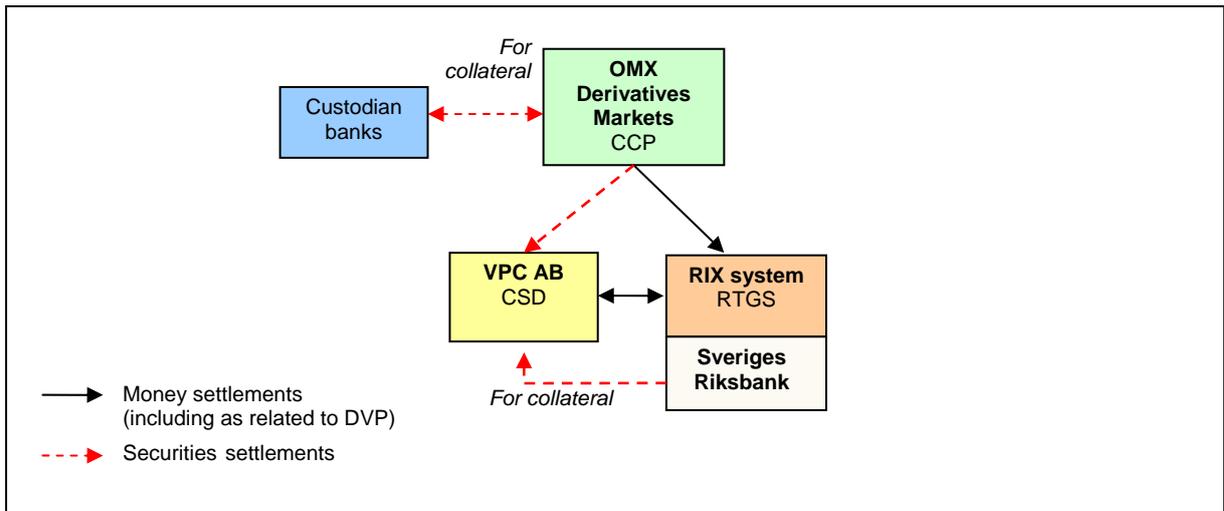
## 1. CDP

The Central Depository (Pte) Ltd (CDP), a wholly owned subsidiary of the Singapore Exchange (SGX), operates the clearing house and the central securities depository for the securities market.

For inter-broker settlement, money settlement occurs in commercial bank money with several settlement banks. Netted amounts within each settlement bank are transferred to CDP's clearing bank via MEPS+ (RTGS).

CDP adopts DVP (model 2) with a slight variation, in that the gross settlement of the securities follows the net settlement of funds. For institutional investors, most trades are settled on a DVP basis, in either SGD or USD, depending on the transacted currency. The net flows among the settlement banks occur through MEPS+ via the clearing bank.

## Sweden



### 1. OMX Derivatives Markets

OMX Derivatives Markets (OMX DM) provides central counterparty clearing services for derivatives denominated in SEK, DKK, NOK, EUR and ISK. The great majority of cash settlement is in SEK, and OMX DM settles those transactions as a direct member in the Swedish RTGS system, the RIX system.<sup>42</sup>

For the collection of collateral and margins, OMX DM's participants choose a custodian institution from the list of institutions approved by OMX DM. For delivery of Swedish securities, OMX DM has an account in VPC AB, the Swedish CSD.<sup>43</sup>

### 2. VPC AB

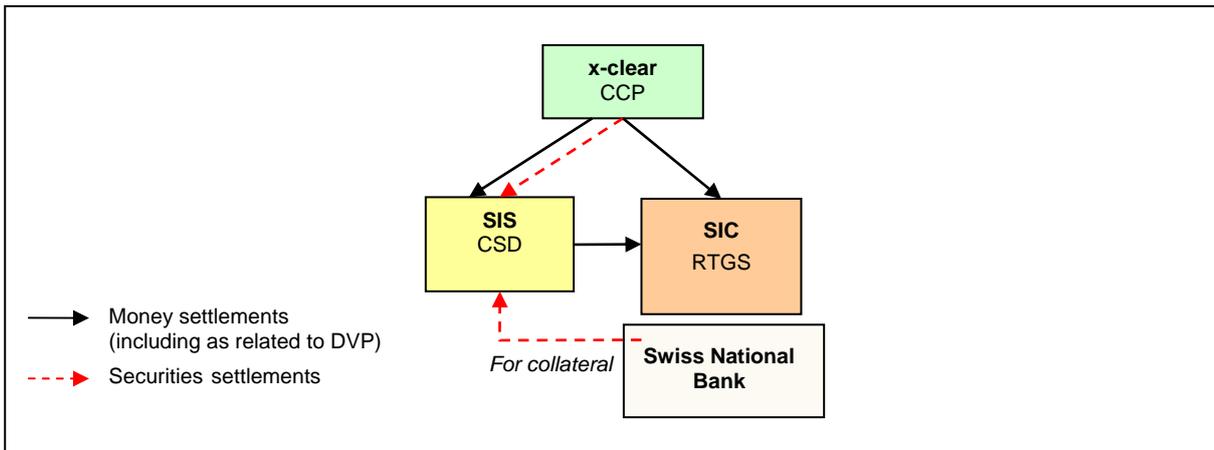
VPC AB offers DVP model 1 settlement in central bank money. The cash leg of the transactions is settled through central bank accounts for securities settlement which are administered by VPC AB (an integrated model). Liquidity can be transferred back and forth between the RIX system and VPC AB during the settlement day, but the accounts are emptied at the end of the day. VPC AB also administers intraday credit on those cash accounts according to the terms and conditions set by the Riksbank.

The collateral which is pledged to the Riksbank for intraday credits in the payment system is held in VPC AB. VPC sends information about the collateral held to the Riksbank's collateral management system, which processes the information and then can adjust participants' credit limits.

<sup>42</sup> It is also a direct participant in the Danish RTGS system for settlement in DKK. OMX DM does not have a membership but instead employs a settlement bank for the TARGET system and the Norwegian and Icelandic RTGS systems.

<sup>43</sup> Deliveries of Finnish, Norwegian, Danish and Icelandic securities take place in each country's CSD.

## Switzerland



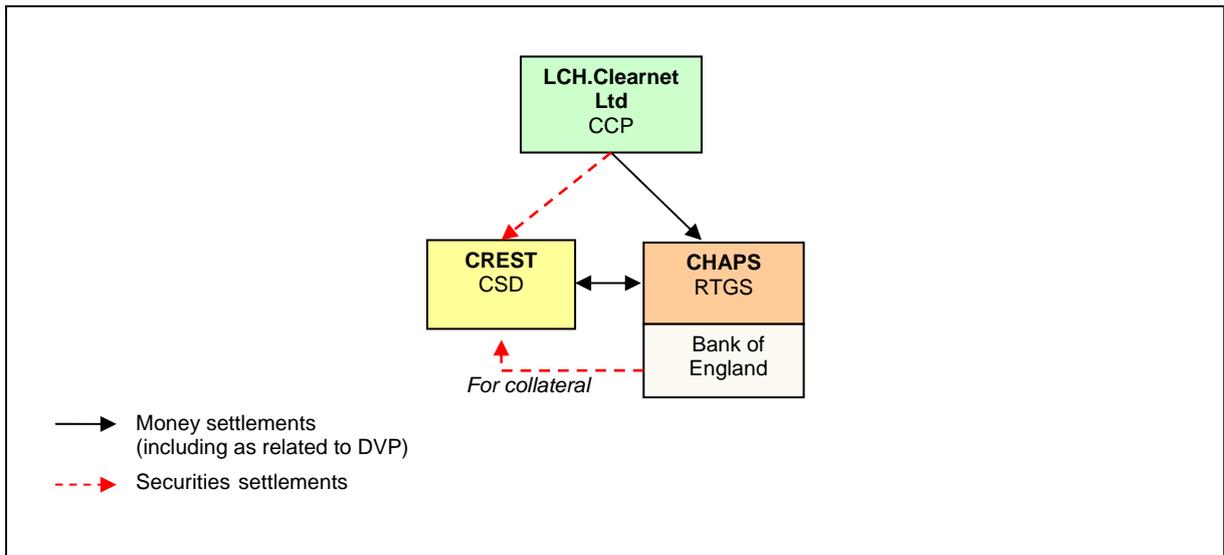
### 1. SIS x-clear

CHF settlements are conducted via SIC or in commercial bank money (eg on the participants' accounts at SIS SegalInterSettle). Other currencies are settled in commercial bank money only. Securities settlements are settled directly via SIS SegalInterSettle, CREST and Euroclear in case of physical delivery obligations. Collateral transfers to the central bank (repo transactions) and other collateral transfers such as for margin requirements or default fund purposes are currently held at SIS SegalInterSettle only.

### 2. SIS SegalInterSettle

SIS SegalInterSettle operates a real-time DVP model 1 system. Central bank money settlement is conducted on the basis of an interfaced model. However, settlement can occur in both via SIC in central bank money and via participants' accounts at SIS SegalInterSettle in commercial bank money.

## United Kingdom



### 1. LCH.Clearnet Ltd

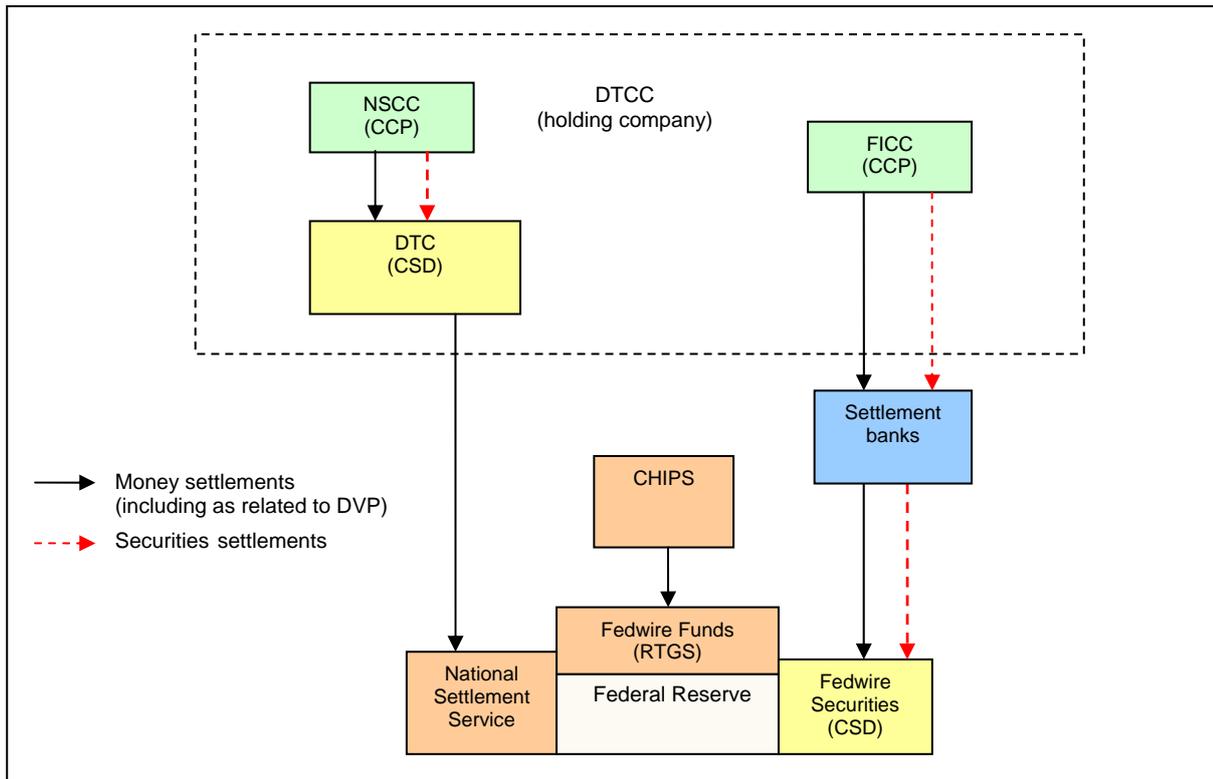
GBP and EUR settlements occur in central bank money. USD settlement flows, which are the largest in absolute value, use commercial bank money for settlement. For GBP and EUR, LCH is not a direct or indirect participant. The Bank of England is the banker to the system. [need physical settlement of securities in CREST (direct, indirect, etc)]

### 2. CREST

CREST provides RTGS in central bank money for GBP and EUR settlement (DVP model 1) by linking with the Bank of England's RTGS system. Settlement in CREST takes place (with finality) in a series of settlement cycles using liquidity earmarked (frozen) in dedicated accounts in RTGS. Inter-settlement bank obligations arising from these transactions (recorded on memorandum accounts in CREST) are applied in RTGS at the end of each cycle. This arrangement represents a hybrid between the integrated and interfaced models.

Banks can transfer liquidity between their CREST settlement accounts and their (CHAPS) payment accounts at the end of each cycle (ie approximately 200 times per day). USD settlement in CREST is supported by end-of-day bilateral net settlement between commercial correspondent banks in the United States.

## United States



### 1.1 Fixed Income Clearing Corporation (FICC) – Government Securities Division (GSD)

Money settlement of securities transactions cleared by FICC-GSD occurs either on the books of a clearing bank or between a clearing bank and another depository institution using the Fedwire Securities Service (through accounts held by clearing banks and other depository institutions with a Reserve Bank). FICC-GSD is not a direct participant in the Fedwire Funds Service and does not have an account with a Reserve Bank.

The Federal Reserve Banks, through their Fedwire Securities Service, act as the CSD for government securities and many mortgage-backed securities. FICC-GSD accesses the Fedwire Securities Service indirectly through two clearing banks. Securities settlement occurs either on the books of a clearing bank or between a clearing bank and another depository institution using the Fedwire Securities Service (through accounts held by clearing banks and other depository institutions with a Reserve Bank).

### 1.2 National Securities Clearing Corporation (NSCC)

Settlement in central bank money occurs indirectly through an account held by the Depository Trust Company (DTC) with a Reserve Bank. DTC uses the Federal Reserve's National Settlement Service for net settlement of participants' NSCC and DTC money positions. NSCC is a direct participant in DTC.

### 2.1 Fedwire Securities Service (Federal Reserve Banks)

The Fedwire Securities Service, owned and operated by the Federal Reserve Banks, is a model 1 DVP system settling in central bank money. Both securities and money settlement are conducted by the Fedwire Securities Service (there is no link with the RTGS for money

settlement). However, the cash accounts for DVP securities settlement are the same accounts used by the RTGS system.

## **2.2 Depository Trust Company (DTC)**

DTC is a model 2 DVP system that settles in central bank money. Securities settlement occurs on the books of DTC as the CSD for corporate securities, money market instruments, and state and municipal government securities. For money settlement, DTC is a direct participant in the Federal Reserve's National Settlement Service, which provides multilateral net settlement in central bank money.

## **3. Clearing House Interbank Payments System (CHIPS)**

CHIPS settles in commercial bank money supported by funding in central bank money. Payments between participants on CHIPS, which are submitted to and stored in a central system queue, are settled on the books of CHIPS throughout the day. Before any of a participant's payments can settle, however, the participant must transfer a set amount of initial funding via the RTGS system into an account at a Federal Reserve Bank. Initial funding provided by participants generally cannot be removed during the day. However, participants may provide additional funding intraday (supplemental funding) to facilitate the settlement of queued payments and may transfer this liquidity out of CHIPS under certain conditions. At the end of the day, there is another round of funding via the RTGS system to enable settlement of any remaining payments in the queue, and then payouts to participants with credit balances are made via the RTGS system.

## Annex 2: Cross-currency CCP-to-CCP links

As listed in the following table, there are currently seven horizontal CCP links operating between CPSS countries. Three of these links primarily support securities markets, while five support derivatives markets. The 1997 CPSS report *Clearing arrangements for exchange-traded derivatives* (the ETD report) explains the numerous operational forms used to facilitate horizontal CCP links. In general, those links that support securities clearing broaden the pool of institutions able to participate in a specific market without those institutions becoming members of two CCPs. In contrast, the links supporting derivatives clearing generally facilitate the listing of eligible derivatives on multiple trading platforms, allowing longer trading hours and deeper market liquidity for the eligible instruments.

### CCP-to-CCP links among CPSS countries

| Central counterparty | Central counterparty                 | Instruments  |
|----------------------|--------------------------------------|--|
| LCH.Clearnet SA      | CCG                                  | Italian government bonds   |
| CDS                  | NSCC                                 | DTC eligible   |
| LCH.Clearnet Ltd     | x-clear                              | SWX Europe eligible  |
| LCH.Clearnet Ltd     | OMX Derivatives Markets <sup>1</sup> | OMX eligible   |
| SGX                  | CME                                  | Eurodollar, euroyen Libor, euroyen Tibor and Japanese government futures |
| CCorp                | Eurex Clearing AG                    | US Futures Exchange (formerly Eurex US) eligible                         |
| LCH.Clearnet Ltd     | TFX                                  | Euroyen futures  |

<sup>1</sup> OMX Derivatives Markets also has a link to VPS Clearing ASA, the Norwegian CCP for the clearing of OMX eligible securities for participants in Oslo, Stockholm and London.

All identified horizontal CCP links occur on a cross-border basis; only the LCH.Clearnet SA and CC&G link occurs within the same currency zone, while all others result in at least one of the two linked CCPs having money settlement procedures in at least two currencies.

While most of the derivatives-related links have existed for some time, all three of the securities clearing links are relatively new. The link between LCH.Clearnet Ltd and x-clear, for example, was established in 2003 to support the clearing of the SWX Europe exchange, a London-based cross-border trading platform upon which many Swiss and other pan-European blue-chip stocks are traded.<sup>44</sup> The link between CC&G (the Italian counterparty) and LCH.Clearnet SA (CCP for the Belgian, Dutch and French markets) to clear Italian government bond trades, originally formed in 2004, was expanded in 2006 to cover additional trading platforms. Both of these links led to the development of inter-CCP obligations which create exposures and require settlement.

In 2006, CDS – the Canadian CCP and CSD – began to sponsor its members' participation in NSCC, the CCP for corporate and equity securities in the United States. As a sponsoring

<sup>44</sup> This relationship will also to be expanded in the future to cover transactions in the London Stock Exchange.

member, CDS does not develop its own positions against NSCC, but instead plays an operational and risk management role with respect to its members' NSCC positions. As a result, CDS may be viewed as having a type of contingent obligation to NSCC in the event that a CDS-sponsored NSCC participant defaults.

These three securities-related links are used on a regular basis, and some process relatively large volumes. For example, nearly 50% of all SWX Europe trades are processed through the x-clear/LCH.Clearnet Ltd link. In 2006, CC&G and LCH.Clearnet SA guaranteed more than 60% of the deals struck in the wholesale market for Italian government bonds (MTS). The CDS/NSCC link is the primary method by which several Canadian banks conduct their cross-border clearing and settlement obligations for DTC eligible securities.

In contrast, while several of the derivatives-related links are used on a regular basis, the volume of transactions processed through these links appears to be limited relative to total activity in the linked systems.

## **Annex 3: CSD-to-CSD links**

In CSD-to-CSD links, one (I)CSD, known as the investor (I)CSD provides its participants with various custody and settlement services for securities issued by another (I)CSD, known as the issuing (I)CSD. CSD-to-CSD links take various forms which typically correspond to the different functions they serve. Some links operate only on a free of payment basis, while others operate on a delivery versus payment basis.

The attached tables only list “direct” links between two CSDs. There are many other links that involve different forms of intermediation by financial institutions. For example, some investor (I)CSDs rely upon the services of a custodian bank to access the issuing (I)CSD (an indirect link), or rely upon the services of a third system to access the issuing (I)CSD (a relayed link). Even if an investor (I)CSD is a direct participant in the issuing (I)CSD, it can rely on the operational processes of a financial institution (ie so-called operated links).

As listed in the attached tables, the working group has identified a large number of direct, cross-border (I)CSD-to-(I)CSD links. While there are many CSD-to-CSD links, available information and anecdotal evidence indicates that only a very small number of links exhibit any significant settlement volumes. Roughly 60,000 securities transactions settle through the CDS/DTC “New York Link” on a daily basis. In interviews conducted for this report, some Canadian banks indicated that this service was the primary method by which they conducted settlement for US securities. For Clearstream Banking Luxembourg and Euroclear Bank, roughly 64% and 84% of settlement activity, respectively, occurs within these ICSDs (internal settlement). The remainder of settlement occurs externally via all forms of links (eg the Euroclear Bank/Clearstream Banking Luxembourg “bridge” as well as other direct, indirect and relayed links). Some links with lower levels of activity are nonetheless important for supporting larger settlement values internalised at the investor (I)CSD.

### **Tables of selected links**

Table 1 lists the direct CSD-to-CSD links in CPSS countries, excluding those between two euro area countries (see Table 2) and excluding those related to CBL, Euroclear Bank and SIS (see Table 3).

As noted in Section 3 of the report, many different CSD-to-CSD links have been established within the euro area, some of which are approved to support ECB credit operations.<sup>45</sup> Table 2 lists links between the CSDs of CPSS countries within the euro area, excluding those involving Euroclear Bank or Clearstream Banking Luxembourg. While there are a large number of links, most collateral used in support of ECB credit operations is delivered through the correspondent central bank model (roughly 80%), and not via link arrangements. Moreover, the 20% of cross-border collateral delivered via links is very concentrated in a small number of links.

As also mentioned in the main report, three different (I)CSDs provide access to a very large number of other (I)CSDs. These entities, Clearstream Banking Luxembourg (CBL), Euroclear Bank and SIS SegalInterSettle, primarily rely upon relationships with local agents in order to act as investor CSDs for securities held in other issuer CSDs. However, in some cases, they

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<sup>45</sup> See [www.ecb.int/paym/coll/coll/ssslinks/html/index.en.html](http://www.ecb.int/paym/coll/coll/ssslinks/html/index.en.html) for a current list of eligible links.

maintain direct relationships with issuer CSDs. The direct links of CBL, Euroclear Bank and SIS are listed in Table 3.

Table 1

**Direct CSD-to-CSD links**

All CPSS CSDs as investors or issuers,  
excluding intra-euro, CBL, Euroclear Bank and SIS

| <b>Investor CSD<br/>(country if outside CPSS)</b> | <b>Issuing CSD<br/>(country if outside CPSS)</b> | <b>DVP (yes/no)</b> |
|---|--|---------------------|
| JASDEC  | CBF  | No                  |
| DTC   | CDS  | Yes                 |
| JASDEC  | CDS  | No                  |
| CDP   | China  | No                  |
| VPC   | CREST  | No                  |
| CDS   | CREST  | Yes                 |
| VPC   | Denmark  | No                  |
| Argentina   | DTC  | No                  |
| CBF   | DTC  | No                  |
| CDP   | DTC  | No                  |
| CDS   | DTC  | Yes                 |
| CREST   | DTC  | No                  |
| Israel  | DTC  | No                  |
| JASDEC  | DTC  | No                  |
| Monte Titoli                                      | DTC  | No                  |
| Peru  | DTC  | No                  |
| CDS   | Euroclear France                                 | No                  |
| CREST   | Euroclear Netherlands                            | No                  |
| VPC   | Finland  | No                  |
| Euroclear France                                  | Morocco  | No                  |
| JASDEC  | Korea  | No                  |
| Denmark   | VPC  | No                  |
| Finland   | VPC  | No                  |

Table 2  
**Direct CSD-to-CSD links<sup>1</sup>**

Links involving the CSDs of euro area CPSS countries

| Investor CSD        | Issuing CSD         | DVP (yes/no) |
|---------------------|---------------------|--------------|
| CBF                 | APK                 | No           |
| Euroclear France    | APK                 | No           |
| APK                 | CBF                 | No           |
| Euroclear Belgium   | CBF                 | No           |
| Euroclear France    | CBF                 | No           |
| Euroclear Nederland | CBF                 | No           |
| Iberclear/CADE      | CBF                 | No           |
| Monte Titoli        | CBF                 | No           |
| OeKB                | CBF                 | No           |
| CBF                 | Euroclear Belgium   | No           |
| Euroclear France    | Euroclear Belgium   | No           |
| Euroclear Nederland | Euroclear Belgium   | No           |
| CBF                 | Euroclear France    | No           |
| Euroclear Belgium   | Euroclear France    | No           |
| Euroclear Nederland | Euroclear France    | No           |
| Monte Titoli        | Euroclear France    | No           |
| CBF                 | Euroclear Nederland | No           |
| Euroclear Belgium   | Euroclear Nederland | No           |
| Euroclear France    | Euroclear Nederland | No           |
| Monte Titoli        | Euroclear Nederland | No           |
| CBF                 | Iberclear/CADE      | No           |
| Euroclear France    | Iberclear/CADE      | No           |
| Euroclear Nederland | Iberclear/CADE      | No           |
| Monte Titoli        | Iberclear/CADE      | No           |
| Euroclear France    | Iberclear/SCLV      | No           |
| Euroclear Nederland | Iberclear/SCLV      | No           |
| Monte Titoli        | Iberclear/SCLV      | No           |
| CBF                 | Monte Titoli        | No           |
| Euroclear France    | Monte Titoli        | No           |
| Euroclear Nederland | Monte Titoli        | No           |
| Iberclear/CADE      | Monte Titoli        | No           |
| OeKB                | Monte Titoli        | No           |
| Euroclear France    | NBB SSS             | No           |
| CBF                 | OeKB                | Yes          |
| Euroclear France    | OeKB                | No           |
| Euroclear Nederland | OeKB                | No           |
| Monte Titoli        | OeKB                | No           |

<sup>1</sup> Following the consolidation of the settlement platforms for the Euronext markets, links among different CSDs within the Euroclear group will cease to exist. For Euroclear Belgium and Euroclear Nederland, existing links for non-ESCB eligible securities will be rationalised via Euroclear Bank, except the link between Euroclear Nederland and Euroclear UK & Ireland (CREST). For ESCB eligible securities, Euroclear France will maintain its links with other local CSDs.

Table 3

**Direct links to and from CBL, Euroclear Bank and SIS**

| <b>Investor CSD</b>   | <b>Issuing CSD</b>    | <b>DVP (yes/no)</b> |
|-----------------------|-----------------------|---------------------|
| Euroclear France      | CBL                   | No                  |
| Monte Titoli          | CBL                   | Yes                 |
| CMU/HKMA              | CBL                   | Yes                 |
| CBF                   | CBL                   | Yes                 |
| CBL                   | Euroclear Netherlands | Yes                 |
| CBL                   | Monte Titoli          | Yes                 |
| CBL                   | NBB SSS               | Yes                 |
| CBL                   | OeKB                  | Yes                 |
| CBL                   | CREST                 | Yes                 |
| CBL                   | CBF                   | Yes                 |
| Euroclear France      | Euroclear Bank        | No                  |
| Monte Titoli          | Euroclear Bank        | Yes                 |
| Euroclear Belgium     | Euroclear Bank        | Yes                 |
| Euroclear Netherlands | Euroclear Bank        | No                  |
| CREST                 | Euroclear Bank        | No                  |
| CMU/HKMA              | Euroclear Bank        | Yes                 |
| SIS                   | Euroclear Bank        | Yes                 |
| VPC                   | Euroclear Bank        | Yes                 |
| Euroclear Bank        | CBF                   | Yes                 |
| Euroclear Bank        | CREST                 | Yes                 |
| Euroclear Bank        | Euroclear Belgium     | Yes                 |
| Euroclear Bank        | Euroclear France      | Yes                 |
| Euroclear Bank        | Euroclear Netherlands | Yes                 |
| Euroclear Bank        | Monte Titoli          | Yes                 |
| Euroclear Bank        | NBB SSS               | Yes                 |
| Euroclear Bank        | OeKB                  | Yes                 |
| Euroclear Bank        | VP                    | Yes                 |
| CBF                   | SIS                   | Yes                 |
| CREST                 | SIS                   | Yes                 |
| DTC                   | SIS                   | No                  |
| Euroclear Belgium     | SIS                   | No                  |
| Monte Titoli          | SIS                   | No                  |
| VPC                   | SIS                   | No                  |
| SIS                   | OeKB                  | Yes                 |
| SIS                   | CBF                   | Yes                 |
| SIS                   | CREST                 | Yes                 |
| SIS                   | Euroclear Belgium     | No                  |
| CBL                   | Euroclear Bank        | Yes                 |
| CBL                   | SIS                   | Yes                 |
| Euroclear Bank        | CBL                   | Yes                 |
| SIS                   | CBL                   | Yes                 |
| SIS                   | Euroclear Bank        | Yes                 |

## **Annex 4: Global banking group scenario analysis**

This annex summarises the global banking group scenario analysis conducted by the working group. The objective of the study was to analyse the role of a global banking group in creating interdependencies among systems, and how those and other interdependencies would function to transmit various disruptions.<sup>46</sup>

In conducting this scenario analysis, the working group considered the potential effects of two hypothetical shocks originating in a global banking group – one operational and the other financial in nature. Both scenarios use a fabricated profile of a global banking group that is very active in the payment and custody businesses, drawing on the working group’s fact-finding.

The scenario of an operational disruption is based on a technical disruption to the global banking group’s funds transfer function, along with the unavailability of primary backup systems. For the financial disruption, the scenario is based on a downgrade of the global banking group’s credit rating to below investment grade. These triggering actions were chosen in order to produce impacts sufficiently large as to illuminate the role of interdependencies in transmitting financial disruptions. Both scenarios consider how the initial disruption further affects the settlement of (i) foreign exchange trades, (ii) securities and money market trades, and (iii) other large-value funds transfers, as well as the associated implications within key LVPSs, SSSs and CCPs. The analyses first identify the direct, automatic (or locked-in or unavoidable) impacts of the scenario, and then project subsequent second-round effects, as well as potential mitigating factors.

### **Operational scenario**

#### **First-round effects (step 1)**

In this scenario, the smooth functioning of several large-value payment systems could be directly affected. In particular, the stricken bank could act as a “liquidity sink” in several systems as it continues to receive funds from other parties but cannot send funds out, thereby accumulating account balances. In this situation, the amount of credit risk borne by other banks intraday, and potentially overnight, could grow substantially as they try to complete their settlement activities despite another bank’s operational problem. These payment systems could face some risk of partial gridlock as other system participants’ access to intraday credit becomes constrained, either due to insufficient collateral or explicit limits. The payment flows of banks’ customers might also be constrained by intraday credit limits.

#### **Second-round effects (step 2)**

There is some potential that other systems, such as CLS, CSDs or CCPs, could also be affected in this scenario. However, most large-value payment systems have contingency arrangements that would allow the afflicted global banking group to make a small number of

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<sup>46</sup> This study primarily serves as an analytical tool and should not be construed as CPSS central banks’ predictions regarding the impact of any actual events. As noted in the main report, the severity of actual disruptions is difficult to predict and could vary substantially from the outcomes anticipated in the analysis.

time-critical payments via alternative arrangements such as “offline” facilities. In addition, other system participants would probably be able to prioritise time-sensitive payment and settlement obligations, even in the light of potential gridlock within the RTGS systems. In addition, correspondents, nostro banks and settlement banks should recognise the operational outage for what it is and meet most of a stricken global banking group’s cash obligations to CSDs and other systems. As a result, the analysis projects that other systems should be operating more or less normally. In contrast, however, FX transactions that are settled outside of CLS and securities or money market transactions that are settled outside a CSD may be more impaired than those settled within those systems. For example, both legs of an FX trade and the cash leg of securities and MMI transactions would be settled gross with individual funds transfers settled in a large-value payment system, potentially via a correspondent. The stricken bank’s manual processing arrangements might not be sufficient to complete a large number of individual transactions. For other system participants, these transactions might be more subject to gridlock than the few critical payments made to other systems.

In summary, the second-round effects of an operational shock appear to be manageable. But it is important to point out that this analysis rests heavily on the assumption that contingency arrangements are effective, and that the operational problem occurs in an otherwise benign environment. If the environment is not in fact benign, as in the latter half of 2007, an operational shock could precipitate larger and potentially disruptive impacts through system interdependencies. The diagram below depicts the operational outage scenario.

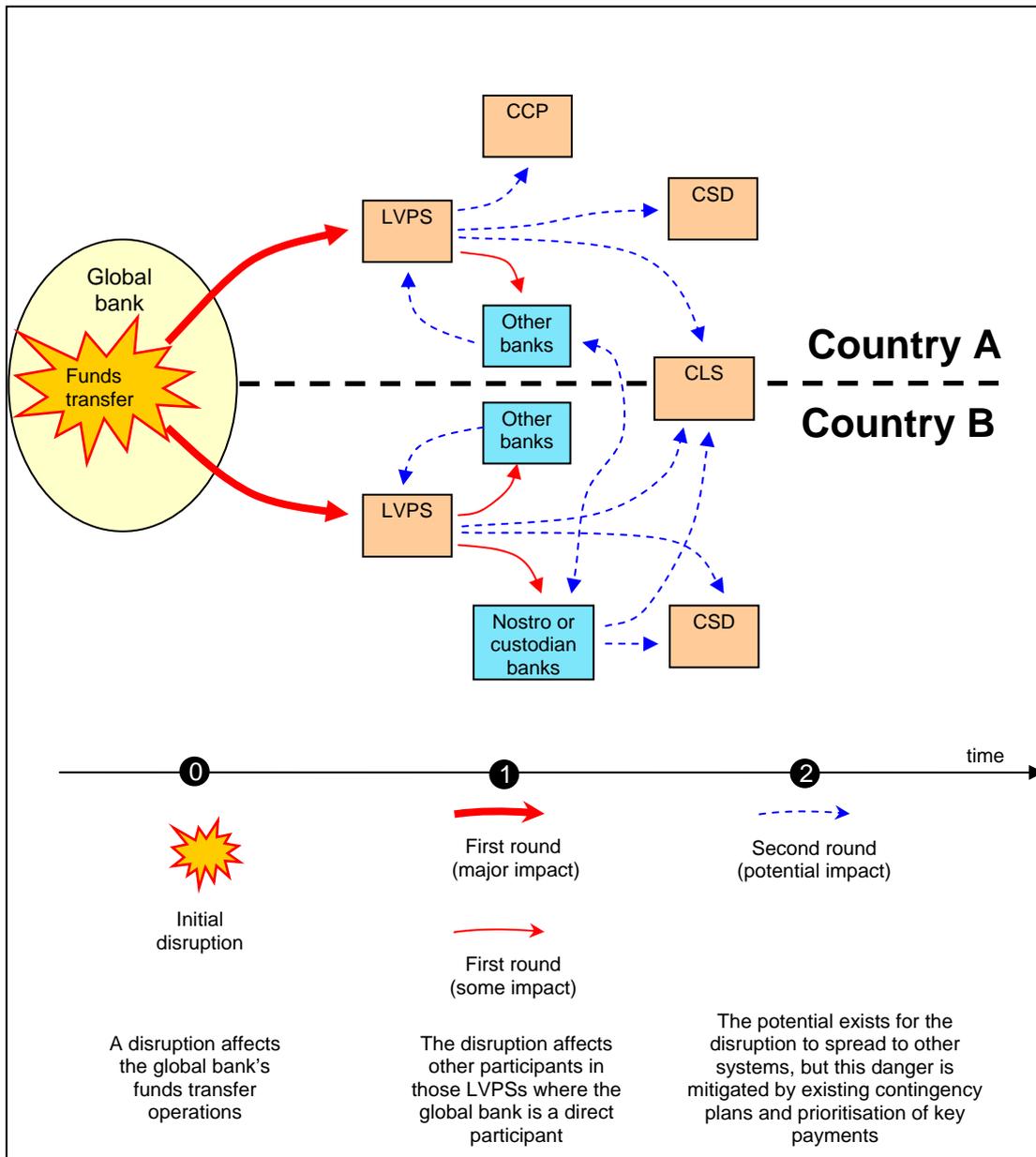
## **Financial shock**

In the financial scenario, a global banking group could face a great deal of liquidity and collateral pressure as counterparties attempt to control their exposure to the afflicted bank. As with the operational scenario, large-value payment systems appear to be at some risk of going into partial gridlock. The source of the problem is entirely different, however, as other system participants deliberately hold back funds transfers to the afflicted bank. CLS, CSDs and CCPs should be operating normally as long as a global banking group could prioritise its liquidity needs and meet cash obligations to these systems.

It is difficult to predict, however, what steps CCPs, CSDs and other systems – or correspondents and custodians – might take to protect themselves. But many or all systems, correspondents and custodians might take strong actions once a global banking group fails to meet a financial obligation to a system (even if it is to another system) or one system takes action that is automatically triggered. This could compound the potential gridlock within RTGS systems. The pressure could be intensified by the global banking group’s much reduced capacity to fund itself in the wholesale market.

It is important to point out again that the analysis rests heavily on the assumption that the shock occurs in an otherwise benign environment. If the environment is unfavourable, the shock could precipitate larger and potentially disruptive impacts through system interdependencies.

**Possible transmission paths:  
global banking group scenario analysis**



## **Annex 5: Members of the working group**

This report was produced for the CPSS by the working group on system interdependencies.

|   |  |
|---|--|
| Chairman  | Denis Beau<br>Bank of France   |
| National Bank of Belgium                            | Benoît Bourtembourg (until December 2006)<br>Kris Bollen (since December 2006) |
| Bank of Canada                                      | Nikil Chande   |
| European Central Bank                               | Ignacio Terol (until December 2006)<br>Simonetta Rosati (since December 2006)  |
| Bank of France                                      | Frédéric Hervo<br>Fabien Renault   |
| Deutsche Bundesbank                                 | Klaus Edelmann<br>Dirk Schrade<br>Sylvia Tyroler                               |
| Hong Kong Monetary Authority                        | Stephen Pang   |
| Bank of Italy                                       | Corrado Baldinelli<br>Paola Masi   |
| Bank of Japan                                       | Takashi Hamano   |
| Netherlands Bank                                    | Carlo Winder   |
| Monetary Authority of Singapore                     | Chek-Tchung Foo  |
| Sveriges Riksbank                                   | Jan Schüllerqvist (until December 2006)<br>Felice Marlor (since December 2006) |
| Swiss National Bank                                 | Thomas Nellen<br>Francesco Re (until December 2006)                            |
| Bank of England                                     | George Speight (until May 2007)<br>Ana Lasaosa (since May 2007)                |
| Board of Governors of the<br>Federal Reserve System | Jeffrey Marquardt<br>Jeff Stehm<br>Lyndsay Huot                                |
| Federal Reserve Bank of New York                    | Lawrence Radecki   |
| Basel Committee on Banking Supervision              | Karl Cordewener  |
| <i>Secretariat</i>                                  |  |
| Bank for International Settlements                  | Douglas Conover  |

Significant contributions were also made by Joanna Shi (Hong Kong Monetary Authority), Pierangela Soda, Giovanna Cicardo and Luigi Sciusco (Bank of Italy), Megumi Takei (Bank of Japan), Simon Debbage and Will Speller (Bank of England).