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Financial infrastructure and corporate governance

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Abstract

An essential part of the financial system is its infrastructure: for example, payment systems, securities settlement systems, central counterparties and messaging services. These enable transactions ranging from retail payments through to business in domestic and international wholesale financial markets. Given this, were any such system to fail, this could affect the whole economy. This threat to financial stability largely explains why central banks seek to ensure – via their 'oversight' role – that financial infrastructures take sufficient measures to mitigate risk. This paper explores the role of governance of infrastructures in the management of systemic risk. We do this by considering the case of a generic infrastructure provider operating under different forms of ownership. We show that, in the presence of consumption externalities, the level of risk mitigation chosen by the infrastructure provider is less than socially optimal. We then show that governance may have a role in adapting a provider's decision-making process to take due account of their risk externalities and, hence, provide a more socially optimal level of risk mitigation. Specifically, we suggest a feasible adaptation could be for infrastructures to appoint external stakeholder representatives to their boards with a specific remit to act in the wider public interest.

Summary

One of the core purposes of central banks is the maintenance of financial stability, which entails their detecting and working to reduce threats to the financial system as a whole. An essential part of the financial system is its infrastructure: for example, payment systems, securities settlement systems, central counterparties and messaging services. These enable transactions ranging from individual consumer payments through to transactions in both domestic international wholesale financial markets. Were any of these infrastructures to fail, the impact would affect the whole economy. Transactions might not be completed, or might be delayed, in turn hampering other transactions; problems in one area could spread rapidly beyond the original source. In other words, there is systemic risk in financial infrastructure. This threat to financial stability largely explains why central banks seek to ensure – via their 'oversight' role – that financial infrastructures take sufficient measures to mitigate risk.

In effective management of systemic risk, many aspects of the design and operation of an infrastructure play a role – among them, overall risk management (notably of credit, operational, liquidity and legal risks), the criteria for participation (defining which institutions can connect to the infrastructure) and system governance. This paper explores the role of governance of infrastructures in the management of systemic risk. If different governance arrangements of these infrastructures affect their incentives to mitigate such risk, then this should help overseers to advocate particular governance structures for financial infrastructures.

To analyse this question, we consider the case of a generic infrastructure provider operating under two different forms of ownership: owned by outside shareholders (and hence maximising profits); or operating as a mutual body of its users, following the arrangements commonly seen in the market for payment services. Intuitively, the mutual infrastructure provider may decide to commit more resources to risk mitigation, as it has a strong, direct incentive to avoid risks to its users' (and owners') own operations caused by problems in the infrastructure.

Nevertheless, from the perspective of the economy as a whole, this level of risk mitigation may still be inadequate. That is because the infrastructure provider may not take account of the infrastructure's malfunction on consumers in the wider economy. This is the disruption likely to be felt by individuals, households and companies very distant from the infrastructure's governance.

If a public authority wished to offset this underprovision of risk mitigation, there are several policies it could adopt. Along with the imposition of direct regulatory requirements, some combination of taxes, subsidies and disclosure standards are commonly considered in mitigating such problems. However, in practice we know there are cases where the information and policy levers to apply potential policies are lacking. In particular, policymakers may have few, if any, direct powers of enforcement over multinational infrastructures (which are becoming increasingly common).

Given that these 'traditional' ways of addressing inadequate risk mitigation might not be feasible in the case of financial infrastructure providers, particularly where these operate in many countries, we consider the alternative of placing external stakeholders on boards to act as 'guardians' of the public interest of systemic risk reduction. In effect, voting by these external stakeholders could re-weight the objectives of the firm to take into account any costs imposed on other sectors of an economy. There are, however, important caveats to this possibility – in particular, identifying appropriate individuals, designing their contracts and ensuring their voice is sufficiently recognised in the infrastructure's decision-making.

On balance, though, we conclude that external stakeholder representation may be a practical, first option in a limited toolkit. Even if formalised powers to address systemic risks in other ways ultimately came about, trying to maximise the results from this market-based route may at least offer a better starting point from which to take further decisions.

1 Introduction

One of the key roles of central banks is the maintenance of financial stability, which entails their detecting and working to reduce threats to the financial system as a whole. An essential part of the financial system is its infrastructure: for example, payment systems, securities settlement systems, central counterparties and messaging services. These facilitate transactions ranging from individual consumer payments through to transactions in wholesale financial markets, both domestic and international. Were any of these infrastructures to fail to operate as intended, the impact would be economy-wide. Transactions might not be completed, or might be delayed, in turn hampering other transactions; problems in one area could spread rapidly beyond the original source. In other words, there is systemic risk in financial infrastructure. This threat to financial stability largely explains why central banks seek to ensure – via their 'oversight' role – that financial infrastructures take sufficient risk mitigation measures.

In effective management of systemic risk, many aspects of the design and operation of an infrastructure play a role – among them, overall risk management (notably of credit, operational, liquidity and legal risks), the criteria for participation (defining which institutions can connect to the infrastructure) and system governance. This paper explores the role of governance of infrastructures in the management of systemic risk. If different governance arrangements of these infrastructures affect their incentives to mitigate such risk, then this fact should help inform the question of whether overseers should advocate particular governance structures for financial infrastructures.

Good governance practices are essentially a form of self-regulation. Aligning the incentives of the decision-makers within financial infrastructure with those of the public good could be used as a complement to informal oversight powers over infrastructures, potentially reducing or even eliminating the need for more formal regulation. This role for governance may prove particularly important where there are practical difficulties or limitations to central banks' formal oversight of particular infrastructures (for example, in the case of multi-jurisdictional entities).

The question of governance, including (as we show later in Section 2) its specific application to infrastructure, has received much attention in recent years. However, little work, if any, has been done on linking governance structure with the degree of systemic risk mitigation undertaken by a financial infrastructure. This may reflect, at least, an initial focus by overseers on more easily measured areas of risk management as oversight practices for infrastructures have developed. Although the optimal governance of infrastructure in the presence of wider, systemic risks has not been directly addressed in the academic literature, there has been considerable work on individual components of the question.

Since we can think of our question as being whether or not infrastructures put sufficient weight on the 'public good' of systemic risk mitigation, one relevant area of the academic literature is the study of public goods and externalities. The standard result is that private provision of public goods results in their undersupply. (See, for example, Atkinson and Stiglitz (1980), Myles (1995) and Falkinger *et* *al* (2000).) Another relevant strand of literature is network economics, as infrastructures are, by their nature, network markets. Economides (1996) discusses different network structures and the nature of the network externalities, which include systemic risk. A recurring issue in the network literature is that government intervention does not always improve social welfare. (See, for example, Shy (2001) and Katz and Shapiro (1994).) As argued by White (1995), there are several reasons why official intervention can fail to achieve the intended outcomes; intervention – if any – must depend on the nature of the market failure.

Several of these issues come together in a paper by Martin and Orlando (2004), in the context of looking at the incentives for members of a payment service network to invest in cost-reducing innovation. They show that while network externalities can lead to a bad equilibrium of suboptimal investment, the introduction of a 'co-ordinator' (perhaps a central bank in the case of payments) to invest on behalf of members can result in a more optimal equilibrium. Moreover, this equilibrium is more readily achieved under mutual ownership of the infrastructure by its members than under private ownership.

The literature on representation and reflection of preferences may inform our concern that infrastructures' decision-making regarding prioritisation of systemic risk mitigation should encompass the wider public interest. Dewatripont and Tirole (1994) discuss such issues in the context of the representation problems depositors face with respect to banks. The issue of preferences is also central to Hart and Moore's (1995) comparison of decision-making in a co-operative and an outside-owned, profit-maximising organisation, where they show that both structures can make inefficient decisions.

In this paper we consider the case of a generic infrastructure provider operating under different forms of ownership. One possibility is for it to be owned by shareholders. Alternatively, it could operate as a mutual body of its users, the arrangement commonly seen in the market for payment services. Intuitively, the mutual may decide to commit more resources to risk mitigation, as it has a strong, direct incentive to avoid risks to its owner/users' own operations caused by problems in the infrastructure.

Nevertheless, from the perspective of what is socially optimal, this level of risk mitigation may still be inadequate. This is because the negative effects of the infrastructure's malfunction on consumers in the wider economy may be insufficiently weighted. This is the disruption likely to be felt by individuals, households and companies very distant from the infrastructure's governance. To bring investment in risk mitigation up to a socially optimal level, it needs the preferences of those in the wider economy somehow to be translated into the resource allocation decisions of the infrastructure.

If a public authority wished to offset this underprovision of risk mitigation, there are in principle several policies it could adopt. For example, along with the imposition of direct regulatory requirements, some combination of taxes, subsidies and disclosure standards are remedies commonly considered in mitigating such problems. However, in practice, we know there are cases where the information and policy levers to implement potential remedies are lacking. In particular, policymakers may have few, if any, direct powers of enforcement over multinational infrastructures (which are becoming increasingly common).

It is here we argue that governance may have a particularly significant role in adapting an infrastructure's decision-making process to take due account of their risk externalities and, hence, provide a more socially desirable level of risk mitigation. One possibility could be for infrastructures to appoint external stakeholder representatives to their boards who would in some sense act as 'guardians' of the wider public interest. In effect, voting by these external stakeholder representatives could re-weight the objectives of the firm to take into account costs imposed on other sectors of an economy. There are, however, important caveats to this possibility – in particular, identifying appropriate individuals, designing their contracts and ensuring their voice is sufficiently recognised in the infrastructure's decision-making. Nevertheless, it may provide a useful complement to formal regulation.

The structure of the paper is as follows. The next section considers some recent governance initiatives and discusses the range of governance structures seen in financial infrastructure providers. Section 3 presents a model that can be used to address the issues raised in the above discussion. Section 4 discusses, in the context of the model, different ways of addressing the systemic risk imposed by the infrastructure provider and the final section concludes.

2 Governance and infrastructures today

2.1 Best practice

Best practice recommendations for corporate governance have grown in both number and detail over the past decade, many arising as a response to perceived governance failings. In the United Kingdom, the first such code was the Cadbury Report (1992), which was followed and developed by a number of other initiatives, several of which were brought together under the 'Combined Code on Corporate Governance' (updated 2003).(1) Many other countries have similarly developed their own codes or regulations in the area of governance.(2) Common elements of good governance are brought together in the OECD's Principles of Corporate Governance (2004, revised).

As most such codes are intended to encompass a variety of ownership structures, they are necessarily fairly general. Nonetheless, some themes emerge in the areas of board structure and the public interest that are relevant to this paper. In particular, the potential value of independent participants in decision-making and corporate monitoring is highlighted in several codes. For example, some call

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(1) The Cadbury Report can be found at www.ecgi.org/codes/documents/cadbury.pdf and the Combined Code can be found at www.ecgi.org/codes/documents/frc_combined_code_june2006.pdf.
(2) There is a listing of governance codes for each country along with international codes on the website of the European Corporate Governance Institute – www.ecgi.de/codes/all_codes.php.

for independence of the chair of the audit committee, and also for the chairman of the board. Moreover, some recommendations advocate the role of independent directors on the board, for example, the OECD Principles of Corporate Governance and the UK Combined Code on Corporate Governance.

There are also a growing number of best practice recommendations specifically designed for financial infrastructures. Within these, the question of governance features prominently. Notably, several recommend the independence of some board members. There is also explicit recognition that decision-making should consider the public interest. An early such set of recommendations were the BIS (2001) Core Principles developed for systemically important payment systems. These state the 'system's governance arrangements should be effective, accountable and transparent', with mechanisms for ensuring independent oversight of management. They also advise that governance arrangements should be 'accountable to the wider community of users'. European Central Bank (2003) adapted the above principles for euro retail payment systems saying 'arrangements should provide proper incentives for management to pursue objectives that are in the interests of the system, its participants and the public more generally'. Broadly similar governance principles also feature in recommendations for other financial infrastructures, including the CPSS/IOSCO recommendations for securities settlement systems and central counterparties, the G30 recommendations for clearing and settlement, the ESCB-CESR standards for securities settlement systems in the European Union and the European Commission's communication on clearing and settlement in the European Union.

2.2 Current arrangements

Governance arrangements for existing financial infrastructure differ significantly, both across different infrastructure types and within the same kinds of infrastructure. Table A summarises the position for a selected set of infrastructures along two dimensions: ownership and independent board representation. Of course, there is fuzziness about both definitions: the degree of restriction of share ownership and the degree of independence of board representatives can both be thought to lie on a spectrum. For the purposes of constructing Table A we have relied on the annual reports of the infrastructures themselves. Several points emerge:

- It is common to see restricted ownership of infrastructure, either through restricted shareholdings or, in particular, mutuality. This is especially the case for payment systems, many of which are user-owned co-operatives.

- Independent representation on the board is more common when there is some outside ownership. Independent representation is rare among user-owned co-operatives.

- Among those infrastructures with independent board representation, there is a significant degree of variation in their numbers relative to the full board.

Table A: Governance structures and board size for selected financial infrastructures in 2004

	General Shareholder	Restricted Shareholder	Member Owned	Public Sector
Independent Board Members	*Clearing Houses:* CME Clearing (20/11), Eurex Clearing (9/9) *Settlement Houses:* Clearstream (6/0, 21/21)	*Clearing Houses:* CC&G (9/?), LCH.Clearnet (19/3) *Settlement Houses:* Euroclear Group (26/26), Monte Titoli (9/?) *Payment Systems:* LINK (21/1)	*Clearing Houses:* NYMEX Clearing (24/5)	
No Independent Board Members	*Clearing Houses:* TCC (9)	*Clearing Houses:* NSCC (21) *Settlement Houses:* DTC (21) *Payment Systems:* CLS (26)	*Payment Systems:* CHAPS (18), EURO1 (15), Visa (22), MasterCard (20), CHIPS (10) SWIFT[(a)] (25)	*Payment Systems:* Fedwire (7), RTGSplus (8) TARGET (18) BOJ-NET (9)

Source: Annual reports.

Notes: Figures in brackets denote number of Board members/of which independent Board members.

(a) SWIFT is not a payment system; however, since it provides the messaging service and interface software used by payment systems it is considered a systemically important infrastructure provider.

To conclude this brief discussion, it seems there is divergence between governance arrangements observed in some financial infrastructure and what is seen as current governance ‘best practice’. Specifically, several infrastructures have no independent directors on their boards and hence may be limiting the extent to which the wider public interest features in their decision making. The next section of this paper explores this issue more formally. It develops a model of an infrastructure operating under different governance arrangements and explores under what circumstances the different arrangements may be appropriate. In other words, the paper suggests an analytical framework to help suggest optimal governance choices given the characteristics of infrastructure arrangements.

3 The model

To explore the link between governance arrangements and infrastructure characteristics, we develop a model that comprises three sets of agents. First, there are consumers, who derive utility from making transactions but experience disutility from the risk that their transactions fail. Second, there is a provider of financial infrastructure – for which we use the example of a payment system. And between these, there is a bank. The bank is a profit maximiser, offering consumers access to payment services, the costs of which are directly related to the level of risk in the infrastructure provider.

Within this model there are two externalities. One is imposed by the infrastructure provider on the bank; say some failure or malfunction in its processing – meaning the bank needs to have contingency arrangements to offer some payment services in the event of such problems. This is a 'production externality'. There is also a 'consumption externality', in that problems with payment services could additionally impose costs on consumers who need to make payments. The model is explained in more detail below.

3.1 The basic model

We assume that there is a unit continuum of identical consumers who obtain utility out of consumption. Consumption is enabled by making payment transactions. So the greater number of transactions, the greater is consumer utility. The number of transactions made by agent i is denoted as q_i. Each transaction has to be made via the bank (which in turn passes the transactions on to the infrastructure) which charges the consumers a cost p per payment, thus reducing their utility. So the total cost of making q_i payments is pq_i.

Consumers also obtain disutility out of 'risk', R. We think of R as the probability of delayed or cancelled transactions. The consumer will experience inconvenience and additional costs caused by the payment system not functioning perfectly. For example, the greater the risk of problems in the payment service, the more cash consumers will hold as a buffer, which itself will have an (opportunity) cost. Consumers may have to seek some alternative, more costly, way of conducting transactions. And if they are unable to make a transaction, they may lose utility being unable to consume something they particularly desire – for example they may miss a 'one-off' opportunity to make a purchase of some item that is rarely available. We assume that the consumers are unable to contract with either the bank or the infrastructure on the level of risk that will be attached to the payments they wish to make. So, the externality of systemic risk imposed by the infrastructure on consumers can be thought of as arising from a 'missing market' in systemic risk.

Another possible interpretation of our utility function is to think of it as a 'mean-variance' function where q is the mean of consumption (transactions made on average) and R is the variance (a 'riskier' system being one where problems could lead to a dramatic reduction in the number of transactions going through in a particular period).

We assume that the representative consumer's utility function takes the following specific functional form:

$$U(q,R) = -aq^2 + bq - cR - dR^2 \quad \textbf{(1)}$$

For simplicity, we have assumed that utility is separable in q and R. This assumption means that the consumers' decision about the number of payments, q, will be independent of the level of risk, R. Put another way, consumers get disutility from R, regardless of the number of payments they make. Our justification for this is that consumers are also mindful of incoming payment, so experience disutility from problems in the payment service whether or not they make payments themselves.

The representative consumer takes risk, R, as exogenously given and chooses the quantity of payments he wishes to make, q, in order to maximise $U(q,R) - pq$. The first-order condition for this problem implies:

$$-2aq + b - p = 0 \quad \textbf{(2)}$$

Aggregating over consumers implies the following demand curve for transaction services from the bank:

$$q = \frac{b-p}{2a} \quad \textbf{(3)}$$

At the other end of the chain, we have a monopoly infrastructure providing the transaction services to the bank. It chooses the price it charges per transaction, p_I, and the level of risk at which it operates, R, in order to maximise profits. We assume that the infrastructure's cost function is of the form:

$$C(q,R) = -\zeta R + \phi R^2 - \gamma q^2 + \eta q \quad \textbf{(4)}$$

where q is the total number of transactions made in the system. The idea here is that the infrastructure can reduce the level of risk by spending money (on, say, risk-mitigating technology). If it makes no investment in risk reduction, then the system will have its maximum level of risk (which, if we normalise to unity, implies $\zeta = \phi$). We think of risk mitigation as essentially a fixed cost to the infrastructure, for example taking the form of investment in a contingency site, the effect of which is to reduce the value of R irrespective of the level of transactions put through the system.

If we denote the inverse demand curve for payments by $p_I(q,R)$, then we can write the infrastructure's problem as:

$$\underset{q,R}{Max}\ p_I(q,R)q - C(q,R) \quad \textbf{(5)}$$

Finally, we assume that there is a monopoly bank offering transaction services to consumers. While this assumption is partly made for simplicity, the monopoly structure seems appropriate given that competition between banks does not appear primarily focused on basic payment services; consumers typically receive standard payment services as part of a bundled current account package so are unlikely to switch from one bank to another based on a decision purely about these payment services. In other words, banks have local monopoly power in payment services over the consumers they serve. In the model, the bank's problem is to maximise profits, obtained by charging consumers a mark-up on the price the infrastructure charges it for each transaction made.

But we also assume that the activities of the infrastructure provider pose a 'production externality' on the bank's ability to provide transaction services to its customers. In particular, we assume that the total cost of providing transaction services for the bank will not only be the direct cost it is charged by the infrastructure but will also depend on the level of risk in the infrastructure. We can think of this as the amount the bank needs to invest in contingency arrangements enabling it to make payments even if there are problems with the infrastructure. We assume that such investment will depend on the level of risk in the infrastructure, R, and will be unrelated to the number of payments. We could think of this as, for example, the cost of setting up a manual process for making payments without the infrastructure or the cost of access to some other infrastructure. Alternatively, we could think of this externality arising from the fact that a more risky infrastructure means the bank will have to explain payment delays to its customers more often with an associated 'loss of goodwill'. For example, even if the customers have no alternative for core payments, they may be disinclined to make additional payments and may no longer come to the bank for additional financial services – which ultimately reduces the bank's profitability. Again, we assume that the bank is unable to contract with the infrastructure provider over a particular level of systemic risk; the externality results from there being a 'missing market' for systemic risk.

We assume the following functional form for the externality imposed by the infrastructure on the bank:

$$\Theta(q,R) = \alpha R + \beta R^2 \quad \textbf{(6)}$$

Putting all this together enables us to write the monopoly bank's problem as:

$$\underset{q}{Max}\ pq - p_I q - \alpha R - \beta R^2 \quad \textbf{(7)}$$

subject to its demand curve (equation **(3)**) and the level of risk imposed by the infrastructure provider, which the bank takes as given.

The first-order condition for this problem implies the following inverse demand curve for transaction provision by the infrastructure:

$$p_I = b - 4aq \tag{8}$$

The sequence of events is as follows. The infrastructure provider chooses the level of risk at which it will agree to settle payments and the price it charges per payment to do so. The bank observes this price and sets the price per payment at which it will offer to settle payments on behalf of consumers. The consumers then decide how many payments they want to make and the bank puts these through the infrastructure.

If we now solve the problem for the infrastructure provider – choosing its output and level of risk so as to maximise profits as given by equation **(5)** – we obtain the results that:

$$q = \frac{b-\eta}{2(4a-\gamma)} \tag{9}$$

and $$R = \frac{\zeta}{2\phi} \tag{10}$$

3.2 The social optimum

In this subsection, we solve the problem faced by a social planner, which gives the socially optimal level of payment transactions and risks. Given our set-up, such a social planner would choose the number of transactions, *q*, and the level of risk in the system, *R*, in order to maximise the sum of consumers' utility, the bank's profits and the infrastructure provider's profits:

$$U(q,R) - \Theta(q,R) - C(q,R) = -(a-\gamma)q^2 + (b-\eta)q - (\phi+\beta+d)R^2 - (\alpha+c-\zeta)R \tag{11}$$

The first-order conditions for this problem imply:

$$q = \frac{b-\eta}{2(a-\gamma)} \tag{12}$$

and $$R = \frac{\zeta - c - \alpha}{2(d+\phi+\beta)} \tag{13}$$

In order to ensure an interior solution for the optimal level of risk in the system, we assume that $\zeta > c + \alpha$. Comparing equation **(13)** with equation **(10)**, we see that the social optimal level of risk is lower than the level that will prevail in the benchmark case outlined in the basic model. The intuition is that the infrastructure provider does not take into account the negative externality that it imposes on both the bank and the consumers when solving its profit maximisation problem; hence, it will generate an excess level of risk relative to the social optimal.

3.3 Mutual ownership of the infrastructure

Now we suppose that the bank takes over the infrastructure and operates it as a mutual.[(4)] As such the mutual will choose the number of transactions, *q*, and the level of risk in the system, *R*, so as to maximise the sum of the bank's profits and those of the infrastructure. So its problem is:

$$\underset{q,R}{Max}(b - 2aq)q + \gamma q^2 - \eta q - \phi R^2 - \beta R^2 + \zeta R - \alpha R \quad \textbf{(14)}$$

The first-order conditions for this problem imply:

$$q = \frac{b - \eta}{2(2a - \gamma)} \quad \textbf{(15)}$$

$$R = \frac{\zeta - \alpha}{2(\phi + \beta)} \quad \textbf{(16)}$$

Comparing equation **(16)** with equations **(13)** and **(10)** we see that the level of risk generated by a mutually owned provider of financial infrastructure is lower than the level that will prevail in the benchmark case outlined in the basic model. However, it is still higher than the level of risk that is socially optimal. Similarly, the number of transactions, *q*, have risen relative to the benchmark case but are still lower than in the social optimum. The intuition is that by taking over the infrastructure provider, the bank is able to internalise the production externality imposed by the infrastructure provider but will still not take into account the negative consumption externality that it imposes on the consumers. This is analogous to results found for the so-called 'double-marginalisation' problem (see for example Vernon and Graham (1971), Schmalensee (1973) and Blair and Kaserman (1978)).

We can note that the difference between social welfare in the world of the mutualised infrastructure provider, W_{Mut}, and that in a world with a monopoly bank and a monopoly infrastructure provider, W_{Mon}, will be given by:

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(4) Here, our monopoly assumption implies that 'mutualisation' means that the bank and infrastructure operate as a combined arrangement, under single ownership. Mutualisation in payments arrangements more commonly describes arrangements where multiple users (banks) collectively own the infrastructure.

$$W_{Mut} - W_{Mon} = \frac{a^2(5a-2\gamma)(b-\eta)^2}{(2a-\gamma)^2(4a-\gamma)^2} + \frac{(\beta\zeta + \alpha\phi)[\beta\zeta(d+\beta+\phi) + d\phi(2\zeta-\alpha) + \phi(\beta+\phi)(2c-\alpha)]}{4\phi^2(\beta+\phi)^2} > 0 \quad \textbf{(17)}$$

Welfare is lowest in the benchmark case outlined in our basic model and is higher – while still being lower than optimal (W_{Max}) – in a world with a mutually owned infrastructure provider. The intuition again is that the infrastructure provider does not take into account the externality that it imposes on both the bank and the consumers when deciding on the level of risk to generate; it simply considers the effects of generating a given level of risk on its own profits. The negative production externality can be internalised through mutual ownership but the negative consumption externality would still remain.

$$W_{Max} - W_{Mut} = \frac{a^2(b-\eta)^2}{4(a-\gamma)(\gamma-2a)^2} + \frac{(d(\zeta-\alpha) + c(\beta+\phi))^2}{4(\beta+\phi)^2(d+\beta+\phi)} > 0 \quad \textbf{(18)}$$

Examining the difference between the social optimum level of welfare and the level of welfare that would prevail in the mutual case (equation **(18)**), we see that this difference is strongly affected by the relative strength of the production and consumption externalities which the infrastructure imposes on the bank and consumers respectively. If the production externality is large relative to the consumption externality then mutualisation will increase welfare to close to that obtained in the social optimum. This is because mutualisation will effectively internalise the larger part of the problem. In the opposite case (where the consumption externality is larger), mutualisation would not raise welfare by much and something more would be needed to help offset the problem faced by consumers.

We have discussed the model using the illustration of the infrastructure provider being a payment system. Looking at payment systems' actual governance (Table A), member ownership – mutualisation – seems to be a very common arrangement. According to the model's results, if the production externality in payment systems is relatively large, then it may be that such infrastructures are already close to the social optimum. In some other financial infrastructures – such as clearing houses and settlement systems – it may well be that the production externalities are not large and the consumption externalities are much more important, suggesting that there would not be much social gain (and possibly some loss) from encouraging such infrastructures to mutualise.

However, even in cases where mutualisation is beneficial, an issue for policy remains of how to reduce the consumption externality to achieve the first best, socially optimal outcome. This is discussed in the next section.

4 Addressing the consumption externality

As we said in the previous section, insufficient resources may be devoted to controlling systemic risks by providers of financial infrastructure. The cause of this problem is the market failure that arises from underprovision of a public good: that of resources allocated to systemic risk mitigation. In this section, we assess various strategies that have been used to address similar problems in other industries and consider whether these might be applicable in our particular case. We examine the advantages and disadvantages of each approach before going on to consider whether 'governance' can be used as a policy tool.

Systemic risk concerns in financial institutions are typically addressed by **direct regulation**. For instance, there is prudential regulation of banks (plus safety nets – deposit insurance and the role of a Lender of Last Resort), and of some other financial institutions. Where institutions have international operations, there are procedures for the role of home and host regulators, and co-operation between regulatory agencies, although these are not watertight. For payment systems, direct 'regulation' takes the form of oversight by central banks. Clearing and settlement infrastructure also have direct supervision (eg by the Financial Services Authority in the United Kingdom). In the non-financial sector, critical utility infrastructures often have tailored regulatory processes designed to address multiple potential problems including risks, investment, pricing and competition. For example in the United Kingdom Ofgem is the dedicated regulatory body of the gas and electricity industries.

However, there are several reasons why statutory regulatory powers may not always prove an effective solution. Direct responsibility, and the potential liability on the regulators, may weaken market discipline and create moral hazard. And, for international infrastructure providers, any arrangements involving multiple authorities and jurisdictions carry particular practical difficulties; agreement and consensus can be hard to achieve. The information available may be inadequate fully to inform decisions and regulators may lack the necessary expertise. In short, for some providers of financial infrastructure direct regulation is not currently possible. And even if it were, it may not sufficiently address the concerns.

In terms of the model in the previous section, direct regulation of the mutual infrastructure provider would require it to set the level of risk to the social optimum:

$$R = \frac{\zeta - c - \alpha}{2(d + \phi + \beta)} \qquad \textbf{(19)}$$

However, this shows how high are the information requirements to achieve this. In particular and in addition to knowing the utility function of the consumers on whose behalf it was acting (c and d), the regulators would need to know the parameters of the infrastructure's cost function (α and β) as well as those of the externality imposed on the bank by the infrastructure (ζ and ϕ).

The regulated infrastructure's problem is now:

$$\text{Maximise } p(q, R_{Max})q - C(q, R_{Max}) - \Theta(q, R_{Max}) \qquad \textbf{(20)}$$

Solving this problem implies:

$$q = \frac{b - \eta}{2(2a - \gamma)} \neq q_{Max} \qquad \textbf{(21)}$$

meaning that regulation of risk alone is insufficient to achieve the socially optimal outcome (equation **(12)**). Price regulation would be also required – but to regulate *both* these would effectively be equivalent to a regulator assuming control of the infrastructure. In this case, the problems described above associated with direct regulation would loom even larger.

An alternative to direct regulation would be to **tax the infrastructure**, with the intention of discouraging the 'production' of excessive risk. In terms of the model, the infrastructure's problem would become:

$$MaxP(q, R)q - C(q, R) - \Theta(q, R) - \tau R \qquad \textbf{(22)}$$

where the latter term represents a tax on each unit of risk. Comparing the resulting first-order conditions with the optimal outcome yields the result that:

$$\tau = c + \frac{d(\zeta - c - \alpha)}{d + \phi + \beta} \qquad \textbf{(23)}$$

ie setting the tax level requires information on the weighting of risk in the utility function and on the optimum level of risk.

While taxes are a common response to an externality (for example, to discourage pollution), there are several reasons why this route seems problematic in the case of financial infrastructure. It would not be easy to decide the amount of the tax (the problem of knowing the value of τ derived above), or to monitor its continued effectiveness. Taxes may create incentives for users to stop using the infrastructure altogether and use alternative, possibly riskier, means of conducting transactions. Such a tax might also create a disincentive for the infrastructure to manage itself appropriately if it lessens concerns about effective systemic risk control. There may be no powers to impose a special tax on the infrastructure, particularly if it operated in several countries. And even if it were possible to impose such a tax internationally, governments would have to decide how to apportion the tax revenue between countries.

Paying the infrastructure provider a **subsidy** to reduce risk is another way to approach the problem. If the subsidy, *s*, is paid per unit of risk reduction (ie the mirror of the linear tax structure above), the mathematical outcome is the equivalent of equation **(23)**, ie

$$s = c + \frac{d(\zeta - c - \alpha)}{d + \phi + \beta} \qquad \textbf{(24)}$$

However, very similar disadvantages to those of taxes also apply to the subsidisation approach. These include the difficult decisions about setting the amount of the subsidy, including how to apportion it between countries in the case of infrastructures operating internationally. The paying of a subsidy could create a disincentive for the infrastructure provider further to improve risk management.

Another option is to make the infrastructure **disclose fuller information** on risks and controls, with the intention of helping users make informed decisions and contributing to pressure on management to improve risk control. Transparency is an area open to suasion by overseers, even in the absence of formal powers. However, even if the information disclosed convinced users/others there was a problem, resultant action (eg via pressure on management to enhance systemic risk mitigation) may prove slow and limited. In particular, the fact that the benefits of systemic risk mitigation accrue to all consumers and not just those individuals putting pressure on the management to enhance risk mitigation – ie that it is a 'public good' – means that the incentives for any single consumer will lead to him exerting insufficient pressure on the infrastructure provider even if the infrastructure provider were completely transparent.

None of the above routes appear to completely mitigate the systemic risk problem, though oversight and information disclosure offer ways of improving the situation relative to the market outcome. Also, our model shows that mutual ownership may in itself go some way to addressing some of the systemic risk concerns; governance is playing a role.(5) Analysing the **governance** route further in this model may offer a way forward in adapting the decision-making structures so that due account is taken of systemic risk as a route to help to address the market failure.

One obvious route could be to place overseers/regulators on boards.(6) However, this may not be viable in all cases – for the same reasons that make direct regulation/control problematic. Notably, it is strongly interventionist and may require powers to effect, though the company may accept the change voluntarily if it sees it as the least bad option, say, as an alternative to formal regulation. For

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(5) This is in contrast to the approach adopted by exchanges, many of which chose to demutualise over the past decade, largely to facilitate faster response to increasingly competitive market conditions. (See Williamson (1999).) However, the nature of risk in exchanges is different from infrastructure such as payment and settlement systems: particularly in that their operations do not necessarily carry systemic implications.

(6) In some cases, central banks do sit on the boards of payment systems as a result of their being one of the users who own the system.

the company and wider users, it can create moral hazard by providing a false comfort. It also risks the overseer/regulators losing their advantage of objectivity if they become closely associated with any successes and failures of the infrastructure. Finally, it leaves open the potential for conflicts of interest between the board member's responsibility to promote the good of the company and any responsibility he might have to the overseer.

Another, less interventionist, possibility in the use of governance is to encourage infrastructures to adopt a wider objective that includes the interests of all stakeholders, including systemic risk considerations and their boards to appoint external stakeholder representatives, specifically charged with representing the interests of consumers. Overseers' influence may prove sufficient to persuade boards to make this change. Indeed, this may well be a change they wish to make, particularly as best practice is moving in that direction and such a change, by acting as a form of 'self-regulation', may reduce the need for separate formal regulation or oversight. Independent directors – whether or not they were specifically charged with representing external stakeholders – could bring greater market expertise than overseers. Appointing external stakeholder representatives is a route for addressing the systemic risk externality that is broadly compatible with the principle of market solutions.

One way of thinking about this approach in the context of our model is to assume that the external stakeholder representatives have a weight of λ in company decision-making and maximise the utility of the representative consumer. In some cases, λ may be interpreted as simply the proportion of the vote controlled by such directors, translating directly into their influence on company decision-making. In other cases, the relationship between the number of votes of external stakeholder representatives and their ultimate influence on company decisions may be more complex; for example, they may carry more weight in influencing decision than their number of votes might suggest, perhaps because they are able to convince others of their arguments, or possibly because not all decisions are put to a formal vote. We can note that we are ignoring issues surrounding the 'principal-agent' structure, of board members (agent) acting on behalf of stakeholders (principals) and the consequential issue of how to align their actions and preferences respectively.

Given these assumptions, the problem for a mutualised provider of infrastructure becomes to choose q and R in order to:

$$\begin{aligned} Max(1-\lambda)\Big(&(b-2aq)q-\alpha R-\beta R^2-\eta q+\gamma q^2+\zeta R-\phi R^2\Big) \\ &+\lambda\Big(bq-aq^2-cR-dR^2-(b-2aq)q\Big) \end{aligned} \quad \textbf{(25)}$$

The first-order conditions for this problem imply:

$$q=\frac{(1-\lambda)(b-\eta)}{2(1-\lambda)(2a-\gamma)-2a\lambda} \quad \textbf{(26)}$$

and $$R = \frac{(1-\lambda)(\zeta-\alpha)-\lambda c}{2((1-\lambda)(\beta+\phi)+d\lambda)} \qquad \textbf{(27)}$$

Comparing these with equations **(12)** and **(13)**, we see that the optimal outcome is achieved provided the external stakeholder representatives have a weight of a half in company decision-making. In practice, it would be unlikely that external stakeholder representatives would ever be granted so much power to affect the decisions made by firms. However, we can note that the presence of such representatives with some degree of bargaining power ($\lambda > 0$) moves the situation closer to the optimal outcome ($\lambda = ½$), with the degree of improvement affected by their bargaining power. We can also note that, in the unlikely case of their becoming too powerful ($\lambda > ½$) we would end up with an inefficient level of risk.

Though the appointment of external stakeholder representatives to the boards of financial infrastructures can help obtain a better outcome from a social welfare point of view, in practical terms, we recognise that the role they could play in systemic risk mitigation is far from being a panacea. For example there are serious challenges to be addressed, such as in finding and appointing individuals who could perform this role and in their subsequent monitoring. And we have not discussed how they could achieve a given level of influence in decision-making (in other words, how λ is determined). There are no easy solutions to these practical issues and how best to go about solving them is left as an area for further work.

5 Conclusions and areas for future work

In this paper we consider a model of a generic financial infrastructure provider operating under different forms of ownership: profit-maximising on behalf of its shareholders or maximising the total profits of its users via mutualisation, the arrangement commonly seen in the market for payment services. Intuitively, the mutual may decide to commit more resources to risk mitigation, as it has a strong, direct incentive to avoid risks to its owner-users' own operations caused by problems in the infrastructure. Our model suggests that welfare under outside ownership of the infrastructure is, indeed, smaller than welfare under mutual ownership; this, in turn, is smaller than the level of welfare achieved in the social optimum. In both cases, this results from the externality of systemic risk in the system. If the production externality is large relative to the consumption externality then mutualisation will increase welfare to close to that obtained in the social optimum. This is because mutualisation will effectively internalise the larger part of the problem. In the opposite case (where the consumption externality is larger), mutualisation would not raise welfare by much and something more would be needed to help offset the problem faced by consumers. Looking at payment systems' actual governance (Table A), member ownership – mutualisation – seems to be a very common arrangement. According to the model's results, if the production externality in payment systems is relatively large, then it may be that such infrastructures are already close to the social optimum. In some other financial infrastructures – such as clearing houses and settlement systems – we more commonly see some form of shareholding arrangement (Table A). It may well be that the production externalities are not large and the consumption externalities are much more important, suggesting that there would not be much social gain (and possibly some loss) from encouraging such infrastructures to mutualise.

The fact that mutualisation on its own does not result in the social optimum implies the need to alter the objective function of the mutually owned infrastructure provider in such a way as to achieve the social optimum. That is, there is a need for policy intervention in order to correct the consumption externality. Our analysis suggests that several 'traditional' ways of addressing externalities might not be feasible in the case of financial infrastructure providers, particularly where these operate in many countries, and, where they were feasible, they would be unlikely to fully eliminate the externalities given the information requirements that would be needed to do this. We then look at the alternative of placing external stakeholder representatives on boards to act as 'guardians' of the public interest of systemic risk reduction. We find that this does appear to offer the possibility of a workable solution, both in the model and in the prospects for its actual implementation. In particular, such a solution could act as a form of self-regulation, potentially reducing or even eliminating the need for more formal regulation. Of course, there are a number of reasons to think that the practical implementation of placing external stakeholder representatives on boards would not be completely straightforward, and that carrying out the proposal would not completely eliminate systemic risk. This suggests an ongoing need for some form of oversight.

Although we believe that our model has been useful in providing a first pass at answering the question of how governance of infrastructure providers might be related to systemic risk, there is clearly plenty of room for future work in this area. Financial infrastructure provision is an example of a network industry in the sense that the utility to consumers resulting from making payments through a particular system is related to the number of other consumers who are hooked up to the system. In future research, we aim to examine how these network effects in financial infrastructure affect the structure of the market for financial infrastructure provision and, hence, risk mitigation by financial infrastructure providers. It would also be interesting to allow for different banks having different bargaining power in relation to decisions taken by a mutually owned infrastructure provider. In addition, we might allow banks to internalise the costs of systemic risk to different degrees. Again, we leave this 'political economy' issue for future work.[7]

To conclude, in this paper we find that external stakeholder representatives may be a feasible, first option for dealing with the externality of systemic risk in financial infrastructure provision within a limited toolkit. Even if formalised powers to address systemic risks in other ways ultimately came about, attempting to maximise the results from this market-based route may at least offer a more appropriate starting point from which to take further decisions.

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