

Volume on the economics of payments

Introduction

The Bank of England has devoted considerable resource over the past few years to the study of the Economics of Payments. Much of this research has been published separately, but to date there has been no attempt to synthesise and draw together key insights from the various strands of work undertaken beneath this banner. This volume seeks to offer just such a synthesis, but in the context of a comprehensive overview of issues around central banks' roles in payment systems; the risks on which central banks focus in their oversight activities; and the challenges central banks face as the payments and settlements landscape evolves.

The Economics of Payments is a multi-disciplinary field, taking in branches of economics such as monetary theory, search theory, game theory and industrial organisation. It also draws on techniques from network theory and makes extensive use of simulation studies to model complex interactions between payment system members. For each of the topics covered, this volume highlights some of the most influential works in the literature, in many cases also offering the more academic reader a summary of the modelling approach adopted as well as the key insights. The volume also draws heavily on empirical insights, in particular applying a historical context to central banks' involvement in payment systems.

We hope that this book will appeal to a wide audience, including fellow policymakers, practitioners – either users or providers of infrastructural services – and non-specialist academic economists and students. Not only do we hope it will offer a good reference text, but also that it will stimulate active debate and encourage additional research in this important field.

Evolution of the role of central banks in payment systems

The Bank for International Settlements defines a payment system as 'a set of instruments, banking procedures and, typically, interbank funds transfer systems that ensure the circulation of money.'¹ Such systems developed in the context of the broader evolution of money and banks and, eventually, central banks. In **Part I** of

¹ CPSS (2003) *A glossary of terms used in payments and settlement systems*, <http://www.bis.org/publ/cpss00b.pdf>.

this volume, we explore this evolution, describing how central banks came to assume a role at the apex of the payments pyramid, and how this early role as provider of the ultimate settlement asset laid the foundation for the role as guardian of monetary and financial stability that central banks typically assume today.

The bulk of money in the economy today exists in the form of bank deposits.

Therefore, to understand how ownership of such deposits is transferred. The early banks emerged from the business of moneychangers and goldsmiths. For instance, in thirteenth century Venice, there was a wide variety of coins in circulation, of varying quality levels. Moneychangers developed a specialist role in the valuation of specie, which over time expanded into deposit-taking activity and the provision of payment services: transactions between merchants could then be settled across the books of the moneychangers, or by the transfer of moneychangers' deposit receipts. This obviated the need to carry, count out and value coins each time a payment was to be settled.

These early banks thus developed the first arrangements for making payments in-bank; that is, they enabled merchants to make payments to one another on the basis of deposits held with the same bank without having to hand over either specie or depositor receipts (effectively bank-notes). Over time, so as to effect transfers between customers of different banks, the banks started accepting claims on each other. Millard and Willison (2006), building on work by He, Huang and Wright (2005), explore this evolution theoretically, demonstrating that the emergence of a payment system is an equilibrium outcome if the system is sufficiently reliable and cheap to use, and if the expected cost of theft of cash is high.

Once banks started building up claims on each other, they needed, at some point, to be able to settle these claims. Such 'final settlement' had to occur via the transfer of an asset that the creditor bank was happy to accept: the ultimate settlement asset. At first, banks started settling interbank claims using specie (i.e., gold and silver coins). But this was in short supply and costly to transport and exchange. This led banks to reduce the costs of settlement by using assets convertible into specie. For example, by the 1770s, London bankers had switched from settling in specie to settling in Bank of England notes, deemed a superior form of settlement asset.

Further efficiency gains could be obtained by settling interbank obligations over the accounts of an institution, rather than by using paper claims. As noted in Norman,

Shaw and Speight (2006), this was sometimes put in place by the public authorities; in other cases it developed naturally, such as when the London bankers switched to using deposits held at the Bank of England as the ultimate settlement asset in 1854, with the Bank of England thereby taking on the role of settlement agent.

Yet the Bank of England of the mid-nineteenth century was still a private bank with private shareholders providing banking services to private companies as well as to the government. At the same time, throughout the nineteenth century, the Bank was repeatedly called upon to support other banks, notably when financial crises threatened the stability of London's financial system. The resulting conflicts of interest prevented it from performing fully the public functions that one associates with a modern central bank. This tension can be observed in some other countries where one private institution had, also during the nineteenth century, evolved to perform settlement - for example, Norway and (arguably) the United States.

Eventually, the conflict could be overcome only by making the central bank a public sector institution: the Bank of England, for instance, was nationalised in 1946. Elsewhere, in countries where no obvious candidate for central bank had emerged (whether through responsibility for settlement or otherwise), there was a general trend during the twentieth century for governments to set up public central banks from scratch.

Once one bank's liabilities – whether its notes or deposits held with it – were established as the ultimate settlement asset, such a bank was in a position to take on the two key central banking functions of ensuring monetary and financial stability. First, the central bank had an incentive to maintain the value of the ultimate settlement asset, doing so by setting the terms on which its liabilities were made available to the banking system. There was therefore a clear synergy between a central bank's roles in providing the settlement asset and promoting monetary stability.

Similarly, there was a link between the provision of the ultimate settlement asset and a central bank's financial stability objective. The provider of the ultimate settlement asset would be able, in times of crisis, to increase the supply of its liabilities to ensure that payments continued to be settled and, under certain circumstances, to prevent the failure of a solvent but illiquid institution. This capability is often described as a central bank's lender of last resort function. But to minimise the frequency with

which it would be required to undertake such action, and hence to minimise any associated costs or risks, the central bank would seek to use its influence to reduce threats to the financial system; that is, it would seek to promote financial stability.

Today, central banks around the world still typically provide the ultimate settlement asset, at least for large-value and wholesale market payments but often for major retail systems also. In many cases, they seek to strengthen their control over monetary and financial stability by also operating key components of the payments infrastructure.

But over time the financial infrastructural landscape has become much deeper, expanding well beyond the domain of central banks. New payment systems and other clearing and settlement infrastructures have emerged, processing particular categories of payments and supporting post-trade processing in particular financial markets.

Indeed, monetary economies have become increasingly dependent upon the existence of this machinery, with values and volumes passing through core infrastructures rising rapidly over time. Central banks have, therefore, taken an active interest, typically via the assumption of an oversight role, in ensuring that the infrastructure is operationally effective, efficient and resilient, and that undue risks are not imposed upon system members and the financial system more generally. That is, they have sought to ensure that the design and operation of the infrastructure itself does not pose a risk to financial, or systemic, stability.

Sources of risk in payments and settlements

But what exactly could go wrong? What risks might arise in the provision of payments and settlements services that pose a threat to systemic stability and to the achievement of a central bank's core objectives? These questions are answered in **Part II** of this volume.

There are two potential sources of systemic risk in payment and settlement systems, where systemic risk is defined as the risk of losses in the wider economy which are not considered by individual system members when they make their decisions.

First, the provision of payment services tends towards concentration and a lack of competition. Along with increasing returns to scale, in what is essentially a fixed cost business, infrastructure provision also exhibits network externalities: the more banks that settle through a particular system, the greater the opportunities for netting and liquidity recycling, and hence the more valuable is membership. This structure

can also lead to ‘single point of failure’ risks: that is, the non-availability of such systems would have widespread effects, and the cost of those effects may not be fully internalised by the monopoly supplier in judgments about, for example, the resources it allocates to ensuring system resilience.

The other variant of systemic risk arises when agents operating within a system are forced to make decisions under increased uncertainty and with unusually impaired information: this risk is a characteristic of the interconnections and strategic interactions between the banks involved and would exist whether or not they were members of a payment system. Where there is a system, however, it is likely to be the channel through which these contagious effects are manifest and features of system design can serve to either exacerbate or mitigate such risks.

These sources of systemic risk may be decomposed into three broad categories: settlement risk; operational risk; and business risk. These may be defined, as follows:

- Settlement risk: the risk of losses arising from failure of settlement to take place with finality as anticipated; this encompasses both credit risk – the risk that a participant in the system defaults on its obligations, imposing direct losses on other members – and liquidity risk – the risk that a participant/participants hold(s) insufficient liquidity in the settlement asset, disrupting the flow of liquidity in the system and leading to delay in or failure of settlement;
- Operational risk: the risk of losses arising from technical failure or other forced interruption to the operations of a payment system (or its core components), or those of its participants;
- Business risk: the risk of losses arising from either suspension (or termination) of a payment system’s (or its core components’) provision of services due to financial pressures.

Sources of settlement risk in payment systems

We first home in on settlement risk, exploring how this risk might manifest itself and identifying where challenges might emerge for a central bank responsible for systemic risk mitigation.

Such risk can be influenced significantly by payment system design and, in particular, the frequency of settlement. Historically, interbank payments have typically been

settled on a net basis. Under this mode of settlement, payment requests received by the banks are collected together over a period of time and the net amounts that the banks owe/are owed are calculated. At the end of the period, the banks settle these net amounts by paying the settlement asset into the system (if they owe) and receiving the settlement asset from the system (if they are owed).

But such systems can transmit individual bank failures more widely. This is because, if payments are credited to customer accounts before final settlement occurs, credit exposures can build up and a failure of one participant in the system can lead to the failure of others. In a ground-breaking simulation study, Humphrey (1985) established significant scope for systemic spillover in the US CHIPS system, which, at that time, settled on a deferred net basis. Subsequent studies, building on this methodology and applying it to other systems, have identified less scope for spillover. Nevertheless, over the past two decades, in part driven by the public sector, there has been a marked shift towards real-time gross settlement (RTGS) of (at least) wholesale, interbank payments. Under RTGS, each individual payment instruction is submitted to the system upon receipt and settled with finality in real time intraday, eliminating interbank credit risk.

RTGS systems do, however, carry risks of their own. In particular, such systems are 'liquidity hungry' relative to net systems. That is, participant banks require more liquidity to settle their payments. Since holding this liquidity may be costly, banks have an incentive to delay non-time-critical payments in the expectation that incoming receipts will provide the liquidity for their outgoing payments. But, if all banks are doing this, then there is a risk of 'gridlock' in the system: the risk that all participants are relying on incoming liquidity, but no-one is in a position (or willing) to make the first payment. This 'intraday liquidity management game' has been the subject of considerable academic and policy interest in recent years, with Angelini (1998) and Bech and Garratt (2003), in particular, highly influential in developing game-theoretic modelling approaches to exploring the implications of such strategic behaviour. New agent-based modelling techniques, such as that described in Galbiati and Soramaki (2007), attempt to combine the relative strengths of game-theoretic and simulation approaches.

Furthermore, to the extent that a large body of payments were delayed until late in the day, the impact of any operational risk that crystallised in the system would be

increased, since there would be greater potential for a large volume of unsettled payments at the end of the day. There could also be dislocation in the end-of-day funding markets as agents await the resolution of uncertainty. Another implication of high liquidity costs may be the by-passing of RTGS systems in favour of either less liquidity-hungry deferred net alternatives or indirect participation (Rochet, 2005).

Settlement risk management in payment systems

So what can the central bank do to ensure that adequate steps are taken to mitigate these risks? We go on to explore some measures that a central bank might take, either via its own payment system risk policy or via its influence on system design (perhaps through its oversight role), to address the sources of settlement risk previously identified.

With RTGS having been adopted widely, it is important that appropriate system design features are incorporated to manage the resultant liquidity burden on banks and prevent either disruption to the flow of liquidity within the system or the diversion of flows to less robust vehicles/systems.

One feature that can help to mitigate liquidity risk is low-cost provision of intraday liquidity by central banks. For example, many central banks lend liquidity to members of their large-value payment systems at a zero intraday interest rate against collateral. They may, in addition, seek to manage the opportunity cost to members of holding such collateral by applying broad eligibility criteria (either in terms of credit-quality, currency or market liquidity). Indeed, with internationally active banks increasingly participating in multiple payment systems, there have been strong industry demands for enhanced arrangements for central bank acceptance of foreign collateral (BIS (2006)).

The imposition of throughput guidelines, examined in detail by Buckle and Campbell (2003), may be another vehicle to ensure that liquidity circulates effectively through the payment system. Under such a regime, the system operator might stipulate that a given percentage of the value of payments should be settled by a given time during the operating day.

The design of the system might also be adapted to reduce the liquidity burden of RTGS, while not compromising materially on credit risk. In this regard, so-called *hybrid* systems have emerged in recent years, with in-built functionality offering the

facility to queue certain outgoing payments until offsetting incoming payments have arrived. Comparing pure RTGS and hybrid systems on the basis of liquidity needs and speed of settlement, Willison (2005) concludes that hybrid systems will tend to outperform as long as the off-setting functionality is available throughout the settlement day.

Finally, where the deferred net mode of settlement is retained, risk-reducing features such as net sender limits and net debit caps can be applied, or alternatively, collateralisation and loss-sharing agreements may be put in place.

Operational and business risk in payment systems

While the literature has tended to focus primarily on settlement risk, it is clear that other sources of systemic risk – namely, operational and business risks – might also be important, particularly with concentrated provision of infrastructure, where single point of failure issues loom large.

The operational capacity of the central infrastructure and/or member settlement banks to process payments in the normal way could be compromised by a number of factors, both internal and external:

- *Internal*: these include technical failures sourced within the system itself or the way in which it is operated.
- *External*: these arise due to problems with a source external to the system and include, *inter alia*, general power failures; problems affecting local transportation arrangements; disruption to telecommunications networks; terrorist action; and natural disasters.

Appropriate technical-level system design, accompanied by sufficiently robust operational procedures, should serve to minimise the likelihood of a failure with a source internal to the system itself. Effective contingency arrangements – back-up facilities; contingency sites etc. – might then reduce the impact of those incidents that do nevertheless occasionally occur. Such contingency measures would typically also be available in the event of operational disruption caused by external factors.

But it is not only the ability of the central system to process payments that is crucial here; the effectiveness of liquidity recycling within the system also relies on uninterrupted operations at the level of the settlement banks. In the extreme, the

inability of a settlement bank to send payments raises the possibility of a ‘liquidity sink’ developing in an RTGS system as available liquidity becomes concentrated on the settlement account of the bank concerned. Intraday, this could cause liquidity shortages elsewhere in the system, which may in turn lead to significant delays to the settlement of payments between the unaffected settlement banks.² The likelihood that a member-level disruption will undermine the effectiveness of liquidity recycling in the system as a whole depends crucially on the structure of the payments network and the behavioural responses of other banks in the system. Recently, a number of simulation studies in the spirit of Bedford, Millard and Yang (2004) have investigated the systemic implications of member-level operational failure in several large-value systems around the world.

It is also important, then, for the individual settlement banks to implement suitable risk controls. As a condition of membership of their economy’s large-value payment systems, central banks typically require settlement banks to comply with certain minimum standards in respect of their internal back-office arrangements for handling payments. An auditable system of self-certification is usually in place to ensure these standards are satisfied. In addition, a range of contingency arrangements can be put in place to limit the impact of instances where a settlement bank is operationally unable to submit payments to the system. For example, there may be the opportunity for stricken settlement banks to send authenticated faxes to instruct the central bank to process manually a small number of high-priority payments.

Similarly, a variety of tools may be applied to address business risk in payment systems. Among these, perhaps the most obvious would be the application of capital requirements. These might be calibrated either to reduce the probability of insolvency; or to mitigate the impact by ensuring continuity of payments during the transition from insolvency of the incumbent provider to installation of a new provider.

Other remedies might include ensuring the bankruptcy-remoteness of key assets applied by the infrastructure provider or *ex-ante* measures to ensure that scheme participants stand ready to contribute financially, should business risk crystallise.

Governance and regulation of payment and settlement systems

² This risk might equally be considered a variant of settlement risk.

Various mechanisms are in place to ensure that these risks are managed and that desired risk mitigating measures are implemented. In particular, as noted, central banks typically assume a role in the oversight of payment and settlement systems, applying internationally agreed standards to the systems falling within their scope. And many central banks continue to exert influence via ownership of their country's large-value system, or the operation of key components of the infrastructure.

In **Part III**, then, we examine the various roles taken by central banks in pursuit of their risk-mitigating objectives. But rather than merely taking these roles as given, we take the opportunity first to explore the theoretical underpinnings of alternative regulatory and governance structures.

Alternative models for governance and regulation

Beyond the systemic risk externalities described in detail in Part II of this volume, the increasing returns to scale and network externalities that imply a tendency towards natural monopoly also have implications for decisions taken by infrastructure providers with respect to competition, access, pricing and innovation.

One potential mitigant here is mutual ownership, which is common in infrastructure provision. This can go some way towards ensuring that the system internalises a high proportion of the costs associated with the crystallisation of risks. However, there may be coordination failures among the owners, as well as potential spillovers beyond the immediate group of members to the wider economy. There may, then, be a case either for external stakeholder representation in governance, as suggested in Allen, Christodoulou and Millard (2006), or public intervention.

Issues around competition, access and innovation tend to be addressed by the competition authorities. The mitigation of systemic risk typically falls to the central bank in its financial stability role. The alternative measures employed by a central bank in addressing the potential sources of systemic risk are described in Part II.

Central bank roles in payment systems

Millard and Saporta (2007) examine closely the alternative roles a central bank might take to influence risks to financial stability posed by payment and settlement systems. They identify three principal vehicles for intervention:

- Public ownership: an ownership stake in the entity governing the payment system;

- Operation of the infrastructure: active engagement in the design, implementation and operation of all, or a sub-set, of the software, hardware, communication networks, data centres and contingency sites underpinning the system;
- Oversight of the system: day-to-day monitoring of system performance to ensure compliance with a set of minimum standards and design principles.

The authors note that ownership and oversight, if supported by adequate (perhaps legal) powers of enforcement, can be substitutes, with a pure oversight model overcoming potential issues around government failure and user-disengagement.

In practice, a variety of models of intervention are applied around the world, reflecting different legacy positions, different political economic environments, and different banking and financial structures. Models of oversight have, however, converged, with an increasing number of central banks assessing their systems against the best-practice guidelines laid out by the *Core Principles for Systemically Important Payment Systems* established by the Committee for Payment and Settlement Systems (CPSS) at the Bank of International Settlements (BIS (2001)). In partnership with the International Organisation of Securities Commissions, the CPSS has also established Recommendations for Securities Settlement Systems and Central Counterparties.

Future policy challenges for central banks

This convergence in standards for oversight in part reflects the evolution of the infrastructure landscape, and in particular, increasing international interdependencies. In **Part IV**, the final part of this volume, we survey the landscape to identify some of the important emerging themes in the early twenty-first century likely to pose regulatory and policy challenges for central banks in the future.

We first consider how the payments and settlements landscape is changing in response to the emergence of cheaper technologies, financial innovation, and new players. Developments here pose challenges in terms of setting the appropriate scope for central bank oversight, and ensuring a level regulatory playing field. We home in on two key drivers of change in the landscape: globalisation, which implies an increased emphasis on international cooperative oversight; and increased provision of infrastructure services by commercial banks, which implies a need for closer cooperation between overseers and banking regulators.

The market structure of the payment and settlement landscape and risk implications

As noted, strong network effects and a high fixed/low-marginal cost structure implies a tendency towards concentrated provision of payment and settlement services. This market structure can have systemic risk implications.

Two potential effects stand out: on the one hand, concentration implies greater ‘single point of failure’ risk, which may need to be addressed via enhanced resilience measures; on the other hand, with a wider network and a larger volume of payment flows passing through the system, liquidity risk in a concentrated system might be lower.

The single point of failure risks we have in mind here are, in essence, operational outage or financial failure of the infrastructure provider. With concentrated provision, the potential impact of crystallisation of such risks is commensurately higher. While the unit cost of resilience, either operational or financial, will be lower as the scale of an infrastructure provider’s operations increases, the private incentive to invest in risk mitigation may still lead to lower resilience than would be socially optimal. Stronger governance or public intervention may, in some cases, be required to raise standards.

Fish & Willison (2006) compare welfare outcomes in concentrated and competitive settings. They establish theoretically that concentrated provision can be socially preferable, provided the highest level of resilience from among otherwise competitive payment systems is adopted, and that issues around monopoly failure can be addressed through appropriate governance measures.

A fragmented market for infrastructure services is likely to have implications for liquidity risk. A bank participating directly in more than one system may face imperfectly correlated liquidity needs and, on occasion, a locational mismatch between its needs and its holdings. In these circumstances, participants either incur costs transferring liquidity/collateral to where it is needed, if this is even feasible intraday, or have to incur costs associated with delayed settlement or outright settlement failure. Were these fragmented systems to consolidate, such frictional costs could be avoided. Furthermore, concentrated provision, by increasing the volume of payments passing through the system, and expanding the network of potential connections, might also improve the efficiency of liquidity recycling, reducing the amount of up-front liquidity required to settle a given body of payments.

These issues have recently been brought to the fore by increased global integration of financial and banking markets. As a result, while, historically, financial infrastructure has typically evolved along national lines, cross-border alliances and mergers are becoming more common. The consolidation of several national central securities depositories to form the Euroclear Group is a recent example in this respect. Given cross-border consolidation in the banking industry, and an ever more integrated global capital market, market participants are increasingly organising their activities with an international focus. The financial infrastructure is adapting to meet these new demands and the regulatory community may need to adapt with it via cooperative international supervisory and oversight arrangements.

But, while the natural tendency may be towards concentrated provision of infrastructural services, regulatory intervention can open up the possibility of greater competition. At the start of the twenty-first century, incumbent providers of post-trade infrastructure are also being challenged by new entrants, particularly those able to clear and settle on an international, multicurrency basis. Indeed, with commercial bank providers perhaps better placed than central banks to provide multicurrency settlement, competition between commercial bank and central bank providers may well intensify.

This more competitive environment may be just a transitory phase, with natural monopolistic tendencies perhaps re-asserting themselves in time, but with ‘the market’ redefined on an international rather than a national scale. Nevertheless, if the US experience of recent decades provides a precedent, it may take a long time to reach a new equilibrium.

Globalisation of payments and settlement

The globalisation of banking is, in many ways, shaping the evolution of the infrastructural landscape. It is worth, therefore, spending some time considering the various policy issues that arise in this sphere.

The global integration of capital markets has spawned a small number of large internationally active financial groups, operating in many different markets and currencies. Facing a complex web of intraday and end-of-day cross-currency liquidity needs, an increasing number of these financial groups have responded via centralisation of the liquidity management function. That is, a central Group Treasury

takes responsibility for management of subsidiaries' liquidity needs, and coordinates the movement of liquidity, and collateral, across parts of the group. Under a decentralised approach, by contrast, each individual entity within the Group manages its liquidity needs independently without reference or recourse to other entities' needs or positions.

The primary motivation for a more centralised approach is the gain in cost-efficiency associated with management of liquidity on a group-wide basis. In the same way that concentrated provision of infrastructure can remove the frictions associated with fragmented pools of liquidity in otherwise separate systems, centralised liquidity management – effected either via recourse to foreign exchange swaps, or cross-border transfers of collateral – allows efficient liquidity-sharing among group entities. International groups may then be able to economise on normal-course holdings of liquidity.

In a model with optimising banks, Manning and Willison (2006) show that, even with an aggregate reduction in liquidity holdings, routine cross-border use of collateral can reduce liquidity risk in payment systems. However, this depends on imperfectly correlated liquidity demands across group entities: a bank facing correlated liquidity shocks – perhaps due to reputational contagion – would be left short of eligible collateral in at least one system. Schanz (2007) focuses on the greater informational efficiency of intra-group cross-currency lending, emphasising its value in stressed circumstances when there might be heightened asymmetric information in domestic interbank markets.

Global liquidity management implies a demand for arrangements that facilitate the cross-border transfer of securities and recycling of cross-currency liquidity surpluses. There have, therefore, been active calls to central banks to accept a wider range of foreign-currency collateral and to work with private providers to enhance infrastructural arrangements for mobilising such collateral.

And with a globally integrated capital market there may, over time, be increased demand for multicurrency settlement services. To the extent that central banks are constrained to offer settlement services in national currency, commercial bank providers may emerge as the only credible multicurrency settlement agents. To this

end, globalisation of the infrastructural landscape may entail a greater role for firms operating as infrastructure; this introduces a whole new set of risk issues.

Firms as infrastructure

Participants in a payment or settlement system hold accounts with the settlement agent, normally the institution in whose liabilities they settle claims on each other. These participants are generally banks, which in turn provide accounts and payment services to their own customers. However, not all banks are direct members of the payment system in which they need to send or receive payments, particularly where they operate outside of their home market. Rather, many seek to access a system indirectly by holding an account with a direct member (referred to as a settlement or correspondent bank).

Such 'tiered' membership of a payment or securities settlement system can be efficient from the point of view of liquidity usage. This is emphasised in several studies, including Kahn and Roberds (2005), Jackson and Manning (2007), Lasasosa and Tudela (2007) and Adams, Galbiati and Giansante (2007).

But, as Harrison et al. (2005) point out, such structures may introduce new sources of risk. For instance, relative to direct membership of an RTGS system settling in central bank money, tiered membership introduces credit risk exposures between correspondent banks and their customer banks: a correspondent bank assumes exposure to its customer in respect of intraday credit extensions; a customer bank assumes exposures in respect of balances held with its correspondent.

Liquidity dependencies are also important, with these also working in both directions: a customer bank is typically dependent on its correspondent for provision of liquidity in respect of payments made intraday in the system on its behalf in real-time; a correspondent is dependent on its customers in respect of inflows of liquidity which can then be recycled in execution of its own, or other customers', obligations.

There are also operational dependencies: a disruption to a correspondent's operations affects the ability of all of its customers to make and receive payments. And finally, firms operating as infrastructure are typically more susceptible to business risk: financial problems in these firms' other business lines might affect their capacity to continue to offer payment and settlement services.

Important questions arise as to how firms operating as infrastructure should be regulated. A firm providing correspondent banking services and internalising a significant portion of payments is, in essence, operating a payment system; similarly, a custodian bank internalising securities transactions is, to all intents and purposes, operating a securities settlement system. So, in respect of such segments of their business, shouldn't firms offering these services be subject to the same regulatory standards as traditional payment or settlement systems?